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GOVERNMENT

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FIGHTING CLIMATE CHANGE AND EMBRACING RENEWABLES

FIGHTING CLIMATE CHANGE IS NO LONGER AN EXPENSIVE HOBBY FOR THE RICH. RATHER, EMBRACING RENEWABLES WILL MAKE EVERYBODY RICHER, SAYS THE DANISH MINISTER FOR ENERGY, UTILITIES AND CLIMATE, LARS CHRISTIAN LILLEHOLT

IN THIS ISSUE

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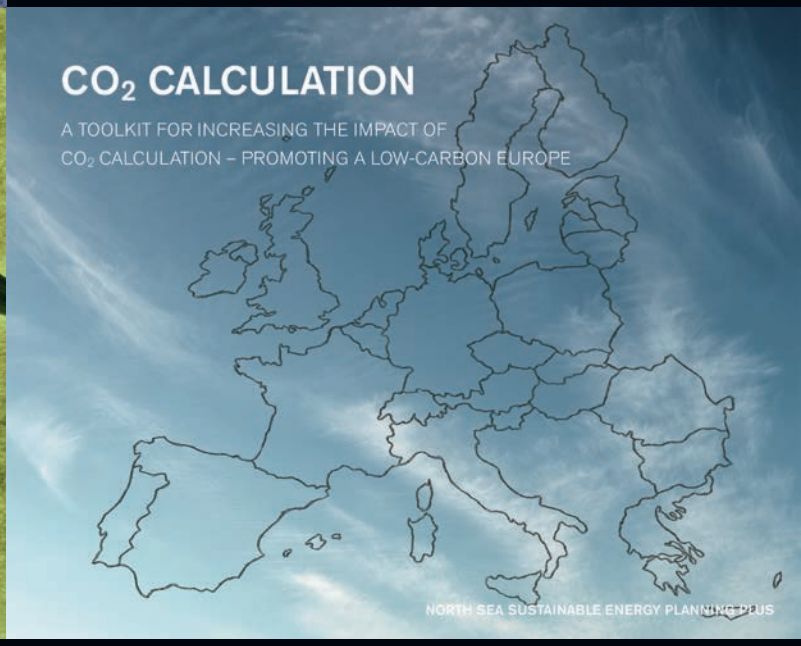
TO DO

DEVELOPMENT OF CULTURAL AND CREATIVE INDUSTRIES IN PRACTICE

Welcome to a handbook that addresses you who work with regional development of cultural and creative industries! For example you, Eva Leemet at Creative Estonia or you, Michal Hladky at Kosice 2013, or you, Jone Zubiaga at Creativity Zentrum in Bilbao who showed great commitment and interest in this method handbook. We are writing for people like you who create fertile ground.



GREEN SHIFT

A HANDBOOK FOR ENVIRONMENTALLY FRIENDLY REGIONS IN EUROPE

This book is about the challenges and opportunities related to the green shift; that is to say, the necessary transition to the low-emission society the world needs in order to limit global warming to two degrees. The book provides a short overview, based on the most recent reports issued by the UN Panel on Climate Change, of the global problem posed by climate change.

CO_2 CALCULATION

A TOOLKIT FOR INCREASING THE IMPACT OF CO_2 CALCULATION

This toolkit is a product of an international cooperation project named North Sea Sustainable Energy Planning PLUS. With the aim of promoting a low-carbon Europe and increasing the impact of CO_2 calculation, partners from six countries have worked together to create this source of inspiration. The project was part funded by the European Union programme Interreg IV North Sea Region.

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FOREWORD

Gianluca Brunetti
Secretary General
European Economic and Social Committee

In 2018, the European Economic and Social Committee (EESC) celebrated its 60th birthday. Its early creation was no accident but a well-considered meaningful decision of the Member States. It happened because the EU's founding fathers had twice experienced a Europe that had fallen apart as a result of devastating world wars that carried off its young people, the lifeblood of Europe. It happened because a large part of society was deprived of its rights – civil society was being governed without being allowed to participate.

Home to Europe's organised civil society

The EESC is home to Europe's organised civil society and a bridge to Europe's citizens. It is an advisory body to the Council of the EU, the Parliament and the Commission, and as such it plays a key role in the EU's legislation by representing the views of workers and employers, as well as the full range of European interest groups, such as farmers, consumers, professionals, environmentalists, etc. It helps to make EU legislation more targeted, relevant and closer to European citizens.

> "A lot is at stake in today's Europe. Although the European Union is a great place to live, dedication to the EU on the part of its citizens is decreasing, which is to the disadvantage of Europeans themselves."

I have been the Secretary-General of this institution since 14 November 2018. Prior to taking on this role, I worked in the European Parliament and in the Council of Europe. My task and that of my team is it to support the 350 members from the 28 Member States in the exercise of their duties.

The commitment we show towards our citizens also applies in-house. My closest European compatriots are the 350 EESC members and my colleagues. Dialogue with citizens starts here, along with responsibility for and commitment to their interests and needs.

This is why I am committed to modernising and simplifying our working methods and creating better – and in particular more efficient and responsive – working conditions for both our members and our colleagues. This also includes facilitating the work between the different sections, coming up with innovative approaches and valuing flexibility. Communication and dialogue are key, both within the institution and with our citizens.

"Brexit has opened our eyes and helped us to understand what is at stake when a country does not want to be any longer a member of the European Union: all the standards, networks and support we have achieved through the creation of the Single Market are gone. The free movement of goods, which helped to make many products cheaper for Europeans, the free movement of people, which made travelling easier and helped many people to find jobs in the other Member States – all of this is gone for a country that decides to leave."

Making Europe accessible to individual citizens

A lot is at stake in today's Europe. Although the European Union is a great place to live, dedication to the EU on the part of its citizens is decreasing, which is to the disadvantage of Europeans themselves.

Brexit has opened our eyes and helped us to understand what is at stake when a country does not want to be any longer a member of the European Union: all the standards, networks and support we have achieved through the creation of the Single Market are gone. The free movement of goods, which helped to make many products cheaper for Europeans, the free movement of people, which made travelling easier and helped many people to find jobs in the other Member States – all of this is gone for a country that decides to leave.

We, therefore, need to put more effort into informing people about the concrete advantages the European Union has achieved for them. However, we also need to respond better to people's worries and concerns, no matter whether they are grounded in facts or merely impressions. We need to take these concerns seriously.

Unity is strength

rEUnaissance is the motto of the current EESC presidency under Luca Jahier. The Renaissance was a cultural movement, which began in my home country of Italy, significantly influenced all other aspects of life and put humans centre stage, thus demonstrating the power of culture.

The EESC's members work directly with the people on the ground. They are aware of citizens' concerns and needs; they bring them to the European level and ensure that they are taken into consideration in EU legislation.

My personal view is that "unity is strength". Therefore, my goal as Secretary-General over the coming years is to reach out to the other institutions, particularly to the European Parliament and the European Commission, to strengthen collaboration and pool our efforts. We will also make our institution more responsive, increase dialogue with our citizens and cooperate with influencers in order to reach out to people and give the EU the human face that its citizens are looking for.

With the Committee of the Regions, we share both our premises and important aspects of our administration. This cooperation should become a role model for working relations with other institutions because I am convinced that collaboration originating from a vision and based on a clear mission is a key part of the success of any organisation. This also allows proper use of taxpayers' money.

When there is teamwork and collaboration founded on transparency and constant communication, we can achieve the best for our people, which is, in the end, our duty and our objective. ■

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OPEN ACCESS

INTRODUCTION

It's a pleasure to introduce the April 2019 edition of Open Access Government, which is now bigger than ever.

We begin with an exciting array of insightful articles as part of our health & social care focus, including Minister of Social Affairs and Health in Finland, Pirkko Mattila, who discusses how The Economy of Wellbeing is a means to taking a holistic approach in tackling future health challenges. Also, a key policy perspective is provided by Baroness Blackwood, at the Department of Health and Social Care in the UK, who details the enormous potential of technology to build the most advanced health and care system in the world.

In our strong research & innovation section, we include comment from Frédérique Vidal, Minister of Higher Education, Research and Innovation in The French Government, who tells us about her stance on the importance of investing in education, innovation and research. In addition, Christian Naczinsky from the Austrian Ministry of Education, Science and Research, explains his opinion on the role of the European Research Area (ERA) in Austria.

While there are more highlights than ever, I do want to mention the Asia focus we have in this packed issue. This includes opinion from Masanori Osumi and Philippe de Taxis du Poët of the EU-Japan Centre for Industrial Cooperation, who tell us why a new era begins now when it comes to promoting industrial, trade and investment cooperation between the EU and Japan.

One of the many features I really enjoyed working on was the interview I conducted with Dr Carolyn M. Hutter PhD at the National Human Genome Research Institute (NHGRI) in the United States. Here, she outlines the important role of research when it comes to applying genome technologies to studying disease.

One of the many high-profile contributors in our comprehensive environment section is from Vice President, European Commissioner for Jobs, Growth, Investment and Competitiveness, Jyrki Katainen, who hails the success of the European Strategy for Plastics thanks to the transparency and full involvement of all stakeholders.

Finally, Danish Minister for Energy, Utilities and Climate, Lars Christian Lilleholt makes a special appearance in this edition. Fighting climate change is no longer an expensive hobby for the rich - rather, embracing renewables will make everybody richer, according to the Minister.

So, I warmly welcome any suggestions for policy-themed content you may have for future volumes of Open Access Government, with more in the pipeline for July and October 2019 and beyond.

Jonathan Miles
Editor

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The Economy of Wellbeing: A holistic approach to tackle future challenges

Minister of Social Affairs and Health in Finland, Pirkko Mattila, explains how The Economy of Wellbeing is a means to taking a holistic approach to tackle future challenges

Currently, many countries are tackling the challenges of the provision of sufficient and sustainable funding for the wellbeing of their citizens. This is very easy to understand since public spending on wellbeing, namely social, health, education and employment expenditure, constitutes a major part of national budgets.

Often the dominating tendency in reforms is to cut these expenditures in order to search for fiscal consolidation in the short-term. Arrangements for wellbeing are mainly considered as costs and something we cannot afford, especially during difficult economic times.

It is clear that a broader approach is needed. We need a better understanding of the interplay between economic dynamics and wellbeing solutions. The very foundation of our societies and economies is human potential. We need to look into ways how to utilise the endless possibilities of our population.

Economy and wellbeing are in the best cases closely interlinked and mutually reinforcing. Economic growth improves people's wellbeing, whereas wellbeing and health of the population enhance economic growth and stability. This interlinkage must be better recognised. In Finland, we are putting forward a holistic approach to this question that requires horizontal thinking and cross-sectoral co-operation. We call this approach the Economy of Wellbeing.

The Economy of Wellbeing is a horizontal approach, emphasising the importance of cross-sectoral cooperation. It is about understanding the role of social, gender, health, employment, education and environmental aspects in relation to economic growth, as well as the stability of economy and societies. It also contributes to the implementation of the UN Agenda 2030, which highlights the balance between economic, social and environmental policies.

A more holistic approach would be useful as we look for sustainable solutions to the current challenges of societies. This approach highlights the importance of evaluating how different policy measures may affect the health and wellbeing and thus employability, as well as the productivity of people. It can also increase our understanding of how investments in wellbeing generate savings, efficiency, productivity, and economic growth. The recent Word Bank Human Capital index, released in October, provides results supporting this.

Investment in human capital and wellbeing can provide direct and clear results, for example, investments in health, including mental health, education, occupational health and safety, as well as gender equality. Together with sound public finances, they are relevant from both macro and micro economic perspectives.

Let us take an example. Should women increase their paid working hours so that gender gaps, in both participation and working hours, disappear completely by 2040, it would boost the economy by an additional 15-30% GDP per capita growth in the Nordic countries – an estimation made by the OECD. Assessment and monitoring the long-term consequences of budgetary policies on both wellbeing and the macroeconomic situation is crucial. We also need to develop concrete tools to integrate gender perspectives into budgetary policies and the whole process of public finance management.

The Economy of Wellbeing also involves microeconomics, for example, the role of medicinal products. In the EU context, it is vital to understand how wellbeing can benefit from and contribute to the internal market.

Pirkko Mattila, Minister of Social Affairs and Health in Finland

"The Economy of Wellbeing is relevant to social stability and security as well. When building safe societies, it is vital to build a sense of security for the people. Sound social protection and access to services, as well as overall societal inclusion are at the heart of each citizen's personal security, while at the same time allow and support everyone to actively participate in the society."

Digitalisation and new technologies will create the ground for innovations and growing businesses, which will help to promote public health and the availability of new medicines.

This is relevant also from the perspective of the ageing population. Longevity is one of the successes of our policies, strongly and increasingly shaping our societies and economies. Ageing of the populations has strong impacts on economic growth, productivity, public finances, the financial sector, as well as wealth and income distribution.

We have a lot of data on the relevance of wellbeing to economic growth and stability. However, we also need to take into account some results, which are not so easily calculable. Even stable and high economic growth does not bring all the citizens along. Paying attention to inclusive growth is, therefore, very important. Social justice and fair treatment are key elements affecting people's experiences of wellbeing.

The Economy of Wellbeing is relevant to social stability and security as well. When building safe societies, it is vital to build a sense of security for the people. Sound social protection and access to services, as well as overall societal inclusion are at the heart of each citizen's personal security, while at the same time allow and support everyone to actively participate in the society.

As with anything worthwhile, we need efforts and time to gain results. Finding solutions require long-term, patient and continuous work.

The Economy of Wellbeing is multidimensional, cross-sectoral and above all topical from global, regional and local perspectives. It is an approach we need in order to meet our future challenges. It's time we engage in open discussion on how to use it – and make our future challenges today's opportunities. ■

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The future of healthcare is created in the OuluHealth ecosystem in Finland

OuluHealth ecosystem is a one-of-a-kind network of committed stakeholders from Oulu in Finland that strive to transform healthcare on a global scale and, as a result, improve people's lives

The rapidly evolving digitalisation of health and wellbeing requires new knowledge and collaboration models to accelerate growth globally. With the population now living longer and rising public awareness of maintaining a healthy lifestyle, a strong need for new solutions has emerged. A wide range of health and social innovations has been developed in Oulu to answer these challenges.

Oulu boasts a well-earned reputation of being a forerunner in communications and digital health technologies. This is also the first city to test the 5G network in a hospital environment. While the world is still talking about 5G, the University of Oulu has already begun to make headway in 6G development. In addition, Oulu is home to a unique health ecosystem, OuluHealth.

OuluHealth – a unique ecosystem for the digital future

OuluHealth, one of the five ecosystems of the Oulu Innovation Alliance, brings together various stakeholders, such as Oulu University Hospital, research institutes, academia represented by the University of Oulu and the Oulu University of Applied Sciences, industry partners, scientists

Every day some 2.6 billion people use technology that has been developed in Oulu.

and the City of Oulu. Set up in 2012, OuluHealth has evolved into one of the leading digital health innovation ecosystems in Europe. There are more than 600 companies in the health, bio, e-health, med-tech, wellness, and food safety industries within the OuluHealth network. Many of these companies utilise high technology, offer cutting-edge expertise and expand to international markets.

"Here you can find high-class competence in next-generation technologies, such as 5G, IOT, AI, VR, AR and Big Data. ICT is also utilised to develop applications, such as wireless biosensors and a variety of wearables for preventive healthcare and diagnostics, as well as improvements in everyday well-being", says **Salla Hirvonen**, Key Account Director of Health & Life Science at BusinessOulu.

Co-operation between research and business is open and enriches the business life. Strong research base will cover the complete pipeline from the basic tissue-level research up to digitally-aided patient-specific decision-making and evaluation of the practical benefits of decision-making services in digital health ecosystems.

A unique environment for successful health technology business

The open access collaboration model is facilitated by the innovation platforms of healthcare providers with real-world environments and a co-creation model. The developers are challenged to work on innovations that answer the needs of the healthcare sector and receive instant feedback on the usability of their solutions.

One of the OuluHealth's assets is OuluHealth Labs, a test and development environment for products and services. Equipped with cutting-edge pilot facilities, it is composed of three testbeds: OYS TestLab – an authentic hospital testing facility at Oulu University Hospital; Oamk SimLab – a versatile simulation and studio environment; and Oulu WelfareLab, which allows testing to be carried out throughout the city of Oulu's social and health service network, including in citizens' homes.

OuluHealth Labs provide the perfect environment for companies to develop their products or services under authentic conditions with genuine users.

Successful investments in research and development

The OuluHealth ecosystem is part of the European innovation partnerships, which develop new co-creation models of collaboration with companies (inDemand, H2020 projects). Healthcare providers announce challenges to the companies and, as a result, new solutions are created right for their needs.

The Oulu University Hospital is investing €1.6 mrd and aiming to become the smartest 5G hospital in the world. The Future Hospital 2030 programme brings opportunities for innovative partnerships with healthcare professionals, as well as for health technology companies to deliver new solutions for the hospital's use.

The University of Oulu (Faculty of Medicine) has established a DigiHealth Knowledge Hub to speed up and facilitate knowledge building in digital transformation, as well as solving the challenges in the creation of future data-driven healthcare solutions. IT competence strengthens the OuluHealth ecosystem capabilities in the fair health data management, efficient and ethical utilisation of artificial intelligence (AI), machine learning, and in developing new predictive analytics for preventive medicine.

Examples of life-changing health solutions from Oulu:

- **A revolutionary wellness ring that helps you get more restful sleep and perform better (Oura).**
- **The wearable collar for patient-oriented screening and diagnosis of sleep apnea (Nukute).**
- **The treatment for healing bone problems and bone trauma (BBS-Bioactive Bone Substitutes).**
- **Next-generation hand-held cameras for fundus imaging (Optomed).**
- **A chair that helps to reduce tension (Neurosonic).**
- **A game used in speech therapy (Peili Vision).**
- **A mobile gym for full body exercise (Weela).**

OULU HEALTH

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Using technology in the NHS to support predictive, preventative and personalised care

The Rt Hon Matt Hancock MP's vision for an NHS that uses technology to support predictive, preventative and personalised care is explored here

The Rt Hon Matt Hancock MP has a vision for an NHS that uses technology to support predictive, preventative and personalised care is explored here. Before we look at that however let's explore some of his career background – we know that he was appointed as the UK's Secretary of State for Health and Social Care during July 2018. Prior to this, he was Secretary of State for Digital, Culture, Media and Sport and Minister of State for Digital. Elected as MP for West Suffolk in 2010, Matt then was a backbencher on the Public Accounts Committee and the Standards & Privileges Committee. Since entering government in 2019, Matt has held a number of important ministerial roles.

> "We want to build a health and care service which is fully able to harness the huge potential of technology. This will save lives, support hard-working staff and deliver the cutting-edge care set out by our Long Term Plan for the NHS."

Before he entered the world of politics, Matt worked as part of his family business and also served as Chief of Staff to the Shadow Chancellor of the Exchequer and an economist at the Bank of England. In terms of his educational background, we know that he holds degrees from Cambridge and Oxford Universities. Married to Martha with three young children, it's interesting to note that Matt is the first MP in modern times to win a horse race.

In his current role as Secretary of State, Matt is responsible for the work of the Department of Health and Social Care, including oversight of social care policy, as well as overall financial control and oversight of NHS delivery and performance.[1] This article looks at one aspect of his remit that concerns the use of technology in healthcare. By way of background, we know that the Department of Health and Social Care wants to "lead the world in the use of data and technology to prevent illness – not just treat it" through the NHS Long Term Plan, according to Baroness Blackwood, Parliamentary Under Secretary of State (Lords).[2]

Matt Hancock bans pagers from the NHS

A significant piece of news came in February 2019, when we find out that Matt Hancock orders the removal of pagers for non-emergency communications to take effect before the close of 2021. All hospitals must, therefore, have plans and infrastructure ready by September 2020 to ensure that this is possible. Staff are encouraged to use mobile phones and apps, for example, because such modern forms of technology are a fantastic way to deliver two-way communications at a lower cost.

It's interesting to note that no less than one in 10 of the world's pagers used by the NHS. The annual cost for the NHS when it comes to using pagers is £6.6 million and in addition, the majority of phone companies have phased out support for these devices. As pagers only enable one-way communication, they are not exactly the most efficient way for NHS staff to communicate. Two-way communication means that no time is wasted and enables greater efficiency, for example, when it comes to dealing with urgent tasks. Of course, mobile phones and apps do support the sharing of information between staff, something that pagers cannot.

Having said this, some NHS trusts will be permitted to keep some pagers for use in emergency situations only, such when Wi-Fi fails or when no other form of communication is possible. To prepare for this massive change in the NHS, a pilot project took place at West Suffolk NHS Foundation Trust (WSFT) in 2017, which made use of a messaging and calling system, Medic Bleep which is like Whatsapp and has enhanced data protection.

Earlier in this article, I mentioned the NHS Long Term Plan and it's true to say that this significant move is the next step towards a fully digitised NHS.[3] We know that the policy paper, The future of healthcare: our vision for digital, data and technology in health and care details what is required so that the UK's health and care system can make the best use of technology to support predictive, preventative and personalised care.

> "Every day, our wonderful NHS staff work incredibly hard in what can be challenging and high-pressured environments. The last thing they need are the frustrations of having to deal with outdated technology – they deserve the very best equipment to help them do their jobs."

Looking ahead, IT systems and digital services used by the NHS will need to meet a clear set of open standards in the near future to ensure that staff can communicate across organisational boundaries. The ability for such systems and services to be continuously upgraded is also important and any system that does not fit such criteria will be phased out. Let's leave the last word to Health and Social Care Secretary Matt Hancock, who explains his views on the need for NHS staff to have the right technology at their disposal so they can carry out their duties in high-pressure environments.

"Every day, our wonderful NHS staff work incredibly hard in what can be challenging and high-pressured environments. The last thing they need are the frustrations of having to deal with outdated technology – they deserve the very best equipment to help them do their jobs.

"We have to get the basics right, like having computers that work and getting rid of archaic technology like pagers and fax machines. Email and mobile phones are a more secure, quicker and cheaper way to communicate which allow doctors and nurses to spend more time caring for patients rather than having to work round outdated kit.

Rt Hon Matt Hancock MP

"We want to build a health and care service which is fully able to harness the huge potential of technology. This will save lives, support hard-working staff and deliver the cutting-edge care set out by our Long Term Plan for the NHS." ■

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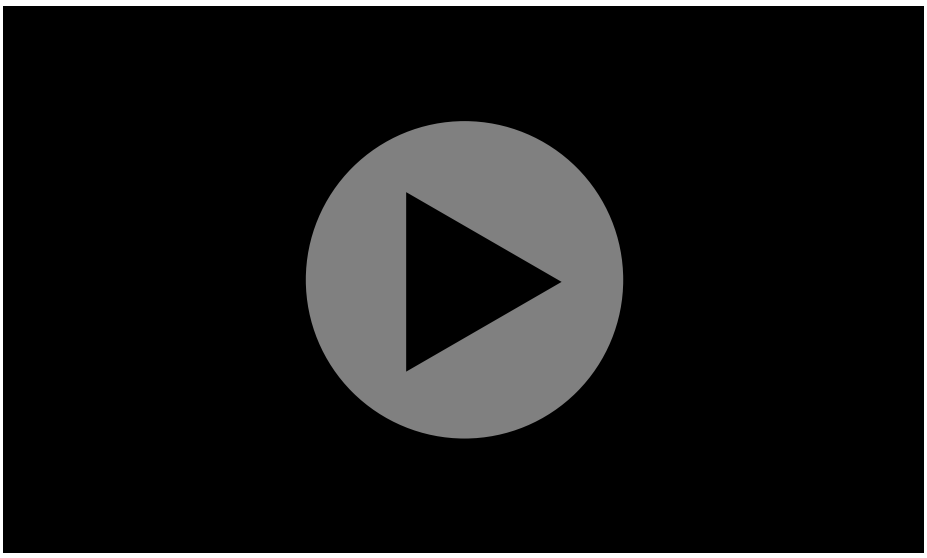
Could a Finnish artificial intelligence (AI) model be the answer to streamlining our health service and transforming the way we're treated?

NHS GP waiting times are at their all-time worst but things are set to improve as the leading Nordic tech firm Klinik Healthcare Solutions, launches a groundbreaking algorithm to take charge of the triage process and automate patient flow for ultimate efficiency.



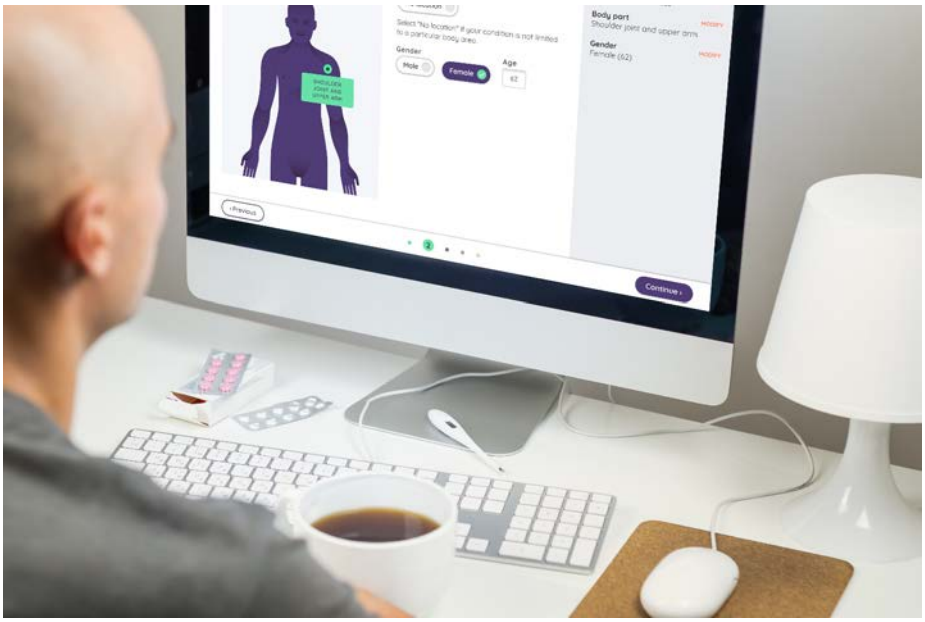
It wouldn't be a day of the week without some media coverage uncovering raging inefficiencies and a shortage of resources in the NHS: doctors, nurses and entire medical teams overstretched nationwide with no obvious solution. But utilising the latest artificial intelligence (AI) technology to step in where human labour is acutely scarce, might just be the answer.

This is the thinking behind Klinik Healthcare Solutions' new collaboration of healthcare and AI, a model first used in Finland, which is now rolling out around the world. Their unique browser-based service runs on a medical algorithm to act as the first port of contact for individuals with their healthcare system. Patients input their symptoms, answer a series of questions and through a thorough analysis of this user input (such as age, gender, symptoms and duration). As such, the programme can then make a comparison with a comprehensive database of over 1,000 conditions and associated symptoms. Within seconds this advanced technology can determine the individual's condition, urgency and avenue of treatment, therefore, a streamlined approach directs patients to the right place, in good time to receive proper care. The near-perfect accuracy and impressive time-saving of this method if automation is one that frees up the time of medical staff, thus, allowing them to be allocated to more crucial tasks aligned with their skill level.

A valid concern in creating such a programme was that existing medical staff would feel side-lined or their skill set replaced but, in fact, the inverse has been reported. Trials of Klinik in Finland's Central Ostrobothnia have shown staff are fully supportive of the new online service and welcomed the new way it enables them to work. With such precise preliminary data and effective patient flow, medical staff have been able to treat individuals in a timely manner and offer positive customer service, which has removed a huge amount of stress from their job roles.

GP's in the UK are currently allocated ten-minute appointments with their patients in which to assess and evaluate symptoms and propose a path of care, which is a near-impossible task in such time constraints. The vision of Klinik Healthcare Solutions is to remove such time-consuming administration so it will no longer be necessary for patients with minor ailments to physically go to a healthcare centre.

To assess the financial benefits of such a forward-thinking scheme, researchers at Aalto University's HEMA Institute (the Institute of Healthcare Engineering, Management and Architecture) in Helsinki, Finland, studied whether there is a link between the treatment costs of patients and the



use of an AI-based healthcare system that directs patients to the correct care. The study examined the Klinik Pro service during its first five months of use at the Myyrmäki Health Center in Vantaa and the result was that the tool brought a 14% saving in the average service costs per patient, translating to a €31 cost reduction per patient during the period of study.

> "It wouldn't be a day of the week without some media coverage uncovering raging inefficiencies and a shortage of resources in the NHS: doctors, nurses and entire medical teams overstretched nationwide with no obvious solution. But utilising the latest artificial intelligence (AI) technology to step in where human labour is acutely scarce, might just be the answer."

Petteri Hirvonen MD, COO of Klinik Healthcare Solutions and one of its founding members, considers the cost reduction of 14% to be a meaningful result. "This is, even in international terms, a significant demonstration of the potential impact of AI-based solutions in healthcare processes. It is crucial that the impact of digital solutions is studied, instead of just going ahead based on assumptions," explains Hirvonen.

But who is behind this robotic health system? Interestingly, an extensive team of experienced doctors and medical professionals including GPs, emergency team specialists and even dentists offering real-life experience in how to diagnose and treat patients with real medical and emotional needs. The AI element is monitored and constantly taught new things by them so as to ensure an up-to-date solid medical foundation.

"We are definitely not just a software company," stresses Hirvonen. "Medicine is an integral part of our daily operations and decision-making. I was previously an on-call emergency physician, travelling around Finland and I've seen more than 100 healthcare units with an infinite number of different work processes."

So what's next? "Targeting GP surgeries to help them modify patient access and improve workflow", says Ben Wood, UK Director of Operations & Sales for Klinik Healthcare Solutions. "Right now we're working alongside medical schools, GP federations and patient groups in the UK to localise our solution in preparation for our UK launch during 2019. This work is critical to ensure we deliver the best possible service to GPs and, in turn, help them to deliver the best experience to their patients."

Paramount to all this, the Klinik Healthcare Solutions AI model has the ability to supply consistent healthcare and uniform quality of service no matter what the patient location is; something that's impossible to achieve solely through human input. With an all-inclusive attitude that everyone deserves a straightforward, efficient symptom diagnosis and treatment plan, it is easy to see that AI technology could well be the way forward to offer the gold standard of medical evaluation on a global scale.

https://www.aalto.fi/news/artificial-intelligence-brings-14-savings-on-average-patient-treatment-costs

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Napp: Reducing the burden of chronic conditions through partnership

Chronic conditions, such as asthma and diabetes, are creating an increasing burden on the health service. Current estimates show that around 15 million people are living with a long-term condition in the UK and 2.9 million of those are thought to be living with multiple conditions at one time.[1,2]

The impact of these conditions is clearly visible through the vast resources dedicated to managing them – approximately 50% of all GP appointments, 64% of all out-patient appointments and 70% of all inpatient bed days.[3] To put that into perspective, the management of these conditions accounts for approximately £7 out of every £10 spent on healthcare in England.[3]

Arguably two of the most challenging long-term chronic conditions facing our national health service are Type 2 diabetes (T2D) and asthma.

T2D is a growing epidemic, affecting approximately 3.5 million people in the UK. This roughly equates to one in every six hospital patients, and that number is expected to rise over the next six years.[4,5] Diabetes is a complex condition, often characterised by associated complications, such as chronic kidney disease and cardiovascular disease.[4] The direct costs spent on TD2 are estimated at £9.8 billion per year, with a further £7.7 billion per year spent treating its complications.[6]

With over 5.4 million people affected by asthma, effectively managing patients with the condition has long been a focus for the health service.[7] Despite this, we are still seeing great variation in quality of care across the UK and discrepancies in patient outcomes based on socioeconomic status.[7] This is also reflected in the resources needed to manage the condition, the NHS spends approximately £1 billion a year on asthma, with £666 million spent on medicines, £160 million on GP consultations, £143 million on disability claims and a further £137 million on hospital care.[8,9]

As increased financial pressures are placed on the NHS, finding ways to help support improved management and patient outcomes of chronic conditions is more important than ever. The NHS long-term plan has highlighted key areas to support improved delivery of care in chronic conditions including achieving recommended diabetes treatment targets, reduced lengths of stay and re-admissions in hospital, and correcting the use of medications, such as inhalers.[10]

Driving improvements in care through clinical education partnerships

Partnerships between industry and the NHS are one way to successfully reach the primary care targets set out in the NHS long-term plan, and support improvements in chronic conditions such as diabetes and asthma.

At Napp we believe that partnerships should be about adding value beyond price. This is why we take a holistic approach to the support we provide to our NHS partners, delivering programmes that range from investment in disease management to educational resources.

Our dedicated educational platform, known as Napp Academy, provides bespoke educational and training resources to support the delivery of the best possible care for patients, by identifying and meeting the unmet needs of our healthcare professional partners across both asthma and diabetes.

Napp Academy works in partnership with *Education for Health* to deliver training courses and bespoke workshops that run throughout the UK. We are able to provide this support through a diploma bursary scheme that covers 75% of the modules cost to ensure healthcare professionals can better support their patients and directly improve patient outcomes.

Our Napp Academy courses are carefully designed to include all relevant clinical guidelines, while ensuring they suit the needs of healthcare professionals who already have experience and/or knowledge of asthma and require an update in the area. The courses include guidance and resources on current evidence and guidelines, assessing and maintaining control

with personalised asthma action plans and case studies on best practice.

Over the past year, our Appropriate Prescribing meeting series has delivered courses across the UK, not just for healthcare professionals but for CCG training leads involved in respiratory care. The series highlighted the vital need for education in respiratory diseases and provided hands on training to aid healthcare professionals in recognising and managing patients, with the ultimate aim of improving the standard of UK respiratory care. The positive feedback from this series and the gaps that it helped identify, has led to the development of a similar series in diabetes, which is expected to launch in Spring 2019.

As the role of prescribers continues to evolve to meet the changing UK healthcare environment, building appropriate educational programmes has become increasingly vital. One of our most successful programmes has been through a partnership with Soar Beyond and the i2i Network. We worked together to support practice-based pharmacists to act as change agents to help improve patient outcomes. The programme delivered workshops that helps practice based pharmacists implement and capture measurable patient and practice outcomes. To date this partnership has upskilled and empowered over 400 practice-based pharmacists with customised modules in diabetes and asthma management, including two uniquely developed by *Practice Nurse and The British Medical Journal* (BMJ). We look forward to continuing this partnership in 2019 and further enabling healthcare professionals to actively improve patient outcomes.

Partnering with industry experts to drive diabetes care

Some of our most important partnerships are with healthcare professionals. We are currently working together to help improve the understanding of emerging data in the fast-evolving and critical area of TD2.

In an effort to support time-stretched primary care healthcare professionals, in 2018 we brought together a group of UK leaders in diabetes to form the Improving Diabetes Steering Committee. The Committee aims to offer evidence-based practical guidance for the use of a recent class of medicines, sodium glucose co-transporter 2 inhibitors, and to help build confidence and understanding regarding the appropriate place for these medicines in T2D management.

The first project from the Committee was the development and publication of a consensus paper: 'SGLT2 inhibitors in TD2 management: key evidence and implications for clinical practice'. Published in *Diabetes Therapy*, the consensus paper, summarised in a simple prescribing tool, has provided over 12,000 clinicians with guidance

that can easily be implemented into their everyday practice.

As the second most downloaded paper from *Diabetes Therapy* in 2018, this partnership has actively addressed one of the key targets in the recent NHS Long Term Plan – supporting the delivery of diabetes care to enable achievement of recommended diabetes treatment targets.[11]

Partnering for a better future

Napp has been working alongside the NHS since its inception. We understand the needs and priorities of the health service, and this has always informed our approach in bringing value-added medicines to the NHS through effective partnerships. This is innate in the way we work, as a partnership-based organisation, placing it at the heart of everything we do and every relationship, from our wholesale distributors to NHS decision-makers.

Our structure and emphasis on partnership working has enabled us to remain agile and gives us the flexibility to make locally driven decisions quickly, in order to help our partners deliver sustainable healthcare solutions that ultimately improve patient outcomes.

We believe that working together in partnership can create a step-change in the UK healthcare system and drastically improve delivery, accessibility and quality of sustainable patient care. For us, delivering strong partnerships begins by ensuring mutually beneficial goals for both partners, engaging the full resources available on both sides and setting out clear and achievable objectives. However, the most important aspects of a great partnership are honesty, and never being afraid to challenge the norm.

> "Our dedicated educational platform, known as Napp Academy, provides bespoke educational and training resources to support the delivery of the best possible care for patients, by identifying and meeting the unmet needs of our healthcare professional partners across both asthma and diabetes."

Amidst the backdrop of ongoing financial pressures for the NHS, and the increasing burden of long-term chronic conditions, mutually beneficial partnerships that support our NHS are more vital now than ever. And as we look to the future – we know that partnerships will be the cornerstone of delivering improved care across the UK.

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The potential of technology to build the most advanced health and care system in the world

Baroness Blackwood, Parliamentary Under Secretary of State (Lords) at the Department of Health and Social Care in the UK explains the enormous potential of technology to build the most advanced health and care system in the world

We're incredibly proud of our National Health Service. Open to all, based on need and not ability to pay, it embodies the responsibility we have to one another across society.

Along with many countries around the world, we face the challenge of an ageing society with people living longer than before and with more complex health conditions.

We need our health service to keep up. As part of a new Long Term Plan for the NHS, the UK Government has recently committed to invest an extra £33.9 billion a year by 2023/24 to make the health system fit for the future. A large part of the plan focuses on harnessing the enormous potential of technology to build the most advanced health and care system in the world.

It's the right thing to do – better tech means better healthcare. An app which gives paramedics access to your medical records when you dial for an ambulance can save your life. Data-driven AI that can compare millions of pharmaceutical compounds is already helping medical researchers develop new treatments and medicines quicker than ever before, helping to improve the lives of patients across the UK. If we can digitise repetitive admin tasks, we can free up doctors and nurses to spend more time with patients.

Last autumn we published our first ever Tech Vision for the NHS. The purpose of the Vision is to make the technical infrastructure that underpins our healthcare system more like the technology underpinning the internet. It's our plan for an NHS that's open and interoperable, continuously upgrading itself with the latest innovations, capable of constant improvement.

Standards and interoperability

This all starts with getting the basics right. Instead of disconnected systems, we need systems that talk to each other because we know that when systems are not interoperable people suffer.

It shouldn't matter where you are in the NHS, whether it's a hospital, a doctor's surgery or an out-of-hours setting, you and your clinician should be able to access your medical record, just as you can access your email from any device.

To solve this, we are not going to create a giant centrally-held database of all 65 million NHS patients. These kinds of approaches have been tried and failed in the past. Instead, we will design, agree and mandate common technical standards so that interoperability is designed in from the start. It will mean, for example, that suppliers cannot sell to the NHS unless they meet our standards, guaranteeing high-quality systems which will be designed around the needs of clinicians and patients.

AI Code of Conduct

The NHS, in its 70-year history, has one of the richest data pools in the world and there is enormous potential for researchers, academics and innovators to use this resource to unlock solutions to some of healthcare's biggest challenges through artificial intelligence (AI) and machine learning.

Imperial College London has recently developed an AI system which can predict the prognosis of patients with ovarian cancer more accurately than current methods – and it can estimate which treatments would be most effective for patients following a diagnosis.

Baroness Blackwood, Parliamentary Under Secretary of State (Lords)

This type of innovation and the potential of personalised medicines is revolutionary and could save thousands of lives in the future. But it is also absolutely crucial that our data is used in a sensible and responsible way. Our new Code of Conduct for Data-Driven systems encourages technology companies to meet a gold-standard set of principles to protect patient data to the highest standards. It will also mean the NHS is fairly rewarded when companies profit from NHS data.

The National Data Guardian (NDG) will play a pivotal role in this by helping to ensure that patients' confidential information is safeguarded securely and used ethically.

Creating a healthtech ecosystem within and around the NHS

We also want the NHS to adopt and invent the latest healthtech innovations. This is partly about how we design our technical architecture. Instead of monolithic systems where one company does all the data, the hosting, the interface and so on – with no incentive to keep up to date – we want modular systems where the different components can be swapped in and out as technology evolves and without us having to rebuild the underlying plumbing each time. This is why standards – the rules for how we build and whom we buy from – are so important.

Crucially, we want to use the power of openness to level the playing field between challengers and incumbents. It's why all of our technical standards will be published on the web. We want everyone in the healthtech to see our requirements so that anyone with the skills and know-how can build for the NHS.

And once a good idea has been proven we want to be able to spread it much faster. So for example, healthtech companies that jump through all the hoops to sell into one part of the NHS should not have to repeat the whole process with a different hospital just up the road.

NHSX

Driving all this through will not be easy, and it requires leadership. It's why earlier this year, the Health Secretary, The Rt Hon Matt Hancock MP, announced the creation of NHSX: a new joint unit among our central health bodies tasked with delivering our Tech Vision.

NHSX is bringing together tech policy levers, powers and funding that have been previously been spread across the NHS, concentrating them into one strong team and one decision-making point. Quite simply, it will mean we can get things done more efficiently and patients can benefit from cutting-edge innovations as soon as possible. ■

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Pulling scientific discoveries through to patients: New treatments for neurodegenerative diseases

Professor Dame Pamela Shaw explains how the National Institute for Health Research (NIHR) supports experimental medicine and translational research in neurodegenerative diseases

Neurodegenerative diseases – such as Parkinson's, Alzheimer's, motor neurone disease and multiple sclerosis – are increasing worldwide as the population ages. Disease-modifying therapies are urgently needed.

Our growing understanding of the neurobiology underlying these diseases has led to the discovery of novel potential therapeutic strategies by laboratory scientists. In England, the translation of these scientific discoveries into exploratory research studies in patients (experimental medicine), clinical trials and new treatments benefits greatly from central support provided by the National Institute for Health Research (NIHR).

The NIHR funds research infrastructure across the country that drives innovation and speeds up the rate of 'pull-through' of scientific discoveries from the lab and into patients. This support for experimental medicine includes Experimental Cancer Medicine Centres , Clinical Research Facilities and Biomedical Research Centres (BRCs). These University-Hospital partnerships mean that patients can benefit sooner from academic progress in some of the world's top research institutes.

In Sheffield, we have the only BRC that focuses solely on experimental medicine for chronic neurological disorders. By working directly with the Sheffield Institute for Translational Neuroscience (SITraN), our centre develops preclinical discoveries into experimental medicine and early phase clinical trials.

Since establishing the NIHR Sheffield BRC in 2017, we have already had excellent examples of 'pull-through' alongside our work to gain a deeper understanding of disease mechanisms and to drive research into symptoms and new treatments. Taken together, this joined-up approach aims to improve the success rate of translating new therapies into the clinic.

As a neurologist, I think that we are beginning to see the start of a new era where we have powerful tools with which to address some of the most intractable and distressing diseases in medicine.

Translational drug trials and biomarker development

At SITraN we carried out the first drug screen in cells from patients with Parkinson's disease, screening over 2000 compounds in high content imaging experiments more commonly used in cancer research. Our screening identified that ursodeoxycholic acid (UDCA), a drug used to treat liver disease, was able to reverse the mitochondrial dysfunction observed in cells from patients with Parkinson's disease.

With support from our core BRC team, we have now started recruiting patients to a clinical trial of UDCA in Parkinson's disease, led by Professor Oliver Bandmann. The UP (UDCA in Parkinson's) study uses novel biomarker measures of drug activity, such as a magnetic resonance spectroscopy technique to measure energy levels in the brain, and wearable sensors to monitor patients' activity in daily life.

A further example of pull-through from the SITraN drug discovery laboratory, this time with a commercial partner, is our research into the neuroprotective effects of an NRF2 activator. The NIHR Sheffield BRC is now working to develop reliable biomarkers of NRF2 activation that could support robust clinical trials of its neuroprotective effects in several neurodegenerative diseases, including motor neurone disease and Parkinson's disease.

Stem cell transplantation for multiple sclerosis

Autologous haematopoietic stem cell transplantation (AHSCT) is a treatment approach that rebuilds patients' immune systems using their own stem cells. It involves harvesting a patient's stem cells from their bone marrow, then ablating their immune system with chemotherapy and repopulating their bone marrow with stem cells that have never interacted with their central nervous system. AHSCT for multiple sclerosis renders the disease inactive in the vast majority of relapsing-remitting patients (JAMA 2019).

Recently we had very encouraging news from the interim analysis of the Multiple Sclerosis International Stem cell Transplant (MIST) trial carried out in Sheffield, Chicago, Uppsala and Sao Paulo. Further research arising from this ground-breaking work is now taking place through Professor Basil Sharrack at the NIHR Sheffield BRC, including a trial funded by NIHR's Efficacy and Mechanism Evaluation programme to compare AHSCT with alemtuzumab treatment across 19 sites in the UK. 'Back-translation' from patients back to the laboratory is underway to further refine and improve AHSCT treatment for patients with multiple sclerosis.

Gene therapy for motor neurone disease

The NIHR Sheffield BRC is supporting research into an experimental antisense oligonucleotide (ASO) gene therapy for patients with motor neurone disease linked to mutations in the SOD1 (copper-zinc superoxide dismutase 1) gene. The protein produced by the SOD1 gene is responsible for around 2% of cases of motor neurone disease. ASO therapy is designed to cancel out the mutated form of this protein.

The phase 1 experimental medicine study led from our BRC by me (European Chief Investigator) and Professor Chris McDermott (Sheffield Principal Investigator) has shown exciting early results and is now progressing into a pivotal regulatory trial sponsored by Biogen. A Biogen sponsored trial for the most common genetic cause of motor neurone disease, associated with changes in a gene known as C9orf72, is also now in set up.

The pull-through of gene therapy for motor neurone disease has been a long-term goal. It has been 10 years since SITraN's Professor Mimoun Azzouz led one of two independent teams that used an engineered virus to replace a faulty gene in animal models of spinal muscular atrophy (SMA), a childhood form of motor neurone disease. This pioneering work helped to lay the foundation for the tremendous success of the clinical trial of viral-vector-based gene therapy for SMA. The pre-clinical work of Professor Azzouz and myself gave confidence that a gene therapy approach could potentially be successful for patients with SOD1-related motor neurone disease.

The SITraN and BRC teams in Sheffield are now working with AveXis to move viral-vector-based gene therapy for SOD1-related motor neurone disease towards being available to patients. The viral-vector-based approach will complement the antisense oligonucleotide trial that is currently in the clinic.

A bright future

Until now Sheffield has been the sole site in the UK carrying out advanced treatment (gene therapy and stem cell) trials for motor neurone disease and multiple sclerosis, respectively, but these promising trials are set to expand.

We are fortunate to have a northern group of NIHR BRCs in Sheffield, Leeds, Manchester and Newcastle that can collaborate on experimental studies of novel treatments, and to have NIHR Clinical Research Facilities that can deliver such cutting-edge trials. Through the investment of the NIHR, we are bridging the pull-through from pre-clinical scientific discoveries into experimental medicine and subsequently clinical research, translating innovative findings into real benefits for patients with neurological disorders. ■

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Key patient information stored in routinely collected healthcare free-text data is still untapped

Goran Nenadic, from The University of Manchester and The Alan Turing Institute, argues for using patient information stored in routinely collected healthcare free-text data

A lot of health and social care research relies on data specifically collected for a particular study, with relatively small sample sizes and a relatively high cost of data collection. However, in many countries, national health and social care services routinely collect longitudinal data to support patient care. Records about patients' encounters with such services are increasingly available digitally on a large scale, providing key information about the concerns, treatments and outcomes of care. Such data has been used not only to support clinical practice but also increasingly as a source of research data to improve our understanding of disease patterns and determinants of health and well-being.

The healthcare data space is also increasingly heterogeneous, including well-structured variables (e.g. from diagnostic and laboratory tests, measurements from monitoring equipment, or coded data) and semi-structured and unstructured data (e.g. images or clinical letters). Structured data, while undoubtedly important, cannot capture all the necessary clinical details through numerical measurements, predefined pull-down menus, clinical codes and checklists. Health and social care systems have, therefore, relied on natural language, which remains the main means of communication with patients and carers, and between professionals. Such communication includes clinical notes, letters, reports and observations, produced by professionals and increasingly, patient-generated comments on their experience, adverse reactions or outcomes that are available on social media or in patient diaries.

Estimates are that 85% of actionable health information is stored in a free-text narrative, which typically records key contextual information, including detailed symptom profiles and personalised treatment plans, as well as patients' risk factors, experience and impact on quality of life. This is particularly extensive in some areas (e.g. mental health and social care), where a free-text narrative is a principal means to record key patient information. However, the text in medical records is often stripped out before records are made available for research purposes due to the privacy issues and, thus, this rich source of data is often untapped.

Several case studies have shown that there is great value in pulling information from a clinical free-text narrative (e.g. in mental health, rheumatology, cancer studies, GP records). While free-text narratives are routinely collected, their automated processing is still not common, mainly due to challenges that analysis of unstructured free text brings with its often complex context-dependent and idiosyncratic terminological constructs. However, the ability to process such data both for an individual patient and/or aggregate them across a specific patient population is a key enabler for a range of artificial intelligence (AI) applications in healthcare, including personalised medicine and clinical decision support: if we could unearth detailed information from very large real-world datasets, we could find out which treatments work best for which patients.

Over the last 30 years, there has been significant work on developing automated computerised methods for large-scale processing of free text, known as text analytics. Such methods process free-text documents and automatically identify, link and extract mentions of key clinical variables and their values, including, for example, diagnoses, problems, symptoms, affected anatomical locations, diagnostic or therapeutic procedures performed, drug/medication prescriptions, adverse drug events, family/social history, and behaviour and quality of life indicators. For example, text-analytics methods can extract specific mentions and details of a radiotherapy treatment from a clinical note, or mentions of social factors (e.g. smoking, alcohol consumption) or emotional concerns in a patient's discharge summary. Similarly, methods have been developed to extract clinical information that may

only be available in a free-text format, such as symptom severity in mental health, detailed prescription extractions or results of specific instruments (e.g. Mini-Mental State Examination). This machine reading through text analytics allows transforming unstructured free-text into a structured representation (clinical variables and values), which can be then used to help clinicians navigate through individual records as well as for further actionable analytics on integrated health data. However, there have been many barriers in text-analytics methods being translated and widely used in practice.

Recognising the needs for and challenges in processing free-text data in health and social care, the UK's Engineering and Physical Sciences Research Council (EPSRC) has established the Healthcare Text Analytics Network (Healtex), bringing together experts from academia, the National Health Service (NHS), regulators, industry and patient communities to identify key barriers in processing free-text data, scope future research directions and disseminate best practice and successful outcomes where large-scale text processing has been instrumental in healthcare research. The network started its activities in 2016 and has facilitated engagements with the wider stakeholder community via workshops, conferences and feasibility funding, aiming to coordinate efforts and provide open, reusable and privacy-aware analytics solutions.

While much is known about public attitudes to the use of health data in general, the network specifically commissioned a Citizens' Jury on whether, and in what circumstances, healthcare free-text data should be used for research. A jury comprised of members of the public in the UK explored the opportunities and potential trade-offs between privacy and the public good and offered broad support for the use of free-text health data for health-related research by academic and NHS organisations. One of the key issues that has been highlighted is that free-text data often contains very detailed and sensitive personal information, including possibly a range of third-party identifiers. This requires thorough de-identification before narrative can be used by researchers. While finding and masking personal identifiable information is a complex task, there have been several efforts to provide automated methods to remove such information from clinical letters and notes on a large scale, with the accuracy comparable to human efforts. We note that de-identified free-text data is mainly needed for the training and validation of text analytics methods, whereas – when used in practice – free-text data would be transformed by text analytics software into structured data before leaving the trusted environments in hospitals, removing the need for de-identification. The network has initiated making de-identified free-text data available through data donations and by generating synthetic data that can be used for training text analytics software.

In addition to free-text data privacy and governance, the network operates a number of other working groups that aim to provide translational benefits to the clinical community. These range from groups focusing on processing mental health clinical letters or mining drug prescriptions, to automated analysis of radiology reports, automated clinical coding of diagnoses, processing of health social media analytics and patient feedback data, to the analysis of veterinary reports. The Healtex network has become a hub for a multi-disciplinary community of clinicians and computer scientists, but also regulators and information custodians, patients and carers, industry, charities and many more, who collaborate on finding the ways to use routinely collected free text to support clinical practice (e.g. summarisation of clinical notes and letters to support efficient browsing and aggregation of a patient's history), clinical, social care and epidemiological research, as well as enabling patients and carers to efficiently search posts on social media.

Given that both research and practice are likely to have a growing need for effective text analytics, Healtex is determined to collaborate with other organisations (both internationally and nationally, e.g. with The Alan Turing Institute for data science and AI, and Health Data Research UK) to provide a forum that can revolutionise healthcare and improve patient outcomes by unlocking the evidence contained in free-text data that is currently widely untapped.

More information about Healtex and how to join the network is available at http://healtex.org .

Healtex

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Genetics: Why investing in basic embryology research must be a priority

Darren K Griffin, Professor of Genetics and Alan R Thornhill Professor of Reproductive Genetics at University of Kent, School of Biosciences lift the lid on why investing in basic embryology research must be a priority

After more than 5 million babies born, in-vitro fertilisation (IVF) is now considered routine. We all know someone who's had IVF and assume that, because it's routine, that it's usually successful. On the contrary, the most likely outcome is failure. The emergence of IVF has led to the development of a number of associated treatments and technologies. In 1990, preimplantation genetic testing arrived with the birth of the Munday twin sisters who were screened for sex as 8-cell embryos because their parents were at risk of transmitting a genetic disease to their sons. With this breakthrough, came the possibility of screening IVF embryos for chromosomal abnormalities - the most common reason behind IVF failure. Normal human embryos contain 23 chromosome pairs (46 chromosomes total). Those with an abnormal number are termed 'aneuploid'. The best-known aneuploidy (three copies of chromosome 21) leads to Down syndrome, but other more common consequences include pregnancy loss, congenital abnormality, infertility and, importantly, IVF failure.

Human reproduction is inefficient. Even couples undergoing IVF are at risk of having chromosomally abnormal embryos. Identifying aneuploid embryos, and then implanting only those testing normal (euploid), theoretically minimises these risks to improve IVF outcomes. The procedure is called PGT-A (preimplantation genetic testing for aneuploidy). Those requiring PGT-A are at a greater risk of aneuploid embryos because of advanced maternal age, prior repeated miscarriage or prior repeated implantation failure. Currently, the test is invasive, requiring the removal of cells from each IVF embryo for genetic testing. This is usually performed on day five or six of development when the embryo has around 100 cells. Removal of five to ten cells at this stage is thought not to harm the future foetus, in part, because the cells removed only represent a small fraction of what will eventually become the placenta.

Early tests for chromosome abnormalities in embryos used a microscopy-based approach with multi-coloured fluorescent probes to identify specific chromosomes in 8-cell stage embryos. However, this method had variable reproducibility, high error rates and not every chromosome was investigated, culminating in many unfavourable randomised controlled trials (RCTs). Considerable in-depth research and development stimulated the introduction of more accurate, sensitive, reproducible tests that simultaneously analysed all chromosomes. The latest version, next-generation sequencing (NGS), is so sensitive that it detects the presence of chromosomally normal and abnormal cells in the same embryo (so-called mosaicism). Some view mosaicism detection as refined selection, others as a distraction which could lead to the unnecessary discard of potentially normal embryos because low-level mosaics can result in normal live-births.

Since randomised clinical trials (RCTs) over 10 years ago demonstrated that PGT-A could possibly harm (rather than improve) a patient's IVF chances by discarding potentially normal embryos which test abnormal, there's been a passionate and polarised debate about whether PGT-A should be performed at all. Authors of the original trials remain fierce opponents, whereas those who benefit directly (and provide benefit by offering PGT-A) remain enthusiastic advocates. As a result of more recent RCTs, observational studies and large validated national datasets, many IVF practitioners now believe that PGT-A can be beneficial, in the right hands, using the right methods for the right patients. The anti-PGT-A faction, on the other hand, argues that current evidence is insufficient to justify PGT-A, that any intervention should only be introduced clinically after at least one favourable RCT and even recent studies are biased, limited in size and poorly designed. In response, pro-factions suggest there's already enough evidence to support PGT-A, it's unfeasible to conduct large RCTs in some areas of reproductive medicine and many widely used IVF procedures were never subjected to RCTs as their benefits are obvious. The opposing factions

become increasingly entrenched and, for now, the debate continues. Recommendations range from suggesting routine application in all IVF cases to complete discontinuation of PGT-A.

PGT-A can improve but will never be perfect; no test is. What both sides agree on is the need for more research. Chromosomal research on human embryos provides a window of opportunity to study the genetics of the earliest stages of human development, as well as how chromosomes segregate in our sperm and eggs. For example, the mechanisms of how mosaicism arises are poorly understood, despite leading to a range of adverse outcomes, including severe genetic disease in new-borns, stillbirth and miscarriage. This applies not only to IVF embryos but to a significant proportion of naturally conceived foetuses too.

One glaring omission from the scientific literature at present, however, is a comprehensive cell-by-cell comparison of a large cohort of blastocyst embryos to establish overall levels of mosaicism. Taking the research further, we might be able to establish what, if any, approaches can be used to reduce levels of aneuploidy (for instance improved embryo culture (postzygotic) or improved ovarian stimulation or patient management) as there is some circumstantial evidence that some aneuploidy may be induced by the methods and treatments used to perform IVF. Through in-depth basic research and comparison with model systems (e.g. mouse, pig, cattle), basic questions not only relevant to PGT-A specifically but to IVF in general (and to naturally conceived foetuses) could be addressed more deeply. For instance:

- Are patterns of mosaicism laid down in the embryo or as a result of differential survival of cell lineages?
- If most embryos have some form of (mosaic) aneuploidy, is this normal and what degree of mosaicism can be tolerated?
- Which aneuploid mosaics are least likely to have adverse outcomes?
- Are IVF embryos representative of normally fertilised embryos? This may well not be the case.
- Do chromosome errors perpetuate further errors in human embryos?

In addition to these basic research studies, we need more RCTs, using real-world conditions, some of which stratify patient groups (for example, comparing advanced maternal age versus recurrent implantation failure versus recurrent pregnancy loss etc.).

Future research priorities

Further research is certainly needed to understand how chromosomal abnormalities arise and perhaps how to prevent them. The prospect of non-invasive testing for embryonic aneuploidy using the culture fluid in which the embryo grows to identify cell-free DNA is exciting and recent evidence of this is promising.

The opportunity for understanding aneuploidy and mosaicism in IVF and in the general population that consists mostly of natural conceptions, must not be missed and there has never been a more important time than now to perform basic (human and non-human) research in this area.

We, the authors, would thus like to conclude with this plea: industry, governments, research councils and charities: please work together to generate more funding for basic research into the chromosomes of human embryos. There are benefits to reap on all sides: For industry, a large proportion of embryos, even from younger women, are aneuploid and will never develop. Identifying those that will and those that won't, may lead to a future where every IVF cycle may involve some variant of PGT-A. For the advancement of medical research, a greater understanding of aneuploidy and mosaicism generally will lead to improved patient management and, more importantly, outcomes for many more couples, which with increasingly older families, is one of the most significant genetic problems in reproduction in our time.

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Delivering improved health and wealth in the UK

Jane Kinghorn, Director of the Translational Research Office at UCL, discusses the importance of research and partnership in improving the health and wealth of the UK

Health research intensive universities such as University College London (UCL), are key to changing the way we think about health and disease and how best to manage them.

UCL works through interdisciplinary partnerships with its NIHR Biomedical Research Centres (BRCs), the NHS, patients and Industry. Through 'translation' we aim to transform scientific discoveries arising from laboratory, clinical or population studies into new therapies, technologies, clinical tools and applications that improve human health.

Evolution of the translational research ecosystem – The past ten years

The research translational ecosystem has changed significantly over the past 10 years. Pharma and biotech industries have reorganised; cutting back on internal research to free-up resource to fund more open innovation and collaborative science. This has led to fragmentation of the delivery of innovation with an increase in the number of SME's and growth of CROs to fill the gap. Several pharmaceutical companies have established open innovation offices and funding schemes to promote translational partnerships with universities.

The aims of industry, universities and partner hospitals are very similar, in trying to deliver new solutions to improve patients' lives. However, the culture, philosophies and motivators of these organisations have traditionally been very different, leading to mistrust and uncertainty of the benefits of working together. This situation has radically changed with all partners adopting a more outward looking collaborative approach. In addition, investment in industry expertise embedded within Universities such as UCL's Translational Research Office (TRO) are bridging this cultural divide.

The government's translational strategy and subsequent evolution of the Industrial Strategy has seen the addition of significant investment to incentivise academics and clinicians to participate in biomedical translation which has transformed the sector:

- The National Institute for Health Research (NIHR) established in April 2006, has invested over £1 billion into health research. 2007 saw the establishment of Biomedical Research Centres (BRCs – NHS/University partnerships focused on the translation of biomedical interventions in clinical settings).

- Working alongside this investment in the NIHR, the government in 2007 gave an additional £132 million to the Medical Research Council (MRC) targeted towards translational research. The MRC introduced several initiatives including the Developmental Pathway Funding Scheme (DPFS).

Impact on clinical trial activity

The impact of this translational research funding strategy is beginning to be realised. The UK has enhanced its standing as an excellent place for industry to invest in performing early clinical trials, enhancing the access of our patients to novel treatments. In the past 10 years the UK has participated in 3601 industry supported Phase I/II trials (Jan09-Dec18) compared to 1137 in the previous 10 years (Jan99-Dec08 – data from Clinicaltrails.gov), second only to the U.S.

Impact on the health & wealth of the UK – Advanced therapies

A key mission of UCL in partnership with our three BRCs – University College London Hospitals (UCLH), Great Ormond Street Hospital (GOSH), Moorfields Eye Hospital) has been to develop a culture of enterprise and facilitate the translation of discovery science at UCL into patient care. The Translational Research Office has been fundamental in linking UCL's translational infrastructure with the BRCs, by bringing together the necessary expertise in design, research management and governance of early phase trials, technology transfer expertise in various disciplines as well as providing links to industry.

We have recently established six Therapeutic Innovation Networks (TINs) to accelerate the development

A film produced by the National Institute for Health Research University College London Hospitals Biomedical Research Centre

of novel therapeutics. The scheme was piloted in 2015, with the establishment of the Cell, Gene and Regenerative Therapies TIN. A comprehensive survey of activity demonstrated UCL's extraordinary strength and depth in this novel set of therapeutic approaches.

UCL, working with UCL Business (UCL's tech transfer office) to create spinouts and partnerships, is a world leader in the clinical translation of cell, gene and regenerative therapies (we perform 59% of all UK cell, gene and regenerative medicine trials). The research excellence and clinical potential has resulted in a number of high-profile Pharma collaborations and spin-out companies including: Orchard £392 million, Autolus £251 million, Freeline £123 million, MeiraGTx £77 million, and Achilles £13 million of investor funding.

CAR T-cell therapy

UCL has a growing CAR T-cell programme based at UCLH and GOSH. There are currently ten phase I/IIa clinical studies of experimental CAR T-cell approaches open at UCL affiliated hospitals which stem directly from this programme (the largest CAR T program in the UK) many of them funded through UCL spin-out Autolus. As an example of pull through from discovery science to clinical application for patient benefit, NHS England announced last year that children and young people in England with B cell leukaemia will be able to benefit from Europe's first full access deal on CAR-T therapy.

Rare diseases

The Medicines and Healthcare Products Regulatory Agency granted a Promising Innovative Medicine Designation to OTL-101, a gene therapy product under development at UCL/GOSH BRC with MRC support, in partnership with Orchard. This designation recognises the significant clinical benefits for treatment of adenosine deaminase deficiency, commonly known as "bubble baby" disease, relative to alternative treatment options.

In March 2018 the first results published from a clinical trial using a new stem cell technology showed that patients regained sight after receiving retinal tissue engineered from human embryonic stem cells. The results of this ground-breaking clinical study described the implantation of a specially engineered patch of retinal pigment epithelium cells derived from stem cells to treat people with sudden severe sight loss from wet age-related macular degeneration (AMD), a major cause of blindness in the over 60s (supported by the London Project to Cure Blindness, a partnership between UCL and Moorfields BRC/NHS trust).

Summary

Through this long-term commitment to interdisciplinary research, NHS and industry collaboration, and the adoption of innovative treatments and technologies, UCL is well positioned to develop further novel approaches to all types of disease and to genuinely and fundamentally improve people's everyday life.

UCL

UCL TRO
UCL TRANSLATIONAL RESEARCH OFFICE

UCLB

NIHR | University College London Hospitals Biomedical Research Centre

NIHR | Moorfields Biomedical Research Centre

NIHR | Great Ormond Street Hospital Biomedical Research Centre

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NHS staff can now upskill in revolutionary Genomic medicine at Swansea University

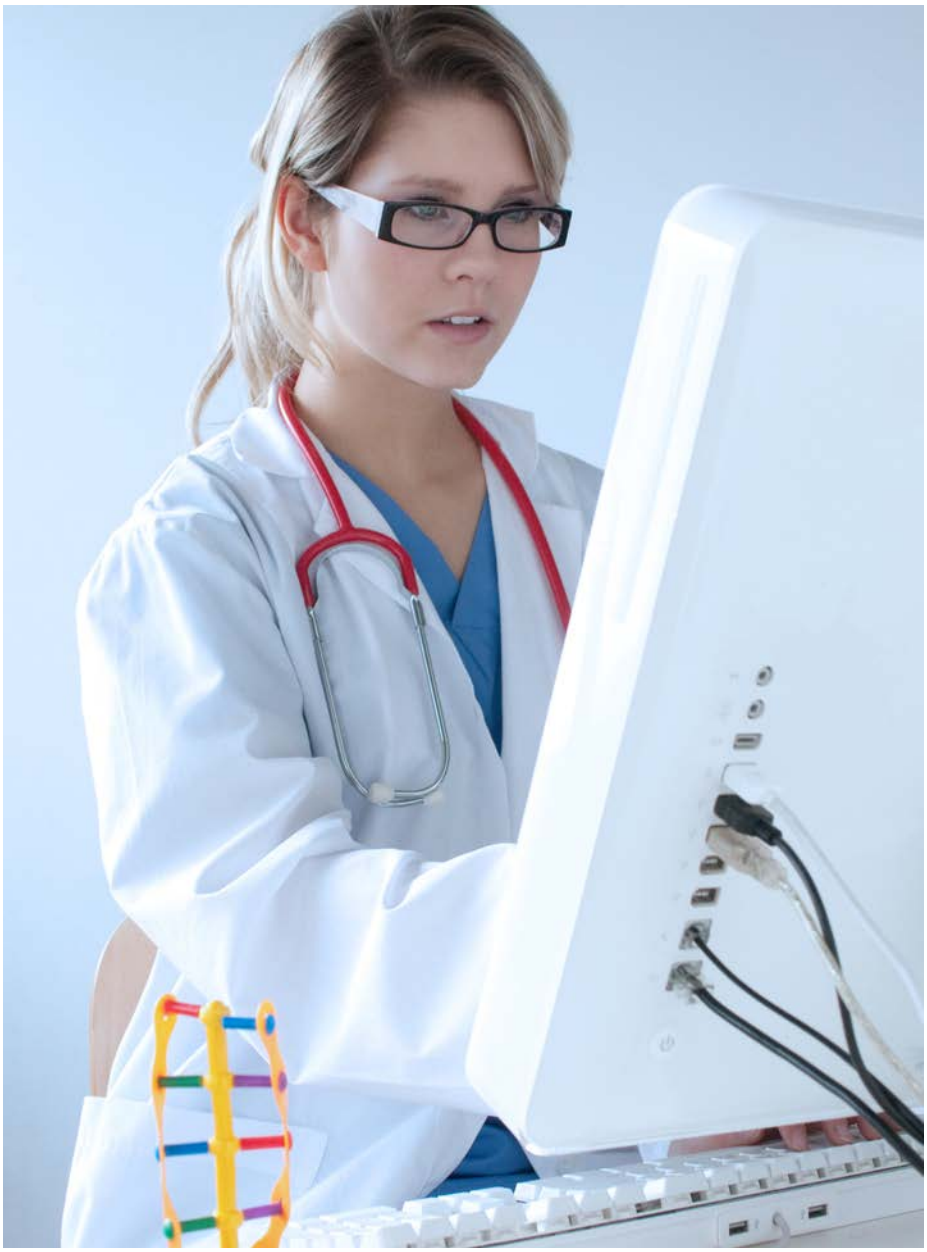
Swansea University Medical School's Master's degree in genomic medicine has been designed to help NHS staff to understand and use the growing personalised medicine approach

Personalised medicine is a revolution in identification, management and treatment of chronic disease and uses an "individual's genetic profile to guide decisions made in regard to the prevention, diagnosis, and treatment of disease". Reaching that goal has been more than 20 years in the making, birthed from an ambitious plan to sequence the first reference human genome. By 2003, scientists had done it for the first time – they had an essentially complete sequence and a map of all the genes in the human body.

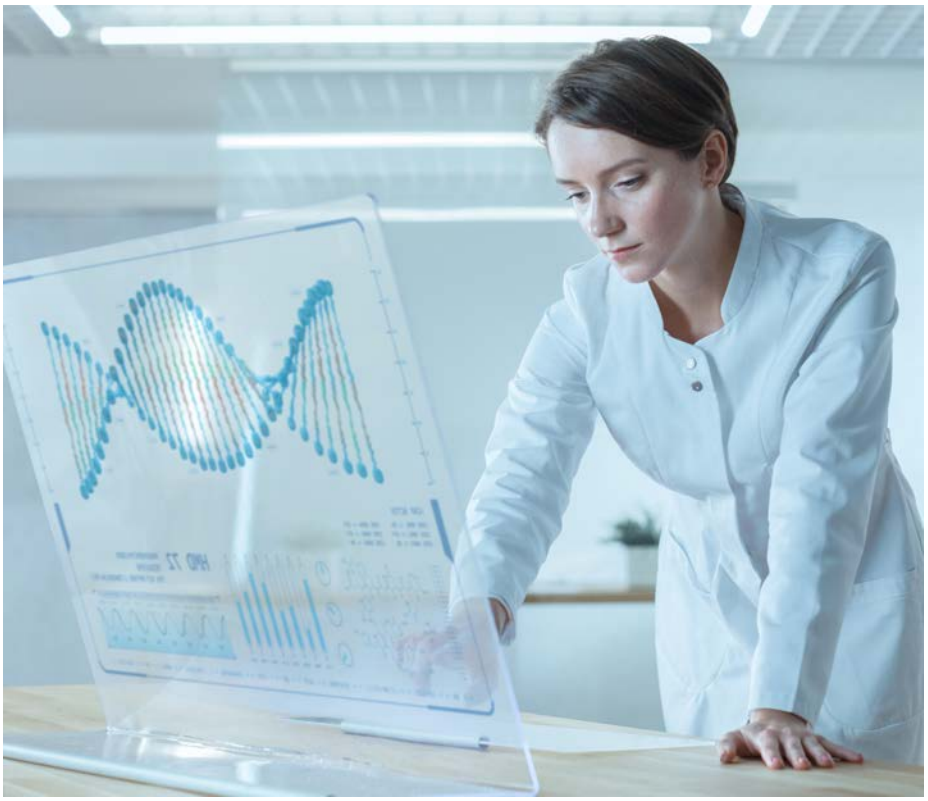
The MSc in genomic medicine at Swansea University Medical School has been developed to support NHS staff with the knowledge and skills to understand and interpret genomic data and help prepare graduates to be able to develop and deliver personalised healthcare.

It is based on the indicative curriculum of Health Education England, NHS England and Genomics England.

A growing number of researchers, healthcare clinicians, and an increasing number of patients are calling for a more personalised approach aimed as much at preventing disease as it is at tailoring treatment once it's there. Call it what you will – personalised medicine, genomic medicine, precision medicine.



It's an approach that emphasises the ways in which your disease risks are unique and different, just like your other, more obvious characteristics. Those disease risks are based on the predispositions written into your genome at birth, combined with your lifestyle and environment. In the case of cancer, the disease has its own genetic makeup, lending each tumour a unique character with unique tendencies and vulnerabilities. And perhaps there is, or soon will be, a drug or treatment or tailored combination of the two that will work better for you than it would for someone else.



"The number of targeted therapies in the pipeline for all diseases is increasing dramatically," says Professor Keith Lloyd, Head of Swansea University Medical School.

"Personalised medicine in the age of genomics means we're living in dynamic times. We have developed this new MSc in genomic medicine at Swansea to help our health professionals take all this new information being gathered and be able to interpret it and use it for the benefit of the patient."

Fully-funded places

Dr Torsten Hildebrandt, Consultant Paediatrician at Abertawe Bro Morgannwg University Health Board is a student on the programme. He says: ***"One in 17 people in the UK is affected by a rare disease, 80% of which are genetic in origin. Many of these conditions will be diagnosed antenatally or in the first few years of life.***

"The application of genomics medicine will allow a more accurate diagnosis, management, surveillance, family counselling and individualised treatment with a significant impact over the lifetime of a child. The MSc at Swansea University Medical School will enable me as a General Paediatrician to stay on top of developments in this field and apply this to the best benefit of my patients and their families."

Programme Director and Associate Professor in Cancer Genetics Dr Claire Morgan says: ***"Genomics is an emerging field of expertise, which has major implications for improving and even revolutionising patient diagnosis, treatment, care and public health.***

"As a result, the Welsh Government have invested £6.8million in the Welsh Genomic Strategy aimed, in part, at training NHS staff in genomics/precision medicine. Here at Swansea University Medical School, we are excited to be part of helping the Welsh Government fulfil their remit by being one of only two Higher Education institutions in Wales, commissioned by Welsh Government, to offer an MSc in genomic medicine with a number of fully funded places for NHS applicants."

Helen Daniels, who is a Research Officer, began the MSc in 2018, she adds: ***"Genomic medicine research is a fast-growing, dynamic field and absolutely key in improving healthcare. As a researcher to have the opportunity to learn more about this revolutionary approach is incredibly exciting."***

To find out more about the MSc in Genomic Medicine please contact Programme Director Dr Claire Morgan at c.morgan@swansea.ac.uk, or call 01792 606543. You can also visit www.swansea.ac.uk/medicine and search the Postgraduate Taught opportunities.

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Leaving no one behind: The importance of strong guidance in public health at the European level

Dineke Zeegers Paget, Executive Director of the European Public Health Association (EUPHA) believes that there is a vital need for strong guidance in public health at the European level and as such, nobody should be left behind

The 2017 Eurobarometer, published in April 2018, concludes that European citizens find having good health as the most essential factor for getting ahead in life (endorsed by 48% of the respondents).[1] The Organisation for Economic Co-operation and Development (OECD) notes that there is a growing interest in the potential for preventive interventions to improve health status in OECD countries and to tackle remaining health inequalities.[2] But in all the discussions going on at the moment – such as the upcoming European elections and discussions on the future of the European Union (EU) – the benefits of investing in health seem to disappear from sight. In the current discussions taking place, the questions about whether we need a dedicated Health Commissioner at EU level and a specific health programme are ones that are debated. However, this is not going in the direction we want to take.

Natasha Azzopardi Muscat, European Public Health Association (EUPHA) President from 2016-2020 is very clear that there is a role for health at European level: "EUPHA is calling for a renewed and updated health strategy that clearly places health priorities at the heart of EU policy. Europe has a role and responsibility to play not only in upholding the highest standards to protect the health of European citizens but also by exerting a normative political influence on the importance of health as a value binding people in the new world order."[3]

European public health has advanced considerably since 1992, a year that marks the birth of European public health, with an article specifically dealing with public health adopted in the Maastricht Treaty. Article 129 calls for more collaboration between countries and community action for the prevention of diseases, in particular, the major health scourges, including drug dependence, by promoting research into their causes and their transmission, as well as health information and education.[4] But since Maastricht, things have changed. First, public health practitioners are facing considerable challenges with the ageing population and the increase in migration. Second, the political landscape, the after-effects of the financial crisis and the new ways of communication are influencing the perception of public health. For instance, the measles eradication was so successful that people seem to have forgotten the illness, as well as the positive effects of vaccination and, are now increasingly hesitant to get vaccinated. This resulted in new measles outbreaks happening throughout Europe.

The political landscape has changed enormously over the past years and political disruptions cause uncertainty on many issues including health. For instance, the decision of the Italian government to reverse the decision to make childhood vaccination mandatory, the head of Italy's national health research organisation, Prof Walter Ricciardi, being forced to quit because of the "anti-scientific" policies of the country's populist government.[5] The active campaigning for health after Brexit by Faculty of Public Health in the UK is another example.[6] And the Austrian government abandoning a smoking ban in bars and restaurants set in motion by the previous government is the third example.[7]

Combine this time of political disruptions with the discussions on whether health should or should not be a priority in the EU and you have a volatile situation –

inevitably requiring us to reconsider our approach to public health policies and politics. Several initiatives and actions to support the public health community to address the politics of public health have already been taken. In our recently published supplement to the European Journal of Public Health "How to Navigate Political Landscapes: Towards a Public Health Political Science",[8] we summarise key political science concepts to provide the public health community with tools and methods for how to integrate public health knowledge into the sphere of decision-making. In April 2018, several key European health-related nongovernmental organisations published a joint statement asking to do more for health at European level.[9] The six asks formulated are self-explanatory:

1. Establish strong leadership on health.

2. Adopt EU-level legislation to prevent diseases.

3. Develop a framework for tackling non-communicable diseases.

4. Support national health systems with expertise and evidence.

5. Empower citizens and patients.

6. Assess the impact on the health of EU policies.

The EU should lead by example in this case, offering guidance, evidence and advice to all European countries to ensure that the health of Europeans is at the centre of everything. This will demand a joint effort from the public health community, from the EU and from politicians. As Natasha Azzopardi-Muscat states in her latest column:[10]

"At this point in which the EU is elaborating the future Multiannual Financial Framework (MFF), Horizon Europe as well as international aid and development programmes, we need to engage in discussion around the metrics and key performance indicators. These play a large role in determining where the efforts, investment and resources in Europe will be directed in the next decade. Health cannot be allowed to be left behind and EUPHA will be playing its part to ensure that nobody is allowed to forget this." ■

Dineke Zeegers Paget

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Centre for Doctoral Training in Prosthetics and Orthotics

The UK is set to train many more highly skilled engineers in prosthetics and orthotics following the announcement of a new global centre of excellence based at the University of Salford

Worldwide demand for artificial limbs, braces, footwear and other devices which help people recover from injury is accelerating, but manufacturers and practitioners require a rare combination of clinical, medical and engineering skills.

The Centre, to be based at the University of Salford, is set to train up to 60 individuals to doctoral level over the next eight years to address the skills gap at home and abroad. Salford's key collaborators are the UK's principal prosthetics and orthotics research centres: Imperial College London, the University of Strathclyde and the University of Southampton.

"The Centre for Doctoral Training (CDT) in Prosthetics and Orthotics will build a world leading engineering and physical science workforce to help ensure that "no one is left behind."

The £11 million project, with £5.3 million coming from the Engineering & Physical Sciences Research Council (EPSRC), partners the Centre with 27 industry and clinical collaborators, including two of the largest manufacturers of prosthetic and orthotic devices, Blatchford and Össur, and the global leader in research in the field, Northwestern University in the U.S.

This unique doctoral four-year research training programme will be complemented by a new Masters programme operating across all four partner universities. Students will be supported by national and global industry, and clinical, patient and service partnerships who will ensure high-quality training, and provide placement and employment opportunities. Many students are expected to be graduates in Engineering with the remainder coming from industry and some from clinical backgrounds.

"Globally, 100 million people need prosthetic and orthotic devices, and this is rising rapidly. With most users now being of a working age, there is an ever-increasing need to develop more sophisticated devices suited to a range of diverse needs", explained Centre director Malcolm Granat, Professor of Health & Rehabilitation Sciences at the University of Salford.

"There is a woeful shortage of research engineers who have a deep understanding of these challenges. Our expectation is that this new centre will create a talented workforce, who will be equipped to produce local and global solutions to transform lives."

The majority of students will come from the UK, but the centre will also work to support training for students from low and middle-income countries, including Cambodia, Uganda and Jordan.

Up to 10 fully funded, four-year PhD studentships are available in the EPSRC Centre for Doctoral Training in Prosthetics and Orthotics, commencing in October 2019. The Centre for Doctoral Training (CDT) in Prosthetics and Orthotics will build a world leading engineering and physical science workforce to help ensure that "no one is left behind."

> "Globally, 100 million people need prosthetic and orthotic devices, and this is rising rapidly. With most users now being of a working age, there is an ever-increasing need to develop more sophisticated devices suited to a range of diverse needs."

The CDT provides training that supports exciting careers in a global healthcare industry that meets the needs of diverse user groups and stakeholders. The CDT combines expertise from the University of Salford, Imperial College London, University of Strathclyde and the University of Southampton, with more than 25 industry partners and national facilities.

In year one, students undertake a training course of taught modules, a short project and a clinical and/or industry placement. For the first six months all students will based at the University of Salford, after which they will move to one of the four host institutions to complete a PhD programme of research.

The PhD studentships are available for a 1st October 2019 start. The closing date for applications is Friday April 5th, 2019. Decisions will be announced by the end of June 2019. Interested? Email us at CDT@salford.ac.uk for more details.

The studentships provide for PhD fees at the host institution and a stipend set at national rates (current stipend for UK students in 2018/19 is £14,777 and is adjusted annually).

Applications are welcomed from UK/EU students but due to funding/eligibility restrictions we are currently unable to accept applications from outside the UK/EU.

However, students from outside the UK/EU with an interest in carrying out a PhD in the field of Prosthetics and Orthotics are encouraged to visit the CDT website or contact CDT@Salford.ac.uk to identify potential PhD supervisors and discuss alternative arrangements.

For more information, please visit https://www.salford.ac.uk/research/doctoral-training-in-prosthetics-and-orthotic/home .

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Imperial College London

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UK Healthcare: Using technology for the adoption of effective medical bed tracking

Brendan Crossey, Chief Executive Officer of Healthcare Analytics Limited places the adoption of effective medical bed tracking under the spotlight, including the innovative use of technology in this aspect of healthcare

The ability to understand the location of every medical bed and their associated mattresses is becoming a necessity, and the raft of legal, regulatory and policy forces driving the adoption of effective bed tracking has never been greater.

All too often, clinical and medical engineering teams face a daily battle to locate beds and mattresses, as they are frequently under utilised and poorly maintained. This creates a risk burden and a significant yet avoidable cost. Inevitably, compromises in relation to time, cost efficiency, safety, patient care and risk management are common.

Hospital assets can be costly, as the cost per bed has risen 90% in the past 15 years. Each hospital bed includes expensive equipment and keeping track of this equipment is often a huge task.

Staff often work in several different specialist teams with different objectives. The result is precious and costly assets misplaced or left in disuse.

Estimates indicate that hospitals will purchase 25% more equipment than actually required for operational needs.

One recent investigation uncovered that a major U.S. hospital took a huge financial hit simply because they were "unable to locate" 383 assets which equates to more than $11m of equipment. A UK Healthcare Trust recently had to replace 150 mattresses that went missing and this paints a grim image of asset tracking in healthcare. This is due largely to poor processes.

With current bed occupancy rates in most NHS hospitals at 95% and above, the locating and efficient management of beds and other assets is paramount and while making institutional changes in the industry will take time, connected technology solutions are becoming an increasingly popular aid to solving these healthcare issues.

These solutions offer hospitals the chance to automate time-consuming services to increase efficiency and improve the patient experience.

The Need

The Healthcare Analytics i-trackbeds solution helps staff to ensure security and regulation compliance, as well as enabling employees to work more efficiently on a daily basis by solving the issues around:

- Locating and managing assets in a large NHS Trust is a huge, almost impossible and very time-consuming task.

- For audit or traceability purposes, it is vital that we capture and hold the history of all interactions with the bed and mattress including its maintenance, service and cleaning history.

- 9% of patients will suffer an HCAI (Healthcare Acquired Infection), with 30% being avoidable and every Healthcare Professional understands the significant negative impact this can have on both the patient and

length of stay. Currently it is impossible to trace the source of infections and therefore the eradication of an outbreak can take days or weeks.

- Nursing Staff spend on average 21 minutes on every shift looking for equipment, and again we recognise the importance of the right bed for the right patient, e.g. bariatric to reduce bed sores or other complications.

- Improved device management, availability and utilisation reduces the need to loan beds and mattresses to accommodate short-term demand.

The process of bed and mattress rentals can be automated with nursing staff able to raise requests for rentals, which are sent for approval, with a remainder raised at end of period and rental companies automatically informed of the return with its location.

What's more, significant rental charges can be avoided by ensuring clinical staff only use specialist beds and mattresses when necessary.

The Solution

This seems like a no brainer concept, so why hasn't it been solved before?

Several technologies have been used in the past for asset tracking, and technologies like Global Positing Systems (GPS) have disrupted a number of industries, however, the limitations of GPS and the high cost of existing systems means managers are often left blind when conducting operations indoors.

Similarly, Wi-Fi and active RFID-based systems can offer dividends, but they come with a huge price tag.

Today, the cost of manufacturing Passive RFID tags has fallen to the point where certain types can be used to cost effectively manage tens of thousands of devices in a hospital environment.

However, the technology is only part of the answer as 80% of the problem is around poor processes, so we need to ensure that we also improve both processes and workflows, and that the solution delivers real benefits to the staff to ensure that they are engaged in the transformational process.

> "Hospital assets can be costly, as the cost per bed has risen 90% in the past 15 years. Each hospital bed includes expensive equipment and keeping track of this equipment is often a huge task."

With this mind, Healthcare Analytics and our partner Multitone engaged in a 2-year research project with the Medicines Optimisation Innovation Centre (MOIC), an innovation unit within the Northern Ireland Health Service to design and build an efficient solution that enables key assets including beds and mattresses to be managed effectively, providing real time asset location, with a built-in task management application for monitoring the availability, cleaning and maintenance of these assets.

Consisting of a small chip and antenna, RFID tags are attached to beds and mattresses. Each tag has a unique device identification number and use radio waves to identify and track beds and mattresses.

We also include a barcode on our tags to allow staff to integrate the history of a device by scanning its barcode using our mobile app.

The mobile app also allows staff to manage requests for bed moves, cleaning and maintenance. All requests, notices and alerts are processed via the Multitone mission critical iMessage Service which guarantees that all messages are sent and received in a timely manner.

The whole service is managed via a Management Dashboard which includes the database and software for processing the data. The software can be integrated with other Patient Administration and Ward Management Systems for truly efficient and effective bed management.

"Our PATIENTS get access to the RIGHT equipment at the RIGHT time for the RIGHT patient – resulting in safer patient care while delivering a better patient experience" *Dr. Naomi Baldwin PhD, Senior Nurse Patient Safety and Performance, Northern Health and Social Care Trust.*

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Cardiovascular disease: How to stop a killer

Cardiovascular disease claims the most lives every year but is largely preventable according to the President of the European Association of Preventive Cardiology, a branch of the European Society of Cardiology

Ischaemic heart disease and stroke are the world's biggest killers.[1] The good news is that 80% of cardiovascular diseases can be prevented with healthy lifestyle habits.[2]

In the INTERHEART study, approximately 90% of myocardial infarctions could be explained by suboptimal lifestyle factors including high blood cholesterol, high blood pressure, smoking, diabetes, obesity, insufficient exercise, drinking alcohol, not eating enough fruits and vegetables, and psychosocial factors.[3]

While we do not have studies on the impact of eliminating all of these risk factors, we do have epidemiological research showing that when there is a population reduction in blood pressure or blood cholesterol, that results in a decreased incidence of myocardial infarction. Similarly, countries that have introduced a ban on smoking in public places have seen an almost immediate decrease in the incidence of acute coronary events.

The reverse is also true: in parts of the world where smoking bans have been revoked, rates of myocardial infarction have gone up. We will see what happens to the incidence of acute coronary syndromes in Austria, which cancelled its smoking ban last year.

Should cardiovascular prevention focus on individuals or populations?

Cardiovascular prevention should be delivered at individual and population levels.[2] For most cardiologists, the focus is on high-risk patients. Here we address lifestyle issues and prescribe medications to control blood pressure and cholesterol to reduce the likelihood of another cardiovascular event.

Governments have a role to play in prevention at the individual level by reimbursing medications and providing funding for cardiac rehabilitation programmes. However, the role of public authorities is even more crucial when it comes to providing healthy environments so that people do not get sick in the first place. Targeting individual high-risk patients has a very high impact on a relatively small part of the population: population-based approaches are the most far-reaching.

> "Motivation is a key element of cardiovascular prevention and digital health has the potential to help avoid first and subsequent cardiovascular events. We already have research showing that daily monitoring with a health app after a cardiac rehabilitation programme increases prolonged participation in exercise."

Most heart attacks occur in people not being seen by a cardiologist. So, if we really want to decrease the global number of cardiovascular events we should also focus on the low-risk population. Small shifts in the risk of disease, or of risk factors, across a whole population consistently leads to greater reductions in disease burden than a large shift in high-risk individuals only.[2] Population approaches also benefit children and reduce health inequalities within and between countries.

All governments should introduce and enforce smoking bans, increase opportunities for physical activity by promoting cycling, tax unhealthy foods and sugary drinks, and much more. In the area of nutrition, Denmark led the way in 2003 by banning industrially produced trans fats, and the European Union (EU) has followed today setting a limit for trans fatty acids to 2% of food's total fat content.

What can GPs do?

Cardiovascular prevention is a lifelong endeavour. It starts before birth and even before conception.

Prof Dr Paul Dendale

Women and men who smoke before conceiving a child cause epigenetic alterations that are detrimental to the cardiovascular health of their offspring.

As the health professional who sees people throughout their life course, GPs have a central role to play in the prevention of cardiovascular disease in all of their patients. That means checking risk factors at every consultation and repeating messages about smoking, weight, activity, diet, and so on.

Who is at the greatest risk of cardiovascular disease?

It is often forgotten that the people at the highest risk of a heart attack are those who have already had one. Opening blocked arteries is an effective treatment and patients are back on their feet very quickly. But they are not cured. Unfortunately, the EUROASPIRE surveys show that coronary patients still have high levels of smoking, unhealthy diets and physical inactivity, resulting in obesity and diabetes.[4] To improve this situation, doctors must prescribe medications at sufficient dosages and refer patients to cardiac rehabilitation. Patients can do their part by complying with lifestyle advice and taking their pills.

Other high-risk groups are those with diabetes, chronic inflammatory diseases such as rheumatoid arthritis, and patients who have undergone chemotherapy or radiotherapy. Then, of course, there are those who have high levels of multiple lifestyle risk factors.

How does the future look?

Motivation is a key element of cardiovascular prevention and digital health has the potential to help avoid first and subsequent cardiovascular events. We already have research showing that daily monitoring with a health app after a cardiac rehabilitation programme increases prolonged participation in exercise. I'm convinced that digital solutions will help us in our continuing battle to reduce the burden of cardiovascular disease.

From a public policy perspective, there is a lot of positive movement today across the EU, including efforts to reduce alcohol consumption and limiting advertising of unhealthy food to children. But this is just a start. Together, the European Association of Preventive Cardiology (EAPC) and the European Society of Cardiology are fully committed to working with policymakers and health stakeholders for a heart-healthy Europe, free from avoidable disease. ■

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Research on cardiovascular disease and the link with noise

Thomas Münzel MD, Omar Hahad PhD and Andreas Daiber PhD discuss the link between noise and cardiovascular disease, in this report about their research in the field

"One day man will have to fight the noise as fiercely as cholera and plague," predicted Nobel prize winner Robert Koch in 1910. In fact, the spectrum of diseases has changed significantly in recent decades, so that currently non-communicable, often chronic, diseases such as cardiovascular diseases account for a significant proportion of the global burden.

There is annually a loss of more than one million healthy life years in Western Europe, measured on the basis of disability-adjusted life years, due to traffic noise-induced diseases [3]. In recent years, noise research has made substantial progress, particularly with regard to relevant clinical studies as well as pathophysiological mechanisms that may play an important role in noise-induced cardiovascular effects, so that reviewing the current literature is essential.

Noise reaction model

Noise is defined as disturbing sound with an objectively (physically) quantifiable dimension expressed as sound levels or decibel (dB (A)) and a subjective (psychological) dimension determined by the individual evaluation of the sound source by the listener (Figure 1). The so-called noise reaction model implicates that besides the direct auditory effects of noise on the organism (for example hearing damages caused by exposure to very high sound levels), the non-auditory noise

Figure 1: Environmental Sources of Noise and Respective Sound Pressure Levels

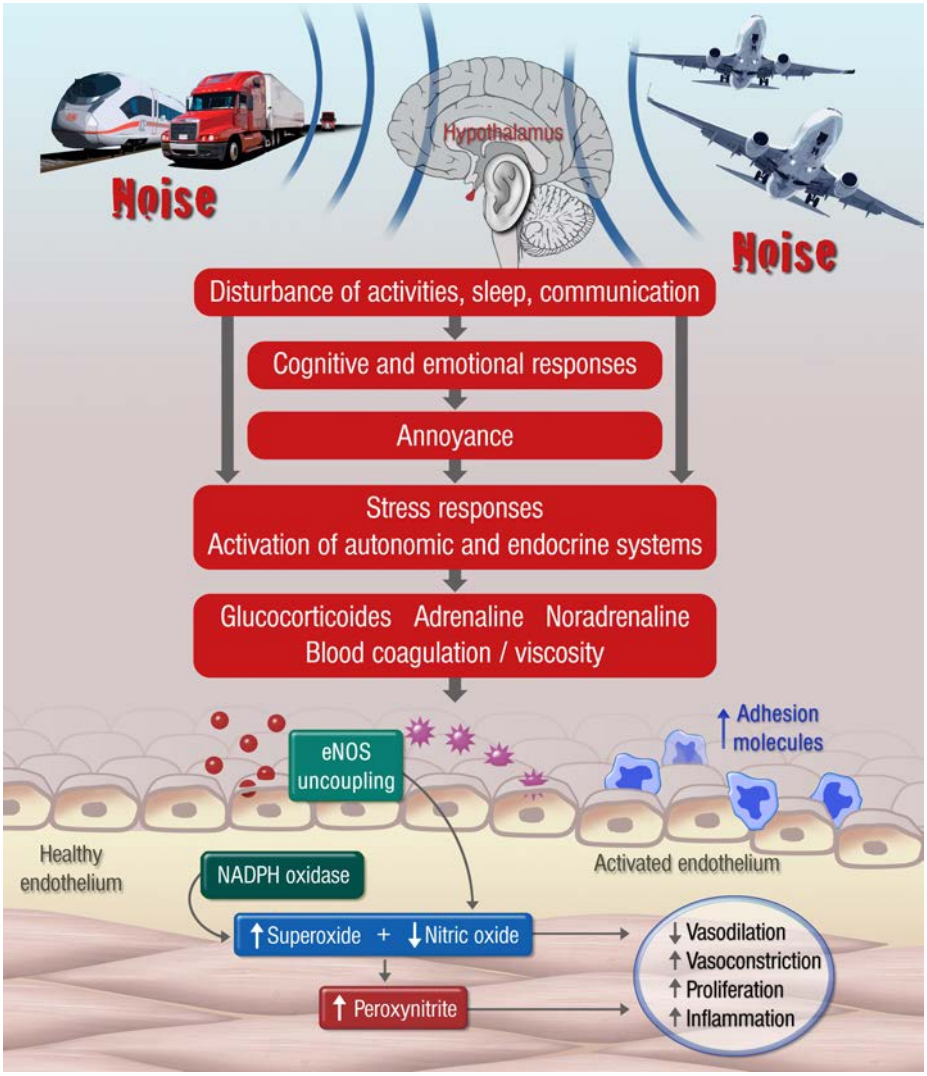

Figure 2: Mechanisms underlying noise-induced vascular damage. Noise causes stress responses that are known to cause vascular (endothelial) dysfunction characterized by an increase in the production of oxygen-derived free radicals such as superoxide such as the NADPH oxidase and by an uncoupled nitric oxide synthase (eNOS) leading to decrease of the vasodilating, anti-atherosclerotic radical nitric oxide (NO) with the consequence of the initiation or acceleration of the atherosclerotic process

effects are the main cause of a subsequent stress cascade (Figure 2).

In this sense, acute and chronic exposure to environmental noise may trigger stress and annoyance reactions, mediated through disturbances of sleep, communication and activities. These cognitive and emotional reactions lead to activation of the autonomic (sympathetic) and endocrine system (e.g., increased levels of catecholamines and cortisone) and, as a consequence, may contribute to an increased risk of developing cardiovascular disease via adverse changes in lipid and glucose metabolism and blood pressure regulation (Figure 2).

As mentioned before, noise is not only a physical stimulus expressed as sound levels, but an individually experienced burden, which is accompanied by a variety of cognitive and emotional reaction patterns in case of inadequate coping. Noise-induced annoyance has been reported to play an important role in the development of noise-induced cardiovascular disease. Noise-induced adverse health effects primarily depend on the extent to which noise is perceived as disturbing [4, 5].

Data from a large prospective cohort study, the Gutenberg Health Study (N = 15,010, conducted at the University Medical Center Mainz) demonstrate that noise-induced annoyance caused by various sources during the day and at night, including aircraft, road traffic and railway noise, is dose-dependently associated with an increased risk of atrial fibrillation [6]. Furthermore, in the Gutenberg Health Study it has been shown that the risk of depression and anxiety increases with increasing noise annoyance [6, 7], which in turn may negatively affect the cardiovascular system.

Epidemiological evidence on the relationship between noise and cardiovascular disease

Due to the increasing demand for mobility in recent years, the scientific assessment of noise-induced health effects in the population comes into focus. The quantity and quality of epidemiological research have improved substantially in recent years with regard to standardisation and estimation of noise exposure, consideration of larger study populations and improvement of adjustment for confounding variables. In addition, conditions such as habituation, sensitisation, conditioning and fatigue are adequately represented in the context of natural living conditions in epidemiological studies. The most important studies focus on coronary heart disease, myocardial infarction, stroke and arterial hypertension.

"Data from a large prospective cohort study, the Gutenberg Health Study (N = 15,010, conducted at the University Medical Center Mainz) demonstrate that noise-induced annoyance caused by various sources during the day and at night, including aircraft, road traffic and railway noise, is dose-dependently associated with an increased risk of atrial fibrillation[6]."

Image: © Mitifo | Dreamstime.com

Stable coronary heart disease

Three meta-analyses showed that traffic noise leads to a significant increase in coronary heart disease[8-10]. A meta-analysis from 2015 by Vienneau et al. included studies on the relationship between aircraft and road traffic noise and incident risk of coronary heart disease[8]. A pooled relative risk (RR) of 1.06 was found starting at 50 dB (A) and per 10 dB (A) increase Lden (weighted day (7 a.m to 7 p.m), evening (7 p.m to 11 p.m), night (11 p.m to 7 a.m) level over a period of 24 hours, with a penalty of 5 dB (A) for the evening hours and 10 dB (A) for the night hours). This effect persisted after further adjustment for air pollution (mainly nitrogen oxide (NO_X) or nitrogen dioxide (NO_2) which were assessed in a subgroup of studies) and after exclusion of studies with no information on smoking status. A meta-analysis of Babisch reached a similar result (RR 1.08) starting at 52 dB (A) and per 10 dB (A) increase Lden (weighted day, night level over a period of 24 hours, with a penalty of 10 dB (A) for the night hours) road traffic noise[9].

In a recent meta-analysis from 2018 conducted by the WHO, the analysis of longitudinal studies showed that road traffic noise increased the risk of incident coronary heart disease by 8%, starting at 50 dB (A) and per 10 dB (A) increase Lden[10]. Since increasing volumes of traffic is not only a concern in terms of noise exposure but also lead to an increased air pollution load, a differentiation of both variables is needed in order to distinguish between effects. Despite the high correlation of both variables, noise and air pollution are considered to have independent and adverse effects on the cardiovascular system(11).

Acute myocardial infarction

Further cohort studies with comprehensive adjustment for air pollution, socioeconomic status and lifestyle factors have found a significant relationship between road traffic noise and the incidence of myocardial infarction[12, 13]. Data from a large Danish cohort (N = 50,744) showed that road traffic noise exposure (10-year average) was associated after adjustment for NO_2 levels with increased risk of myocardial infarction with a hazard

ratio (HR) of 1.12 per interquartile range Lden(12).

Similar results were found for a Swedish cohort (odds ratio 1.38) for road traffic noise [13]. A nationwide Swiss cohort study (N = 4,415,206) investigated the impact of aircraft, road traffic and railway noise on cardiovascular mortality [14]. The strongest relationships after adjustment for NO_2 levels were found for mortality due to myocardial infarction with an HR of 1.038 for road traffic, 1.018 for railway and 1.026 for aircraft noise starting at 30 (rail and aircraft noise) or 35 dB (A) (road traffic noise) and per 10 dB (A) increase.

In a further analysis of a Danish cohort (N = 57,053), road traffic noise exposure increased the risk of incident myocardial infarction by 12% starting at 42 dB (A) and per 10 dB (A) increase Lden after adjustment for NO_x levels, smoking status, education and diet [15].

Stroke

Based on a large-scale cohort study (N = 57,053), Sørensen et al. established that road traffic noise, independent of NO_X levels, smoking status, diet and alcohol consumption, increased the risk of stroke by 14% starting at 55 dB (A) and per 10 dB (A) increase Lden[16]. A further large-scale study including 3.6 million residents around London Heathrow Airport showed that aircraft noise during day (7 a.m to 11 p.m) as well as during night (11 p.m to 7 a.m) was dose-dependently associated with increased hospitalisation after stroke after control for age, sex and lifestyle factors with a higher hospitalisation risk for noise during day than night [17]. Similar results were found in the same study for mortality after stroke, even after adjustment for particulate matter exposure (PM10 – particles less than 10 micrometres in diameter). These results indicate that in particular night-time aircraft noise is associated with the adverse effects on the cardiovascular system. Another study that included 8.6 million residents of London found that road traffic noise was associated with an increased risk of stroke-related hospital admission [18]. In addition, the study could demonstrate that road traffic noise (>60 vs. <55 dB (A)) during the day was significantly associated with increased all-cause mortality in adults.

Arterial hypertension

A meta-analysis of 24 studies showed that road traffic noise is associated with an increased risk of hypertension starting at 45 dB (A) and per 5 dB (A) increase[19]. However, since this analysis only included cross-sectional studies, the causal interpretation is limited. In further large-scale prospective studies, however, a relationship between aircraft and road traffic noise exposure and increased risk of hypertension could be demonstrated [20-22], with a higher impact for night-time aircraft than for road traffic noise [22].

Mechanistic insight from translational studies

There are only a few studies that provide mechanistic insight into the relationship between noise exposure and markers of cardiovascular risk. More recently, our group demonstrated that simulated night-time noise (30 and 60 flights/night, peak sound level of 60 dB (A), mean sound level of 43 and 46 dB (A), respectively) in healthy subjects and in patients with prevalent coronary heart disease is associated with worsening of vascular (endothelial) function (measured by flow-mediated dilation), increased stress hormone levels (epinephrine) and decreased sleep quality [23, 24]. Interestingly, the impairment of vascular function in healthy subjects was significantly improved by the single administration of vitamin C (2g, p.o. [23]). This suggests that increased oxidative stress was at least in part responsible for aircraft noise-induced impairment of endothelial function. Two recent animal studies could further reveal relevant molecular mechanisms by which noise induces vascular dysfunction [25, 26].

Hereby, Münzel et al. demonstrated that simulated aircraft noise exposure for four days led to a significant increase in stress hormone levels, increased blood pressure, changes in vascular wall gene expression and impaired vascular function, mainly due to an increased free radical formation and oxidative stress [25]. With these studies, two important enzymes were identified being involved in the initiation of aircraft noise-induced vascular dysfunction: the nicotinamide adenine dinucleotide phosphate oxidase (NADPH oxidase) and the nitric oxide synthase (NOS). The noise-induced dysregulation of these enzymes enhanced the formation of reactive oxygen species, which directly led to decrease the vascular bioavailability of nitric oxide (NO), an important radical with powerful vasodilator and antiatherosclerotic properties and thus resulted in the impairment of endothelial function (Figure 2). Our group also demonstrated that in addition to vascular dysfunction, cerebral damage was notified when aircraft noise was applied during the sleep but not during the waking phase [26].

Thus, these findings confirm results from sleep research which demon-

strated that short and fragmented sleep is associated with increased risk of cardiovascular disease [27]. A recent WHO meta-analysis showed that traffic noise significantly increases the risk of sleep disorders, which may be a relevant factor in the development of cardiovascular disease [28]. Results of the SAPALDIA study (Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults) also showed that the amount of traffic noise events, especially at night, is associated with increased arterial stiffness, an important marker of vascular dysfunction [29].

Summary and conclusions

Epidemiological studies could clearly demonstrate that traffic noise exposure is a significant risk factor for the development of cardiovascular disease. Current experimental studies emphasise that (in particular night-time) noise may induce vascular dysfunction triggered by the increased formation of free radicals, inflammatory processes and oxidative stress at the vascular and cerebral level, which in turn promote increased blood pressure and atherosclerosis. These studies could identify crucial pathophysiological markers that may further allow the development of drug strategies in order to minimise the adverse effects of noise on the organism. The present results also show that traffic noise is a novel cardiovascular risk factor. Considering the new WHO noise guidelines with recommendations for significantly lower noise levels during the day- and night-time [30], actions are needed that allow adequate protection against the adverse health effects of traffic noise and, in particular, noise during night-time.

Key messages

- Epidemiological studies show that traffic noise increases the risk of cardiovascular diseases such as arterial hypertension, coronary heart disease, myocardial infarction and stroke.
- Acute and chronic noise exposure trigger stress responses that lead to activation of the autonomic and endocrine system, initiating development of cardiovascular risk factors.
- Pathophysiologically, night-time traffic noise, in particular, induces oxidative stress and inflammatory processes at the cerebral level, which negatively affects the vascular system and lead to endothelial dysfunction and an increase in blood pressure.
- Traffic noise has to be acknowledged as an important risk factor for cardiovascular disease, a risk factor that cannot be modified by patients or doctors but rather by politicians introducing noise limits that protect the people from adverse cardiovascular effects by noise.
- Accordingly, more emphasis has to be put on the implementation of noise mitigation strategies.

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Abbreviations:

Lden: Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise (i.e. 19.00-23.00).

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The childhood obesity challenge: Improving the health of the next generation

Adam Fletcher, Head of British Heart Foundation (BHF) Cymru tells us exactly what the key ingredients are for improving the health of the next generation

In just a few decades, childhood and family life have changed beyond recognition. Children now typically spend more time indoors and in front of a screen than ever before. Combined with major changes in how food is produced, marketed and sold, this has had a significant impact on children's weight.

Today in the UK, nearly 30% of children are obese or overweight [(1)]. Overweight or obese children are five times more likely to become obese adults and the progress that has been made in reducing mortality from heart and circulatory diseases, such as heart attacks and stroke, is beginning to stall because of these trends [(2)].

BHF-funded research has helped understand the connections between obesity, diabetes and heart and circulatory diseases. Adults with diabetes are two to three times more likely to develop heart or circulatory diseases [(3)]. This is because high levels of glucose in the blood can damage artery walls. This can lead to a build-up of fatty deposits increasing the risk of heart attacks and stroke.

A range of actions are now urgently needed to improve children's diet, as well as changes to our schools and communities to support children and families to be more active.

Improving children's diets

As a member of the Obesity Health Alliance, the British Heart Foundation is advocating for the introduction of a new 9 pm 'watershed' for the advertising of high fat, salt and sugar products across all media that children are exposed to. This would protect children not just from adverts in print and broadcast on the TV and radio but also from digital advertising online and via social media, apps, games and in public spaces. The evidence supports limiting the power of advertising, which can lead children to pester their parents to buy certain products as well as influencing the total amount they eat [(4)].

Changing school settings to restrict the sales of less healthy food is also an effective approach, although the effectiveness of these 'junk food bans' within schools is limited where local supermarkets and other retailers close to schools are promoting unhealthy products and using buy-one-get-one-free and multi-buy offers. For this reason, it is vital that the government's commitment to further restrict promotions in the retail sector is implemented fully.

Families can also be supported to make healthier choices through better nutritional information. We have recently seen an important government pledge to make calorie labelling on the menus in restaurants, cafes, pubs, coffee shops and takeaways mandatory. This is an important commitment and must apply as widely as possible to have an effect. 'Traffic light labelling,' showing the sugar, salt and saturated fat content of foods, should also be widely available for foods we eat both at home and on the move.

We also need to see greater progress in reducing the sugar, salt and calorie content of food and drink. Increasing the current levy on sugary drinks and extending this levy to other products may be necessary to bring forward this progress. The Chief Medical Officer for England has suggested widening the current levy to include sweetened milk-based drinks and baby foods with added sugar. As well as changing consumer behaviour, 'sugar taxes' can be important in encouraging manufacturers to change their products.

Adam Fletcher, Head of BHF Cymru

More active childhoods

Most schoolchildren do not meet the Chief Medical Officer's guidelines of 60 minutes or more physical activity a day, every day of the week. Low levels of physical activity compound the problem of poor diets and contribute to the overall burden of childhood obesity.

One promising approach for encouraging greater physical activity in schools is the 'Daily Mile' – this is a simple and free way of getting all children out of the classroom for about fifteen minutes every day to run or jog, at their own pace, with their classmates. 'Active lessons' in which pupils spend time in the classroom being active while learning is also a popular and effective way to improve both students' education and health together.

In addition, we need to focus on how built environments can facilitate more active lifestyles for children, including through investment in the active travel infrastructure. Local authorities who want to use their powers to promote active travel should be supported to do so. At a national level, to ensure healthy community environments, policy areas such as urban planning and transport should be 'health proofed' more effectively.

Ending health inequalities

While increasingly prevalent nationally, that is not to say obesity is evenly distributed: children growing up in poor areas are even more likely to be overweight. By age 11, obesity rates are twice as high in the most deprived areas compared to the least deprived [5]. This will reinforce current inequalities in heart and circulatory diseases later in life.

Reducing the number of children growing up in poverty is vital for improving all aspects of child health, including reducing the number of children who are overweight or obese. Policies such as free healthy breakfasts and lunches and school-holiday food and fitness clubs can also help to mitigate some of the impact of childhood poverty on diet and ill health in deprived communities.

Another way to try and address these massive inequalities is to target more intensive and costly programmes at the most deprived communities, such as family-focused weight loss interventions for children who are overweight and annual child measurement as recommended by the Royal College of Paediatrics and Child Health (RCPCH). However, such approaches should be trialled before being rolled out due to uncertain benefits and the high costs involved.

Obesity during childhood and youth has now reached epidemic proportions and represents a potential time bomb for the future burden of heart and circulatory disease, especially in the poorest communities. Only through a new mix of evidence-based approaches will the challenge of childhood obesity be addressed effectively. ■

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Implementing infection prevention and control (IPC) programmes worldwide

We spoke with Prof Benedetta Allegranzi at the World Health Organization (WHO) to find out about the importance of implementing infection prevention and control (IPC) programmes to reduce healthcare-associated infection (HCAI) and sepsis worldwide

The World Health Organization (WHO) calls on everyone to be inspired by the global movement to achieve universal health coverage (UHC), that is, achieving better health and well-being for all people at all ages, including financial risk protection, access to quality essential healthcare services and to safe, effective, quality and affordable essential medicines and vaccines for all. Infection prevention and control (IPC), including effective hand hygiene, is a critical part of achieving UHC because it is a practical and evidence-based approach that has a demonstrated impact on the quality of care and patient safety across the health system.

In this interview, Prof Benedetta Allegranzi shares her thoughts on why WHO is calling health facilities and governments worldwide to establish and implement infection prevention and control (IPC) programmes to reduce especially healthcare-associated infections (HAIs) and sepsis. This is because there is strong evidence that specific measures, such as effective hand hygiene can reduce the transmission of pathogens, spread of antimicrobial resistance (AMR) and the occurrence of HAIs which all pose a major health problem worldwide.

The conversation includes a focus on the extent to which HCAIs and sepsis affects patients every year on a global scale. Benedetta explains that according to WHO estimates hundreds of millions of patients are affected annually by HCAIs. In Europe, every year almost 9 million patients acquire an infection while receiving care in hospitals and long-term care facilities. On average, HCAIs affect 7% and 15% of patients in high-income and low- and middle-income countries, respectively. Hospital-born babies in low- and middle-income countries are at a higher risk of being affected by neonatal sepsis, with infection rates three to 20 times higher than in high-income countries. Overall, sepsis affects more than 30 million people worldwide every year, potentially leading to 6 million deaths. Benedetta then develops this key point to us in further detail.

"It is estimated that the burden is much higher in low- and middle-income countries and it affects specific populations, for example, it is estimated that there are 3 million newborns and 1.2 million children suffering from sepsis globally every year.

"Among pregnant women, this is also a major issue, for instance, sepsis is estimated to cause 1 in 10 maternal deaths on average. Most of this occurs in low- and middle-income countries, so these are the most affected populations."

Last year, the focus of the WHO SAVE LIVES: Clean Your Hands 5 May campaign was the prevention of sepsis in healthcare, something that Benedetta is keen to elaborate on.

"The focus was the prevention of sepsis and this can happen in two ways. Firstly, preventing pathogen transmission and infection reduces the number of infections. This is the first step towards preventing sepsis, which is the clinical evolution of an infectious status to a life-threatening illness that injures tissues and organs; therefore, if you prevent infection this contributes to reducing sepsis. Prevention of infection is mainly based on using effective hygiene practices such as hand hygiene, both in health facilities and the community, and establishing functioning infection prevention and control programmes in health care facilities.

"Secondly, to reduce sepsis itself, it is important to recognise sepsis signs and symptoms timely and treat it appropriately with antibiotic treatment of infection and supportive therapy."

Continuing the themes of SAVE LIVES: Clean Your Hands 5 May 2018, Benedetta then underscores the key messages to convey in this respect, such as why ministries of health should implement the 2017 WHA sepsis resolution and make hand hygiene a national marker of healthcare quality. By way of background, WHO Member States adopted a resolution on improving the prevention, diagnosis and treatment of sepsis at the Seventieth World Health Assembly in May 2017.

"First of all, it is really important to remember that all WHO Member States endorsed this resolution on sepsis which is about improving the prevention, diagnosis and clinical management of sepsis. Therefore, there are specific actions that the WHO Member States or countries should establish, including education and training as Benedetta goes on to explain in more detail.

"Firstly, they should raise more awareness about this problem with different audiences, of course, such as health care professionals, patients, patient associations and the community for the early recognition of the signs and symptoms of potential situations which can evolve to sepsis. Of course, in this approach, there is also a need for raising awareness of the importance of this problem using the data mentioned earlier on the extent to which sepsis affect patients, so people can understand that this can potentially be a big problem. An effective way to raise awareness is to launch local or national campaigns on sepsis.

"At the national level, it is important to develop policies and guidelines on sepsis prevention, diagnosis and clinical management according to the 2017 WHA sepsis resolution. Also, health systems should educate and support general practitioners (GPs) who are frontline professionals who may recognise sepsis in a timely manner when a patient has an infection which has evolved into a severe condition.

"Emergency staff and these type of healthcare professionals are also crucial but so are patients and communities who need to understand the severity of this condition and recognise the early signs and symptoms. Guidance and toolkits enable processes which detect sepsis timely and immediately establish the right treatment this goes with education and training, which should be different depending on the target audience, such as highly specialised training for emergency professionals to handle sepsis in an appropriate way.

"On diagnosis, there are specific diagnostic tests that can be done to recognise the condition of sepsis and not all of these are currently available in all countries. As such, the provision of diagnostic tools and equipment can be quite important when we talk about a healthcare system and infrastructure at the national level for countries and governments."

To bring the discussion to a close, Benedetta highlights that sepsis and septic shock are really life-threatening conditions which can emerge in terms of the evolution of infection. This often happens when inappropriate or ineffective treatment is given for an infection. When treatment is ineffective, it means that AMR plays an important role in the sense that it can be a factor which jeopardises the effectiveness of antibiotic treatment that is given for infection.

"As you may know, AMR is a threat and a big problem in most countries and, therefore, strategies for sepsis prevention should include strong national action plans and activities to reduce AMR and, in particular, to preserve the use of specific antibiotics which are still effective but if misused they will certainly become ineffective in the future." ■

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Tackling sepsis through hand hygiene

Chris Wakefield, Vice President, European Marketing & Product Development, at GOJO Industries-Europe Ltd explores hand hygiene and how infection prevention measures can be strengthened to help save lives

According to the UK Sepsis Trust, each year in the UK, there are around 250,000 cases of sepsis,[1] a rare but serious complication of an infection. It is often called 'the silent killer', because, without quick treatment, it can lead to multiple organ failure and death. Sepsis is believed to be the cause of around 46,000 deaths in the UK every year[2]. That's a greater number than bowel, breast and prostate cancer combined[3].

> "Infection prevention and control isn't down to one person or product; it's everyone's challenge. Only by comprehending and being aware of good hand hygiene behaviour and its consequences for patient protection, can we tackle the effective prevention of problems such as sepsis."

Awareness of this dangerous condition is increasing amongst consumers and healthcare professionals alike, due to high profile coverage on national television, as well as an increasing number of 'real-life' stories appearing in the national press. The focus of these items is often to help others spot the symptoms, as this condition is notoriously difficult to diagnose.

Rarely highlighted, however, are the strategies which can help prevent sepsis from developing in the first place. It is a fact that good hand washing and sanitising practice not only play a key role in the prevention of sepsis in healthcare but can also help fight the spread of antibiotic resistance.

This fact is also supported by the WHO (World Health Organization). Last year, it called on all health facilities to prevent healthcare-associated sepsis through hand hygiene and infection prevention and control (IPC) action, via its 'It's in Your Hands' campaign. On World Hand Hygiene Day this year, (5th May 2019), the WHO will be continuing to promote the importance of good hand hygiene, via its annual SAVE LIVES: Clean Your Hands message.

Success hinges on compliance

It is vital that everyone in a healthcare setting takes all appropriate steps to prevent infection, including paying careful attention to hand hygiene. This is important for staff, who already make this part of their daily lives, but, also, importantly, for visitors and patients themselves – as everybody must comply for infection to be prevented effectively.

Startling research, however, shows that 25% of people don't wash their hands after using the washroom[4], while a further 46% don't wash long enough to be effective.[5] This highlights a genuine huge need for education and awareness so that everyone understands why, how and when hands should be cleaned.

As a founder member of the Private Organizations for Patient Safety group, GOJO Industries-Europe is a strong

advocate of the 'total solution' approach to making hand hygiene second nature to everyone. This means everyone understanding the importance of hand hygiene and having the right products available in the right place, at the right time, to carry it out. A truly successful hand hygiene system should combine three key strategies: Accessibility, scientifically advanced formulations and education.

Accessibility is key

It is particularly vital that there are adequate, appropriately positioned, hand hygiene facilities at the point of care. Dispensers should be easily accessible, simple to use, and as close as possible – ideally within an arm's reach of where patient care or treatment is taking place. Importantly, point-of-care products should be accessible without having to leave the patient zone.

Dispensers can be wall-mounted, free-standing, push-activated or touch-free. Touch-free dispensers are becoming increasingly popular. Intuitively sensing the presence of hands, they dispense just the right amount of product every time, and the fact that they are touch-free also increases their hygiene rating.

Scientifically advanced formulations

Choose soaps and sanitisers which are hospital grade and kind to skin – these can be gel or foam format. Choose formulations that have been tested and have passed key hospital norms EN 1500, EN 14476 and EN 12791, for assurance that they are safe for use in healthcare locations.

The high frequency with which many healthcare workers wash or sanitise their hands means that the formulations must also be gentle on the skin. If using hygienic hand rubs, which is a popular choice in healthcare settings, choose one that is at least 70% ethyl-alcohol, clinically proven to kill germs within seconds.

> "...25% of people don't wash their hands after using the washroom, while a further 46% don't wash long enough to be effective. This highlights a genuine huge need for education and awareness so that everyone understands why, how and when hands should be cleaned."

Education and awareness

Putting up notices, posters and other visual displays in key germ hot-spots such as washrooms and waiting areas is fundamental to improving hand hygiene behaviour. They make very effective prompts, but can also offer advice on the best techniques. Good hand hygiene companies can offer sound advice on the most effective approaches, as well as provide materials, based on their knowledge and market insight.

Accessibility + Formulations + Education = Success

For a truly successful hand hygiene system, these three elements must be joined together – without one, the system will not work effectively. People must learn the benefits of good hand hygiene, and understand that they play an important role in improving health outcomes, not only in health care settings but in their everyday lives, through their own health, well-being and productivity.

Infection prevention and control isn't down to one person or product; it's everyone's challenge. Only by comprehending and being aware of good hand hygiene behaviour and its consequences for patient protection, can we tackle the effective prevention of problems such as sepsis.

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Introducing cystic fibrosis (CF) from an expert perspective

Gary Connett from the University Hospital Southampton NHS Foundation Trust introduces the subject of cystic fibrosis (CF) from his expert perspective, on behalf of the Cystic Fibrosis Trust

The UK has one of the highest incidences of cystic fibrosis (CF), just behind Ireland, according to Dr Gary Connett from the University Hospital Southampton NHS Foundation Trust, who we were fortunate to interview on behalf of the Cystic Fibrosis Trust.

By way of introduction, we know that cystic fibrosis (CF) is a genetic condition affecting more than 10,400 people in the UK. Those affected are born with CF and cannot catch it later in life, but one in 25 of us carries one copy of the faulty gene, usually without knowing, as this does not cause symptoms. Two faulty genes are needed for CF to occur. Dr Connett reveals his own thoughts on CF, which affects both children and adults.

"It is the most common genetic, life-limiting disease and is caused by the lack of a protein that works on controlling the movement of salt and water across cell surfaces. When the protein is missing secretions on the cell surface get sticky and clogged up. This results in severe complications particularly affecting the lungs, the digestive system and can also cause diabetes, liver damage and, in the majority of cases, early death from respiratory complications."

The conversation then turned to detail Dr Gary Connett's views on new precision medicines and their potential role in improving the outlook for CF children and adults. He explains that the current treatment of CF is very much about battling the complications that occur as a result of the underlying defects in the cells which go wrong. He elaborates on this in his own words:

"We're treating the infections with antibiotics, we're trying to correct the malnutrition, and we're using lots of treatment to increase the clearance of airway secretions, but all of this is downstream from the underlying problem. What these new medicines offer is the potential to actually get to the root cause of the problem and treat the underlying defect at the cellular level; putting back the missing protein at the cell surface to make things work for the patients."

Artificial intelligence (AI) to improve respiratory care

Dr Connett then shares his opinion on advancements in artificial intelligence (AI) to improve respiratory care, indeed, he believes that it has great potential for CF patients. He tells us that CF is well placed to benefit from AI and machine learning because there is robust data currently available about CF patients held on the CF registry developed by the CF Trust for all affected UK patients.

> "The research priorities for cystic fibrosis (CF) will now be concerned with identifying the best products within this next-generation of treatments and getting these to patients. There will be ongoing issues around adherence and we know that it is human nature to not always take what is in your own best interests. We need to do as much as possible to support patients to take all their treatments for maximum benefit. These medicines also have to be made available at a fair price for NHS patients."

"These data lend themselves to machine learning through AI software programmes. Colleagues have already been using these data to predict the timing of the need for a lung transplant amongst more severely affected patients. The use of AI software can better predict when a transplant is needed, which is likely to result in more timely operations with better outcomes. The rich data source held on the UK CF registry lends itself to many other AI analyses for the benefit of patients and it is hoped that this will happen in the near future.

The way forward for respiratory care and research priorities

In closing, Dr Connett leaves us with his thoughts on the way forward for respiratory care for CF patients and future research priorities in the field. He underlines the successes in CF that have been achieved through the effectiveness of multi-professional teams working according to high standards of specialist care. He stresses how therapies, that he hopes will shortly be available for all who might benefit, are an unprecedented step change and that there is great excitement about this in the CF community.

"Good CF care is very much a team-based approach including doctors, nurses, dieticians, physiotherapists, psychologists, pharmacists and a whole host of healthcare professionals working together in the best interests of patients. Paying attention to detail, ensuring good adherence to treatment and supporting families and affected individuals are all important components of care.

Future treatments are at an exciting stage of development with potential benefits that we have not seen with previously available therapies. The next-generation of these medicines are likely to be even more effective in correcting the missing CF proteins at the cellular level and should benefit the vast majority of CF sufferers.

"The research priorities for CF will now be concerned with identifying the best products within this next-generation of treatments and getting these to patients. There will be ongoing issues around adherence and we know that it is human nature to not always take what is in your own best interests. We need to do as much as possible to support patients to take all their treatments for maximum benefit. These medicines also have to be made available at a fair price for NHS patients." ■

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Employing "living biobanks" to advance biomedical research

A group of seasoned experts from the International Society for Biological and Environmental Repositories explain the notion of employing "living biobanks" to advance the field of biomedical research

Technological advancements over the recent decades have enabled the long-term storage of high-quality biological material at very low temperatures. We can now store biological material for a great length of time in biobanks: where biological samples (bodily fluid or tissue) and associated data are collected, annotated, transferred, stored and redistributed for future research in order to improve our understanding of health and disease. The process which enables the preservation of structurally intact living cells and tissues is called "cryopreservation." More specifically, during cryopreservation, biological materials are cooled to cryogenic temperatures, commonly to -196 °C/-321 °F the temperature of liquid nitrogen. At these low temperatures, biological activity slows considerably, effectively halting the biochemical reactions that lead to cell death and DNA degradation and allowing for near indefinite storage of the samples.

Recent scientific advances in cryopreservation have enabled the prospect of establishing "living biobanks" that store viable, functional tissue or replicable cell types for years to decades. This could have a significant impact across basic biological research, medicine and the biopharma industry; however, the effects of such applications are underexplored. For example, banking and long-term storage of stem cells or stem-like cells in different stem cell platforms represent a fundamental resource, preserving the original features of stem cells for patient-specific clinical applications.[1]

The International Society for Biological and Environmental Repositories (ISBER) recently held a roundtable discussion at the 2018 annual meeting on this concept, building on a National Science Foundation (NSF, U.S.)-funded technology road mapping process, the recent "Organ Banking Summits" held at Harvard and Stanford Universities, and roundtable discussions were held at the White House and on Capitol Hill during the last several years. Further demonstrating the application and promise of these technologies, the National Cancer Institute (NCI) recently launched a new project entitled "The Human Cancer Models Initiative (HCMI)" which is a collaborative international consortium that is generating novel, next-generation, tumour-derived culture models (living biobanks) annotated with genomic and clinical data.

The "Apollo Program" of living biobanks

The above meetings focused on developing a mini-"Apollo Program" in cryopreservation to lengthen the shelf-life of living tissues and whole organs. Early proofs of concept for such research advances include the banking of whole sheep ovaries (resulting in live births), human digits, human cartilage, and a rabbit kidney at deep cryogenic temperatures and storage of organs such as rat hearts and rat livers at high subzero temperatures. The U.S. government is currently funding dozens of labs to develop cryopreservation methods for living tissues. This concept has received significant support from diverse stakeholder organisations such as (i) the International Society for Cryobiology, which has co-organised several meetings and sessions on the concept, and the (ii) American Society of Transplantation, which launched a new branch of its organisation focused on this concept. A number of organisations were signatories to a consensus article in Nature Biotechnology outlining the vast potential of these advances to change the landscape of medicine and biomedical research.[2]

Researchers agree that many biobank tissues represent "low hanging fruit" in this effort, as the technical hurdles are much lower for collections of cells or simple tissues than for larger vascularized tissues or whole organs. There are a great number of tissues (or cells) and/or

biologics that could soon be stored in "living biobanks". These can include solid tumour biopsies, organ and brain slices, resected brain tissue, cadaveric donor skin, cadaveric bone marrow, reproductive organs and tissues, pancreatic islets, a variety of neonatal tissues, and blood vessels.[3]

"The U.S. government is currently funding dozens of labs to develop cryopreservation methods for living tissues. This concept has received significant support from diverse stakeholder organisations such as (i) the International Society for Cryobiology, which has co-organised several meetings and sessions on the concept, and the (ii) American Society of Transplantation, which launched a new branch of its organisation focused on this concept. A number of organisations were signatories to a consensus article in Nature Biotechnology outlining the vast potential of these advances to change the landscape of medicine and biomedical research."

Potential impacts

The awaiting scientific discoveries are only one of the essential steps towards a great many potential applications. Techniques currently developed within the context of living biobanks and cryopreservation of living tissue can be applied in preclinical testing, designing disease models, biomarker discovery, toxicity (safety) evaluation of pharmaceutical agents, greatly improved tissue quality for immunohistochemistry (IHC) leading, for example, to precision medicine approaches in the diagnoses and treatments of cancer types.[4]

This same concept is already being applied to cell lines such as tumour and primary epithelial cells, for example, patient-derived xenograft models, organoids, conditionally reprogrammed cells, induced pluripotent cells, and other cancer precision medicine applications, these represent an unexhausted resource of living biobanks. However, these concepts are applied in very many different ways by the academic and private sectors, representing an actively growing field that has yet to reach clinical consensus or maturity. ISBER is launching a special interest group to explore these and other applications. This group will unite stakeholders in these diverse areas, who will aim to provide (hopefully universal) recommendations to guide the development of new biobanking technologies and ultimately the establishment of the first living biobanks.

Even without further advances in cryopreservation technology, the existing technological opportunities today can greatly expand the number and applications of living biobanks. However, key challenges need to be overcome in order to capitalise on these opportunities, including a clearer articulation of both the scientific and clinical impact, as well as of the prioritisation of funding and regulatory actions required to allow this emerging field to reach its full potential. ■

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Anaemia: Challenges and concerns on iron deficiency

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group provides an overall perspective and analysis on the public health concern of anaemia, including the challenges and concerns when it comes to iron deficiency

According to the World Health Organization (WHO), anaemia is a public health concern that affects low-, middle- and high-income countries through highly relevant adverse consequences on both health and socioeconomic development. Anaemia implies a low blood haemoglobin concentration. However, measurements of haemoglobin, even along with mean corpuscular haemoglobin concentration, mean corpuscular volume, total iron-binding capacity, transferrin saturation, and zinc-erythrocyte protoporphyrin, among other tests, are not reliable indicators to determine the cause of anaemia.

The most significant contributor to anaemia is iron deficiency, leading to a type of anaemia named as iron deficiency anaemia. Indeed, near to 50% of cases of anaemia are associated with iron deficiency, in addition to adjacent causes of anaemia, including micronutrient deficiencies, such as folate, riboflavin, vitamins A and B12; acute and chronic infections, such as malaria, cancer, tuberculosis and HIV, and inherited or acquired disorders related to haemoglobinopathies (Bouri and Martin, 2018).

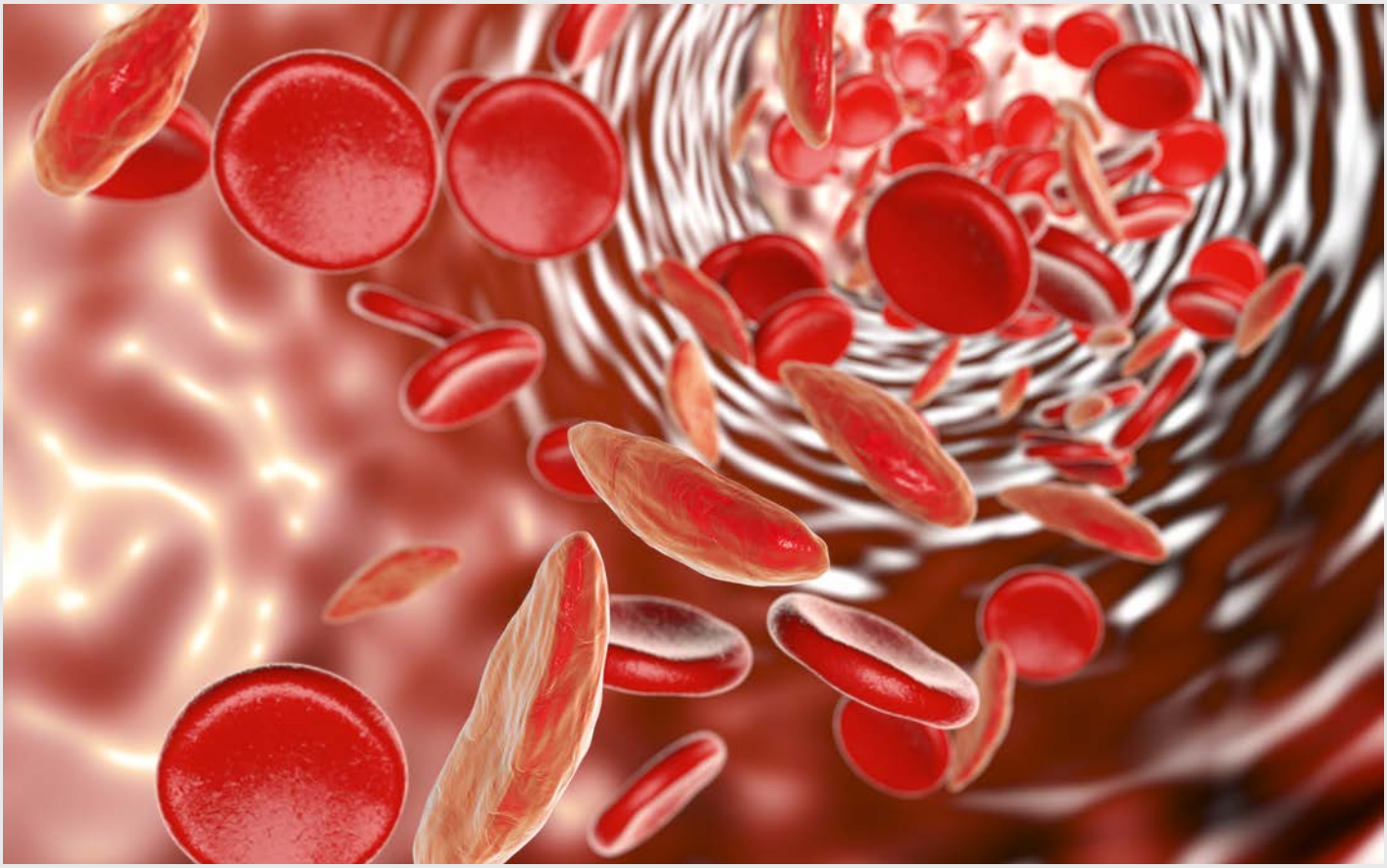
About the most significant health concerns related to iron deficiency adversely affects, deficiencies in cognitive and motor development causing extreme fatigue and low productivity are the most frequently noted. During pregnancy, iron deficiency anaemia may lead to low birth weight and an increased risk of maternal and perinatal mortality. The Micronutrients Database of the WHO Vitamin and Mineral Information System (VMNIS) summarises data on the micronutrient status of populations, collected from the scientific literature and through collaborators, including WHO regional and country offices, United Nations organisations, ministries of health, research and academic institutions, and non-governmental organisations. According to the information provided by VMNIS, approximately 43% of children, 38% of pregnant women, and 29% of women of reproductive age have anaemia globally, which represents around 273 million children, 496 million non-pregnant women and 32 million pregnant women worldwide (Eshag and Lindow, 2018).

Treatment and surveillance

Adequately treating anaemia demands an integrated approach founded on recognising and tackling the most remarkable contributing factors. From a public health perspective, iron deficiency anaemia should be addressed over the base of a dietary diversification and improved access to food, in combination with iron supplementation programmes (Minck et al., 2018). Other community actions must include programmes related to the treatment and prevention of infectious diseases (Rao et al., 2018). However, public initiatives must be also reinforced with new approaches to the disease, also tackling underlying causes not directly related to socioeconomic conditions (McGrath and Cotter, 2018).

Broadly speaking, iron deficiency is the consequence of a long-standing negative iron balance. Iron is stored mostly in the liver as ferritin or hemosiderin. When these molecules begin to progressively diminish their concentration, the needs of normal iron turnover cannot be met any more. From this critical point onward, this deficiency starts to compromise the supply of iron to the transport protein apotransferrin, and subsequently, transferrin saturation diminishes, whereas transferrin receptors in the circulation and on the surface of cells, including the erythron, increase.

Regarding therapeutics innovation, it is important to highlight that most oral iron therapeutics enclose



the ferrous form of iron (Fe^{2+}). However, recent innovations are starting to provide stable complexes for delivery by tightly binding ferric iron (Fe^{3+}) to three maltol molecules, thereby resulting in a more effective, well-accepted oral iron treatment. Ferric maltol molecules allows developing more stable delivery methods facilitating iron absorption while minimising iron accumulation in human tissue and free-radicals generation in the gut. This molecular behaviour prevents further damage by free radicals in the gastrointestinal mucosa, hence avoiding inflammation and/or iron overload.

Final remarks

The WHO's second global nutrition target for 2025 calls for a 50% reduction of anaemia in women of reproductive age. This goal can only be achieved through a synergistic combination of key programmes that address the most relevant factors contributing to a low blood haemoglobin concentration in human tissues, adequately customised to local conditions, aetiology and the prevalence of anaemia. ■

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Delivering a sustainable healthcare system: Protecting health in Japan

The mission of the Ministry of Health, Labour and Welfare (MHLW) in Japan in protecting people now and in the future, as well as delivering a sustainable healthcare system, are detailed here

The mission of the Ministry of Health, Labour and Welfare (MHLW) in Japan can be summed by the catchphrase: "For people, for life, for the future." On the Ministry's website, we find out that this catch-phrase concisely summarises the notion that MHLW takes a role in protecting people and their lives – not only now but also in the years ahead.

Probing further into this most important notion, we learn that to achieve this purpose, action guidelines have, therefore, been set out for employees at the Ministry to abide by which are:

- The Ministry undertakes its tasks in a fair manner in accordance with high ethical standards.
- They supply administrative services in response to the demands of the public and times we live in.
- They also act from the point of view of individual citizens.
- They also strive for an open government approach, which is facilitated by providing information in an easy-to-understand way.

In addition, it's also important to add to put the afore-mentioned guidelines into practice, so the Ministry must be mindful of the following factors on a daily basis as they undertake their duties and take an active approach:

- The Ministry carries out their work efficiently and quickly by approaching their job with a sense of both pride and responsibility.
- They locate issues on their own initiative and work together to seek a solution.
- They also endeavour to keep up their level of ability and to remain in a state of continual improvement. (1)

"Amidst rapid population ageing, advances in medical technology, and major shifts in healthcare, a healthcare system that contributes to financial stability while engaging each sector of society to support a nation of health and well-being, where each person is empowered to realise their full wellness potential."

Prevention of heat strokes

One example of precisely how the MHLW is protecting Japanese people and their lives is the advice they give when it comes to preventing heat strokes. The important point here is that heat stroke can be prevented if the correct preventative measures are taken. The Ministry's website underlines that the individual must have a correct understanding of heat strokes and be aware of any changes in their physical condition. Added to this, it is also important to watch out for other people and as such, help prevent them from getting heat stroke.

We know that heat stroke happens under the conditions of humidity and high temperature in which case, the balance of the water and salt in the body is disrupted and thermoregulation does not function in the way it should. So, with the accumulation of heat in the body, symptoms such as fatigue, muscle aches, heavy sweating and nausea appear. In some very severe cases, the person experiences a loss of consciousness.

Going back to this point about prevention, in this case, we know that the intake of water and salt is recommended. Added to this, it is recommended that elderly people and children should follow this advice, even if they do not feel thirsty. It's interesting to note that indoor environments can create heat strokes but this can be prevented by adjusting temperatures using air-conditioning and electric fans. Other suggested measures include wearing a hat, seeking shade and not going outside during the afternoon on a very hot day. (2)

Conclusion – the priorities for healthcare in Japan

Looking ahead, the Ministry has a very clear goal to deliver a sustainable healthcare system that delivers unmatched outcomes through care that is responsive and equitable to each member of society, and that contributes to prosperity in the country and across the world. A healthcare system must be designed for all lifestyles and people – including people of all ages and providers – where each person is supported to make the life choices that are right for them. This notion is explored further as we leave the last word to the Ministry of Health, Labour and Welfare (MHLW) in Japan about their vision for the future of healthcare. This takes us back to the point made at the beginning of the article about the Ministry's role in protecting people and their lives – now and in the future.

"Amidst rapid population ageing, advances in medical technology, and major shifts in healthcare, a health-care system that contributes to financial stability while engaging each sector of society to support a nation of health and well-being, where each person is empowered to realise their full wellness potential." (3) ■

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Advancing research and developing new therapies for inherited retinal eye diseases

Takeshi Iwata, Division Director at the National Institute of Sensory Organs, National Hospital Organization Tokyo Medical Center, tells us about advancing research and developing new therapies for inherited retinal eye diseases

The Japan Eye Genetics Consortium (JEGC) was established with the support of the Japanese Ministry of Health, Labour and Welfare to investigate genes responsible for inherited retinal diseases, including inherited optic neuropathy and inherited normal tension glaucoma. Phenotypic information and blood samples were collected from more than 38 ophthalmology departments in Japan. Whole exome analysis was performed for over 2,500 DNA samples collected, resulting in a large number of gene mutation specific to the Japanese population. A number of novel disease-causing genes were also identified in this study. These novel genes will open new insight into how retina functions to maintain normal vision.

Common eye diseases, such as cataract, myopia, glaucoma and age-related macular degeneration are partly due to genetics, but the influence of a person's genotype is more profound in inherited eye diseases. Inherited retinal diseases (IRD) are a group of rare ocular disease which effects retinal function, leading to a number of eye disease including retinitis pigmentosa (RP), macular dystrophy, Stargardt's disease, stationary night blindness and 34 other diseases. These diseases are caused by gene mutation leading to the failure of cell function in the retina, such as photoreceptors, retinal pigment epithelial (RPE) cells, and bipolar cells. Inherited optic neuropathy and inherited glaucoma are caused by the failure of retinal ganglion cells (RGC), another cell type in the retina. Gene mutations are found in dominant, recessive, x-linked or sporadic forms and may change in certain ethnic groups or occur more commonly in particular ethnicities. Over 260 genes have been identified mainly in the Caucasian population but not enough studies have been conducted in the Japanese patients.

To determine the types of IRD in the Japanese population and to identify the disease-causing gene mutation, the JEGC was established in 2011. Initial members were from ophthalmology departments of National Hospital Organization Tokyo Medical Center (NHOTMC), Aichi Medical University, Nagoya University, Mie University, Teikyo University, and Kinki University and the total number now involved has increased to 38. The project was initially funded by the Japanese Ministry of Health, Labour and Welfare and later by the Japan Agency for Medical Research and Development (AMED). This was the first attempt in Japan to survey IRD patients on the scale of the entire country. Since many of the inherited retinal diseases are extremely rare, collaboration at the level of one country is necessary to collect enough patients to study the disease.

Each ophthalmologist enters a patient's phenotype information and the family pedigree into the JEGC Genotype-Phenotype Database. In addition to text-based information, fundus photo, fluorescein angiogram, optical coherence tomography, autofluorescence, electroretinogram (ERG), visual field and other phenotypic images are collected from each patient and family member. To maintain the quality of the diagnostic, JEGC designated ten ophthalmologists specialised in each retinal disease. Saliva or blood samples are sent to the National Institute of Sensory Organs (NISO)/NHOTMC for whole genome analysis. Over 1,400 family pedigrees have been collected, and the consortium aims to gather 5,000 in total. From the beginning of this project, we were surprised to observe that 80% of families studied were found to have novel gene mutations. Approximately 8% of the families were found with a potentially novel disease-causing gene of unknown function. Functional analysis is underway to characterise each of these genes in detail.

In 2015, the funding for JEGC project moved to a new government agency AMED. AMED was established in April 2015 to combine grant funding of three Japanese ministries to catalyse the process of medical innovation and overcome the barriers between ministries, connecting talented research groups in Japan and elsewhere to accelerate medical research and therapeutic development. Under the AMED funding, additional goals of identifying

the molecular mechanisms of disease onset and development of therapies for retinal eye diseases were added to the project. After genetic analysis of over 1,300 patient families, over 100 families are potentially caused by novel genes of unknown functions. JEGC has identified five novel genes for occult macular dystrophy (RP1L1), Leber's congenital amaurosis (CCT2), retinitis pigmentosa (C21orf2), cone-rod dystrophy (C21orf2), macular dystrophy (LRRTM4) and continuously works on the rest of the novel genes. We were able to show that knock-in mice from each gene also developed a patient-like phenotype which adds more proof to the disease association.

Takeshi Iwata

"Common eye diseases, such as cataract, myopia, glaucoma and age-related macular degeneration are partly due to genetics, but the influence of a person's genotype is more profound in inherited eye diseases."

A significant amount of information has been accumulated for how a normal retina functions, however, the biological influence of each gene mutation to a normal retina has not covered for all disease-causing genes. As more novel disease-causing genes are discovered, the mutant functional study needs to catch up. The omics, genome, transcriptome, proteome techniques are being applied to this investigation. Induced pluripotent stem (iPS) cells, from patients are generated and differentiate to neuronal cells, RPE cells or other retinal cells to observe the patient condition in the mimicked cells. We also developed mutant animal models using CRISPR/Cas9 gene editing system to prove that one amino acid substitution can lead to the onset of disease. Protein interaction studies and protein modification analysis is performed as part of the functional analysis of mutant proteins.

These functional analyses provide basic seed information to search for a potential drug to prevent or slow down the progression of the diseases. Such a result was achieved in our lab from functional analysis of inherited glaucoma gene optineurin (OPTN). A mutation in OPTN can lead to severe glaucoma with strong penetration in the family with the mutation. A patient carrying this mutation is likely to lose half of their visual field by the age of 40 and will progress to full blindness by the age of 80. The mutant OPTN E50K protein strongly binds to a protein called TANK binding kinase-1 (TBK1), which gave us drug target. We found that by chemically inhibiting TBK1, this protein association was greatly reduced. We further identified an FDA-approved drug Amlexanox that inhibited TBK1and tested this for a year with disease model OPTN E50K knock-in NTG mice. After one year, we showed that the drug provided significant neural protection from the precursors to glaucoma. JEGC is regularly contacted by pharmaceutical companies from around the world who are planning clinical trials. A number of clinical trials are underway in JEGC.

From the success of JEGC, Asian Eye Genetics Consortium (AEGC) was established in 2014 by four countries. In 2018, a plan to expand to Africa and South America was unanimously approved and Global Eye Genetics Consortium (GEGC) was established. GEGC China was launched in May 2018 and GEGC India in February 2019. In each of the regional GEGC meetings, JEGC has been shown as one of the successful models to maintain its structure representing the entire country. As we move towards an era of globalisation, it would be easier to share genetic eye information through similar organisations from each country. GEGC has now grown to 30 counties and is being promoted to countries throughout Asia, Africa and South America.

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Neurobiological research drives the ability to treat mental illness

Jeffrey Borenstein, of the Brain & Behavior Research Foundation (BBRF) argues that research drives the ability to treat mental illness and details why funding innovative neurobiological research is a priority

Since the war on cancer was declared 50 years ago, billions of dollars have rightfully poured into cancer research. Comparatively, mental illness which affects the lives of one in four people, receives a mere fraction of that amount of money for research. It is impossible to overstate the economic, social and personal toll mental illness takes on individuals and society. Mental illness is a real, treatable, medical condition that affects the brain. We know that living with a mental illness is not a choice, or something that's in someone's control – just like having any other medical condition.

The time has come to declare war on mental illness and place a priority on funding innovative neurobiological research for better prevention, diagnosis, early intervention, and treatment. The field of psychiatry and neuroscience has seen tremendous scientific advances, but we need to expand basic, translational and clinical research to better understand the workings of the brain and why things go wrong and test new medical and psycho-social approaches.

We also need to raise awareness, eliminate stigma, and remove barriers to treatment.

A growing global problem

While we are making progress, the evidence is overwhelming that mental illness is a significant public health crisis.

Suicide is now the 10th leading cause of death among American adults and the second leading cause of death for young people ages 10 to 24. Suicide rates have risen for every age group, except older adults. And a recent study in the British Medical Journal found that incidents of self-harm among girls aged 13 to 16 increased by 68% over a four-year period.

We also continue to see an increase in psychiatric illnesses among veterans, and the rising death toll from alcohol and opiate abuse has decimated families and entire communities. Millions of people with serious mental illnesses go untreated, and U.S. prisons and jails have tragically become de-facto psychiatric hospitals.

Globally, psychiatric illness has become one of the major conditions affecting the health of the world population. The World Health Organization (WHO) predicts that by 2030, depression will be the leading cause of disease burden.

Supporting science research for recovery, BBRF funds the most innovative ideas in psychiatry and neuroscience to better understand the causes and develop new ways to effectively treat brain and behaviour disorders. These disorders include depression, bipolar disorder, schizophrenia, autism, ADHD, anxiety, borderline personality disorder, obsessive-compulsive disorder, addiction and post-traumatic stress disorder. BBRF grants support a broad range of the best ideas in brain research and our grantees have taken substantial steps forward on the path to developing new treatments and finding cures for mental illness.

The Brain & Behavior Research Foundation (BBRF) supports cutting-edge research that offers the greatest potential for breakthrough discoveries. These discoveries are changing what it means to live with mental illness. BBRF grants are focused on four priority areas: basic research to understand what happens in the brain to cause mental illness; new technologies to advance or create new ways of studying and understanding the brain; diagnostic tools and early intervention to recognise early signs of mental illness and treat as early as possible; and next-generation therapies to reduce

symptoms and ultimately cure and prevent brain and behaviour disorders.

BBRF grants enable outstanding young scientists to begin a career in research as they look to answer important questions or help identify new potentially game-changing targets for treatments.

In fact, a RAND Europe analysis of the global mental health research funding landscape found that we are the top non-governmental funder cited in published articles and virtually every scientific journal in psychiatry, neuroscience, molecular biology, and genetics includes articles on the research achievements of BBRF grantees. Most importantly, BBRF grants have a proven multiplier effect and have led to additional funding from the government, university and industry sources. In fact, the $394 million in grants BBRF has awarded since 1987, has resulted in more than $3.9 billion in additional funding for scientists.

Advances from BBRF grantees continue to define the leading edge of all research in the mental health field. Examples include the use of Clozaril for the treatment of schizophrenia, transcranial magnetic stimulation for depression and other conditions, deep brain stimulation for treatment-resistant depression, the ongoing development of rapid-acting anti-depressants, magnetic stimulation therapy that can be used to treat depression without causing the memory loss that can happen with electroconvulsive therapy (ECT), and optogenetics which helps scientists around the world to better understand the brain.

Increase funding for mental illness now

Now, more than ever, it is important to reduce stigma, prejudice and stereotypes about mental illness and encourage people who have a psychiatric condition not to suffer in silence, but to seek help. By educating the public about the scientific and biological basis of psychiatric disorders, and the amazing progress we are making in brain and behaviour research, we hope to change the culture. With so much that needs to be done, how do we make people pay attention to this issue? How do we increase funding for research and make mental health a top priority so that help is available to all who need it?

> "Globally, psychiatric illness has become one of the major conditions affecting the health of the world population. The World Health Organization (WHO) predicts that by 2030, depression will be the leading cause of disease burden."

Only through a combination of public and private funding for high-risk, high-reward research will we generate significant scientific discoveries that change the lives of people with mental illness and their families and impact our larger society.

Our scientific understanding of how the brain works and what happens when illness occurs is helping to change people's attitudes about mental illness. Research has led to tremendous improvements in how we treat psychiatric conditions and the availability of better treatment has also changed people's attitudes.

Research offers hope for further advances in treatment and ultimately cures and methods of prevention and is the key to helping people with a mental illness live full, productive, and happy lives. ■

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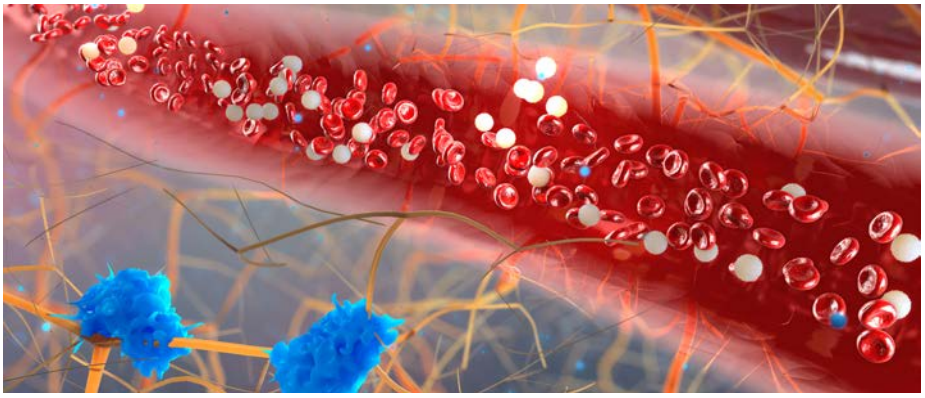
The vascular origin of mental health disorders

Anju Vasudevan from McLean Hospital/Harvard Medical School looks at the progressive change in thought around brain blood vessels and their direct contribution to mental health illness

The cerebral cortex is essential for the integration and processing of information that is required for most behaviours. The exquisitely precise laminar arrangement of neurons, axon collaterals and dendritic processes arise during embryonic development when neurons migrate successively from proliferative ventricular zones to coalesce into specific cortical layers. Abnormalities in neurons and defects in cortical inhibition have long been implicated in the etiology of schizophrenia, autism spectrum disorders (ASD), anxiety and depression.

Brain development, however, like a gem that is cut with many facets that sparkle, is not limited to neuronal changes but is also supported by concomitant development of its vasculature. Correct functioning of the cerebral cortex necessitates the concerted assembly of both vascular and neuronal networks. Here, I will discuss the progressive change in thought with respect to brain blood vessels and its direct contribution to mental health illness from the earliest developmental time points.

Until a decade ago, blood vessels in the embryonic forebrain were believed to be a homogenous population of vessels, responding passively to the metabolic demands of growing neuronal populations. Our work depicted the diversity in embryonic forebrain vascular networks, by differentiating them as pial versus periventricular, based on anatomy, origin,



growth patterns and developmental mechanisms[1]. The tapering vessels joining the periventricular and pial vessels may represent the earliest arterial-venous communication. The periventricular vascular network develops in advance of and is independent of neuronal development by embryonic day 11 to act as a substrate and provide critical guidance cues to instruct key events that follow in the embryonic telencephalon, for instance, neurogenesis (birth of new neurons), radial migration of projection neuron precursors and tangential migration of GABAergic interneurons[2,3].

Interestingly, the periventricular vascular network not only acts as a physical substrate for neuronal migration but also holds the key to several novel developmental mechanisms and pathways. Gene expressions for biological processes and canonical maps containing genes controlling neurogenesis, neuronal migration, chemotaxis, and axon guidance were enriched in periventricular endothelial cells, when compared to pial endothelial cells, signifying new and unknown roles[3].

Pial endothelial cells, on the other hand, showed enrichment in inflammation and pathological process categories. When genes expressed in periventricular endothelial cells were classified according to disease categories, an enrichment was observed in psychiatric disease categories[3]. Our studies, therefore, implicate a new cellular substrate – periventricular endothelial cells as being contributory to a wide swath of neuropsychiatric diseases with schizophrenia, epilepsy, bipolar, mood, depressive disorders and autism topping the list, shedding light on a new problem.

Certainly, the problem is very significant because it means that we have focused on psychiatric illnesses from a neuronal perspective extensively when intrinsic defects within blood vessels may be the actual trigger. These results also highlighted the great need to validate and understand the functional significance of novel genes expressed in periventricular endothelial cells/blood vessels and its specific contribution to psychiatric disease symptoms.

So, we went on to investigate why genes traditionally believed to be confined to GABAergic interneurons were enriched in periventricular endothelial cells – among them were *Gad1* and *Gad2* – these encode GAD proteins that synthesise GABA, $GABA_A$ receptor β3 subunit (*Gabrb3*) and vesicular GABA transporter (*Vgat*). We designed strategies to specifically render endothelial $GABA_A$ receptors dysfunctional or turn off GABA release from endothelial cells[4]. This led to the discovery of the novel vascular GABA signaling pathway operating via forebrain endothelial cells that has an intricate and powerful control of prenatal brain development events – angiogenesis, neurogenesis and neuronal migration. Changes in this pathway left lasting signatures on cortical circuitry and blood flow in the postnatal brain with consequences for behaviour[4]. Dysfunction of endothelial $GABA_A$ receptors was sufficient to cause behavioural abnormalities similar to psychiatric disease that was characterised by one or more of these core symptoms – impaired social recognition, reduced social interactions, communication deficits, increased anxiety or depression.

On the other hand, complete loss of endothelial GABA release resulted in significant abnormalities in developmental milestones and led to a model reminiscent of childhood epilepsy or autism spectrum disorder. Alterations in postnatal behaviour were characterised by periods of quiescence, interrupted by tremors and a reduction in voluntary movement and the mice failed to survive beyond two months of age. For the very first time, our studies describe how intrinsic defects within telencephalic vasculature/endothelial cells from the earliest developmental time points can independently mould neuronal signaling pathways with far-reaching consequences for brain development and behaviour[4]. It also highlights how variations in vascular GABA levels can cause diversity in psychiatric symptoms[4].

We expect our work to bridge a gap between vascular biology and psychiatry. Abnormal vascular pathologies and disturbances of cerebral blood flow have repeatedly been observed in patients with schizophrenia, autism, anxiety and depression using old and new technologies. However, these disturbances were usually linked to inflammation or changes in neural plasticity. Our project uncovers a direct cause of change in blood flow in psychiatric disorders that originate from intrinsic defects in blood vessels from the earliest developmental points. There is a great need to better understand the spatiotemporal regulation of endothelial cell gene expression and function in brain vascular networks at both developmental and adult stages in normal and disease conditions. The neuro-vascular communication initiated in the prenatal period is likely to acquire greater complexity after birth. Blood flow may provide spatial and temporal information, modulating excitation and inhibition in cortical circuits, thereby affecting representation. Therefore, if there is an intrinsic defect within brain endothelial cells, it has to be identified and corrected for the restoration of brain health.

We hope to apply this new scientific knowledge not only to gain a deeper fundamental understanding of novel origins of psychiatric disease but also to generate new and effective treatments. In ongoing projects, we are tapping into the potential of embryonic periventricular endothelial cells/angiogenesis, in multiple ways to prevent the origin of diverse psychiatric symptoms by rescuing vascular defects in the prenatal brain or by developing vascular therapies for repair and regeneration in the postnatal and adult brain. We envision a future where the 'healing touch' of angiogenesis therapy will bring relief to patients suffering from mental health disorders. Determination of brain blood vessel health should, therefore, become a part of our routine health visits and check-ups.

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Bold action by Congress delivers victory to millions living with Alzheimer's

Rachel Conant, Senior Director, Federal Affairs, Alzheimer's Association explains how bold action by the U.S. Congress delivers victory to the millions of people living with Alzheimer's

With a strong bipartisan vote in an otherwise partisan environment, the U.S. Congress just delivered a victory to millions of Americans currently living with Alzheimer's disease and their caregivers.

By passing the Building Our Largest Dementia (BOLD) Infrastructure for Alzheimer's Act (P.L. 115-406), Congress has authorised $100 million over five years (FY20-FY24) to build and enhance the U.S.'s public health response to the Alzheimer's crisis.

Public health initiatives work at the community level to protect and improve the health and safety of the entire population. This means safe water to drink, vaccines to prevent deadly diseases, interventions to reduce smoking, and emergency preparedness tools to save lives.

Thanks to Congress, working together in bipartisan fashion, we can now also add to that list a nationwide public-health infrastructure that is expanding to promote prevention and improve quality of life for those living with Alzheimer's.

Alzheimer's poses a significant threat to our nation, killing more people than breast and prostate cancer combined. Alzheimer's is the sixth-leading cause of death in the United States, devastating more than 5 million Americans currently living with the disease, as well as their more than 16 million unpaid caregivers.

The Alzheimer's Association estimates that these unpaid caregivers provided 18.4 billion hours of care valued at over $232 billion in 2017. Equally as staggering is the financial burden Alzheimer's places on American society, with the direct costs of caring for those with the disease totalling $277 billion in 2018 alone. Unless something is done, the Association projects those costs could rise as high as $1.1 trillion by 2050.

But now, thanks to the BOLD Infrastructure for Alzheimer's Act, millions across America have reason to be hopeful.

By creating a modern public-health infrastructure, the new law will help: improve early detection and diagnosis; reduce both health disparities and risks associated with avoidable hospitalisations and cognitive decline; enhance support to meet needs of caregivers; and support care planning and management.

To help develop this infrastructure, the BOLD Infrastructure for Alzheimer's Act authorises $100 million over five years to accomplish three critical initiatives:

1. Establish Alzheimer's Disease and Related Dementias Public Health Centers of Excellence across the country. These Centers of Excellence will increase the education of public health officials, health care professionals, and the public on Alzheimer's, brain health, and health disparities. The Centers will also provide technical assistance to public health departments across the country in implementing effective Alzheimer's interventions and expand innovative public-private partnerships that focus on addressing the cognitive impairment and health disparities.

2. Award funding to State, local and tribal public health departments to implement Alzheimer's public health interventions focused on priorities like increasing early detection and diagnosis, reducing the risk of cognitive decline and preventing avoidable hospitalisations. This funding will also help public health departments implement strategic actions like those identified in the Healthy Brain Initiative's Public Health Road Map.

Image: © William Perry | Dreamstime.com

3. Increase the analysis and timely public reporting of data on Alzheimer's, cognitive decline, caregiving, and health disparities. This data is critical to identifying opportunities for public health interventions, helping stakeholders track progress in the public health response, and enabling state and federal policymakers to make informed decisions when developing plans and policies.

> "Thanks to Congress, working together in bipartisan fashion, we can now also add to that list a nationwide public-health infrastructure that is expanding to promote prevention and improve quality of life for those living with Alzheimer's."

While the CDC is preparing for the Act's implementation, determinations on awards for the Centers of Excellence and public health departments cannot happen until the Centers receive the FY20 funds appropriated by Congress.

That timing will depend on the appropriations process in Congress this year, but it is likely CDC funding will be awarded and allocated in 2020. In the meantime, the Alzheimer's Association – working through its advocacy arm, the Alzheimer's Impact Movement – is continuing to work with allies in Congress and across the country to ensure these initiatives are implemented as quickly as possible.

The sooner we can apply the public-health approach necessary for reducing risk, detecting early symptoms, and supporting caregivers, the sooner we can reverse Alzheimer's devastating trajectory. ■

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Intramembrane proteases in the immune system

Prof Dr Regina Fluhrer from the LMU & DZNE in Munich and Prof Dr Bernd Schröder from the TU in Dresden, Germany, explain how intramembrane proteases contribute to the proper development of immune cells

The immune system is crucial to protect organisms from a variety of pathogens, including bacteria, viruses and fungi. However, the development and function of immune cells need to be tightly controlled in order to avoid reactivity against the host, which is termed autoimmunity. A variety of common diseases, including rheumatoid arthritis, multiple sclerosis (MS) and inflammatory bowel disease (IBD) are caused by an overshooting activity of the immune system and inflammatory reactions. Many drugs commonly used to suppress the immune system in those patients like corticosteroids which act in a very general way and have significant side effects when long-term treatment is required. Despite major advances over the last few years, there is still a demand for therapeutic strategies targeting specific components of the immune system.

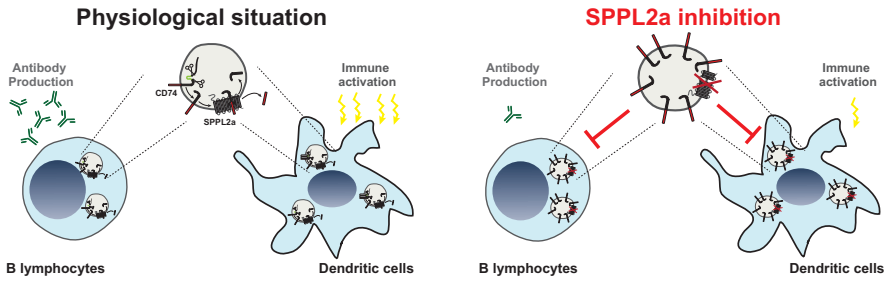
Regina Fluhrer, Professor of Biochemistry at the Biomedical Center of the Ludwig Maximilians University (LMU) and at the German Center for Neurodegenerative Diseases (DZNE) in Munich, Germany

Bernd Schröder, Professor of Physiological Chemistry and Molecular Biology at the Institute of Physiological Chemistry at the Technische Universität Dresden, Germany

In this context, it was an important finding that certain intramembrane proteases, which are druggable enzymes and can be targeted by small molecule inhibitors, control the development and function of certain immune cells. Intramembrane protease represent enzymes embedded in cellular membranes which can cleave the transmembrane domain of membrane-spanning substrate proteins (for more details see the October 2018 edition of Open Access Government). One of these intramembrane proteases is Signal peptide peptidase-like 2a (SPPL2a) which is localised in the membrane of lysosomes, an intracellular compartment involved in degradation of proteins and other macromolecules. With its ability to cleave transmembrane proteins, SPPL2a contributes essentially to the turnover of these proteins.

Although the discovery and characterisation of further SPPL2a substrates is still ongoing, one substrate of particular importance in immune cells is the CD74 protein which has several well-established functions in B lymphocytes and dendritic cells (DCs). Whereas the latter are particularly important to recognise invading pathogens, B cells produce antibodies targeting the "intruders" which is a major mechanism to clear infections.

A specific step in the degradation of the CD74 protein requires intramembrane proteolysis by SPPL2a. Therefore, in absence of the protease a small, membrane-embedded fragment of CD74 massively accumulates in B cells and DCs and disturbs their development and function. SPPL2a deficiency in mice results in a major impairment of both cell types and in humans, it causes increased susceptibility to infections with mycobacteria like tuberculosis (TB). The reduced ability of humans with mutations in the SPPL2a gene to fight mycobacterial infections can be explained by a loss of



The intramembrane proteases SPPL2a as a novel target for therapeutic immunosuppression, illustrated by Bernd Schröder

specific DCs, which are required to trigger immune responses against these pathogens. Thus, the presence of SPPL2a and its ability to degrade CD74 represents an important checkpoint in B cells and DCs. The dependence of these cells on SPPL2a may allow to deplete them in patients with SPPL2a specific inhibitors, which could be beneficial in different disease contexts like MS or Systemic lupus erythematosus (SLE) and represents an interesting novel concept.

Besides ensuring the proper maturation of immune cells, it is also important to tightly control their number, since the unrestricted proliferation of, for instance, B cells results in diseases like multiple myeloma. One protein that is involved in the regulation of B cell survival is the B-cell maturation antigen (BCMA). It is expressed on the surface of B cells and is cleaved by the γ-secretase complex that contains the intramembrane protease presenilin as an active subunit (for more details see July 2019 edition of Open Access Government). The inhibition of this cleavage results in accumulation of BCMA and an increased number of B cells in the bone marrow, indicating that an intramembrane protease is critically involved in an immunoregulatory mechanism to limit B cells in bone marrow and most likely also in plasma.

SPPL3, another intramembrane protease and homologue of SPPL2a, is crucial for normal development of Natural Killer cells (NK cells). NK cells are part of the innate immune system and critical for tumour surveillance as well as clearance of virally infected cells. After development in the bone marrow, NK cells migrate and populate all organs of the body where they undergo final maturation steps and become fully active “guardians”. Deficiency of SPPL3 in mice results in impaired maturation of NK cells and reduced clearance of tumour cells. This makes SPPL3 an interesting player in the immune system and in tumour defence. However, before SPPL3 is considered as a therapeutic target, it needs to be further investigated if it is indeed dysregulated in immune deficiencies or malignant tumours.

As these examples show, several intramembrane proteases play pivotal roles in specific immune cells. It seems that their activity represents critical checkpoints which these cells need to bypass in order to differentiate and become functionally mature. Certainly, the mechanisms involved in the differentiation processes will require further work to understand them at the molecular level. But previous research has unambiguously shown that defining the action of intramembrane proteases in immune cells will increase our general understanding of how we fight infections and the way in which this may be exploited to control an over-activated immune system.

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Supporting vital Alzheimer's disease research in the U.S and beyond

The work of the National Institute on Aging (NIA) is placed into focus here, with examples of how they are supporting vital Alzheimer's disease research in the U.S and further afield

National Institute on Aging (NIA) is one of the 27 Institutes and Centers of the National Institutes of Health (NIH) in the United States (U.S.). Their work concerns the leading, "a broad scientific effort to understand the nature of ageing and to extend the healthy, active years of life". [1] As a primary Federal agency, the National Institute on Aging supports and conducts Alzheimer's disease research.

When it comes to research on ageing and the health and well-being of older people, the Institute aims to understand the nature of ageing and the process, as well as the diseases and conditions associated with growing older, so that the healthy, active years of life can be extended. The Institute's mission can be summed up as follows:

- Supporting and conducting biological, clinical, genetic, behavioural, social, and economic research on ageing.
- Fostering the development of research and clinician scientists in the field of ageing.
- Providing resources for research.
- Disseminating information on ageing and advances in research to healthcare professionals, the public, and the scientific community.

In addition, we know that NIA pursues their mission by funding extramural research at medical centres and universities throughout the U.S. and further afield; maintaining an active communication and outreach programme; and conducting research at NIA laboratories in Bethesda and, Baltimore, Maryland. [2]

Alzheimer's disease research

Looking at one aspect of the Institute's work, it's worth noting that Alzheimer's disease is a progressive brain disorder that gradually slowly destroys both memory and thinking skills and, eventually, the ability to carry out the simplest tasks, and as such is irreversible. It is the most common cause of dementia in older adults and while it is more common as people grow older, it's not a normal aspect of ageing according to the Institute. [3]

In recent research news, we find out that researchers have been able to map how Alzheimer's pathology spreads across brain networks. Recent advances in genetic biomarker research and neuroimaging and genetic biomarker research have enabled scientists to identify two proteins, tau and beta-amyloid, which are hallmarks of Alzheimer's accumulating in the brain over a period of time. It was also discovered that the patterns of tau and beta-amyloid accumulation were related to specific genetic profiles, which helps us to much better understand Alzheimer's disease risk and possible new avenues for monitoring and diagnosis and monitoring of the disease, in this fitting example of NIA-supported research. [4]

In other topical research news, we learn that taking part in the arts could improve the health, well-being, and independence of older adults. Some specific example identified here include singing group programmes, theatre training, and visual arts for older adults. Lisa Onken, PhD, of NIA's Division of Behavioral and Social Research, shares her thoughts on this most interesting piece of research in her own words.

"Researchers are highly interested in examining if and how participating in arts activities may be linked to improving cognitive function and memory and improving self-esteem and well-being. Scientists are also interested in studying how music can be used to reduce behavioural symptoms of dementia, such as

Image: © Vampy1 | Dreamstime.com

stress, aggression, agitation, and apathy, as well as promoting social interaction, which has multiple psychosocial benefits."

Picking up on the point about singing programmes identified earlier in this article, it's interesting to note that in the view of Julene K. Johnson, PhD, of the University of California, San Francisco School of Nursing: "There's a pressing need to develop novel, sustainable, and cost-effective approaches to improve the lives of older adults. Singing in a community choir may be a unique approach to promote the health of diverse older adults by helping them remain active and engaged. It may even reduce health disparities."

Those who took part in the community choir showed positive results within six months, in particular, it increased interest in life and reduced feelings of loneliness. "The study showed increased interest in life because singing in the choir provided a regular, structured activity for participants," notes Dr Johnson. "Access to regular activities in diverse, low-income communities is vital for older adults to remain active and engaged in their community." Looking ahead, we know that NIA is addressing the need for more rigorous research that can demonstrate the efficacy and cost advantage of interventions when it comes to the arts. [5]

In closing, I hope that the examples here demonstrate NIA's endeavour to lead on scientific efforts, for example, around Alzheimer's disease research, to understand the nature of ageing and to further the healthy, active years of life for older adults. ■

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Ageing and chronic kidney disease (CKD): The phosphate connection in biomedical science

Dr Makoto Kuro-o from the Division of Anti-Aging Medicine, Jichi Medical University in Japan gives a fascinating glimpse into an aspect of biomedical science that concerns the subject of how phosphate accelerates ageing, including his thoughts on chronic kidney disease (CKD)

On the subject of how phosphate accelerates ageing, my current research interest stems from my serendipitous discovery of an obscure mutant mouse strain that inherits a premature ageing syndrome in an autosomal recessive manner. The mutant was named after a Greek goddess klotho who spins the thread of life. Mice homozygous for the klotho allele (kl/kl) develop complex ageing-like phenotypes when they are around four weeks of age, including atrophy of multiple organs (gonads, thymus, and skin), sarcopenia, vascular calcification, cardiac hypertrophy, osteopenia, cognition impairment, hearing disturbance among others, resulting in frailty and premature death. The klotho allele is a severe hypomorphic allele for the klotho gene, which encodes a single-pass transmembrane protein and is expressed primarily in renal tubular cells.

Subsequently, we found that Klotho protein functions as the receptor for fibroblast growth factor-23 (FGF23). FGF23 is a "phosphaturic" hormone secreted from the bone upon dietary phosphate intake and acts on renal tubular cells to inhibit phosphate reabsorption, thereby, increasing phosphate excretion into urine. Mice defective in klotho expression (kl/kl mice) suffer from phosphate retention and develop hyperphosphatemia due to impaired urinary phosphate excretion, indicating that the FGF23-Klotho endocrine axis is indispensable for maintaining phosphate homeostasis. Importantly, restoration of the phosphate balance by placing kl/kl mice on low phosphate diet rescues them not only from hyperphosphatemia but also from the ageing-like phenotypes, leading me to conclude that phosphate retention is primarily responsible for premature ageing. Since then, the long-term goal of my research has been to elucidate the mechanism by which phosphate accelerates ageing.

CPP (calciprotein particles): The true culprit of accelerated ageing?

It has been known for decades that extracellular phosphate is toxic to the cell at high concentration. For example, when vascular endothelial cells are cultured in high phosphate medium, they undergo apoptosis. In vascular smooth muscle cells (VSMC), high phosphate medium induces calcification associated with the phenotypic transition of VSMC to osteoblast-like cells. However, high extracellular phosphate fails to exert these effects when the extracellular calcium concentration is low or when inhibitors for the formation of

calcium-phosphate, such as pyrophosphate or phosphonoformic acid, are present in the medium.

These findings indicate that it is not phosphate per se but calcium-phosphate precipitates (CaPi) that are responsible for these phosphate woes. In vivo, CaPi circulate in the blood in the form of CPP (calciprotein particles), which are colloidal nanoparticles of CaPi adsorbed by serum protein fetuin-A. CPP have the ability to induce endothelial cell damage, VSMC calcification, and innate immune responses as if they were a pathogen. Based on these observations, I have proposed "the CPP theory of ageing". Namely, CPP may be a "pathogen" that accelerates ageing through inducing arteriosclerosis and chronic inflammation.

CKD as a clinical model for accelerated ageing

Recent clinical studies have demonstrated that blood CPP levels are increased with the progression of chronic kidney disease (CKD). CKD is defined as a state of impaired renal function that persists for three months or longer, regardless of the cause of kidney damage. In many cases, however, CKD occurs as a complication of diabetes or hypertension and as a consequence of natural ageing. Accordingly, more than 10% of the total population worldwide is estimated to suffer from CKD. In CKD patients, high blood CPP levels are associated with vascular calcification, arterial stiffness, and inflammation.

Furthermore, a clinical parameter that reflects the propensity for CPP formation predicts their prognosis. Considering the ability of CPP to induce cell damage and innate immune responses in vitro, the correlation between blood CPP levels and the CKD complications may actually be causation. This notion is consistent with the CPP theory of ageing and, if proven, may justify CPP as a new therapeutic target for CKD. To obtain a proof-of-concept for the CPP theory of ageing, my collaborators and I have developed a "CPP adsorption column" that can be connected in series in the hemodialysis circuit to remove CPP from the blood during hemodialysis sessions, and is currently investigating whether the column may be effective in the treatment of arteriosclerosis and inflammation using an animal model.


Dr Makoto Kuro-o

It should be noted that CKD patients in advanced stages resemble kl/kl mice: Both suffer from high blood CPP levels, low Klotho expression, and multiple ageing-like phenotypes, including vascular calcification, cardiac hypertrophy, and increased mortality. In addition, these phenotypes can be alleviated by restriction of dietary phosphate intake both in kl/kl mice and in CKD patients. The striking similarity between kl/kl mice and CKD patients has led to the concept that CKD can be viewed as a state of accelerated ageing.

Physiology and pathology of colloids

In general, insoluble materials such as lipids and CaPi are adsorbed by specific serum proteins and converted to colloidal particles to be dispersed in the blood. Lipids are adsorbed with apoproteins, converted to colloidal particles called lipoproteins, transferred through the bloodstream between tissues, and eventually stored in the adipose tissues. However, when lipoproteins are increased in quantity and/or altered in quality (e.g. LDL vs HDL) and mistargeted to vasculature, atherosclerosis ensues. When mistargeted to the liver and skeletal muscles, lipids cause fatty liver and insulin resistance. These pathological conditions caused by ectopic lipids are correctively called "lipotoxicity".

Likewise, CaPi binds to fetuin-A to form colloidal particles called CPP. CPP may function as a carrier that transfers calcium and phosphate to the bone for storage. However, when CPP are mistargeted to vasculature, vascular calcification may ensue. Vascular calcification is the other form of arteriosclerosis besides atherosclerosis, but in contrast to atherosclerosis being treated with statins, no specific treatment for vascular calcification is available. When mistargeted to other extraosseous tissues, CPP may exert toxicity and inflammation in systemic organs and ultimately accelerate ageing. I expect that research on CPP will be appreciated as a new field of study in biomedical science as important as research on lipoproteins in the foreseeable future.

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Defining dementia and Alzheimer's in the 21st century

Paul Edwards, Director of Clinical Services at Dementia UK, explores what dementia actually means in the 21st century, including the all-important differences between dementia and Alzheimer's

Our population is ageing and that brings the increased risk of dementia. This creates problems not only for families but for the workforce and for our creaking health and social care systems, which are not designed or adequately funded to cope with the scale of the issue. We need to be asking ourselves how we can shine a light on this condition across society but just where do we even begin?

> "If we truly want to overcome one of the greatest health issues of our time then we need a concerted effort across society; families, friends, employers and the government need to wake up to what dementia clearly means."

Paul Edwards

Firstly, we need to understand what dementia is at its most literal level. As a neurodegenerative condition, it causes alterations to the brain which can lead to behavioural changes, memory loss and ultimately, death. Some people are confused about the differences between dementia and Alzheimer's. Dementia is an umbrella term encompassing over 200 different subtypes, of which Alzheimer's is the most common. In addition to this, some people are unaware that there are subtypes which affect much younger people. It's also not solely down to genetics and affects each family differently.

Families are in urgent need of clarity around dementia. They come across myriad emotional and practical challenges; from managing the unpredictable behaviour of a diagnosed relative to asking questions on financing care or end of life needs. Social isolation affects them hugely as they avoid meeting friends and family through fear of how others may perceive a diagnosis of dementia, or simply because their demanding caring responsibilities give them no time. The impact of dementia on families means we should help them to not be too hard on themselves, and see that dementia is a growing problem which shouldn't be ignored, or stigmatised. We should also make them aware that there is support out there from dementia specialists like Admiral Nurses, who can help them live confidently and with less fear in the face of the condition.

With society on the verge of a workforce crisis, employers need to be providing clarity around the condition as well. Recent statistics from Carers UK shows that over two million people have left work as a result of the emotional toll of caring. Whilst these figures do not exclusively relate to people with dementia, they show the scale of the problem. Many people within this bracket are sandwich carers, which means they have the dual responsibility of caring for an older relative, as well as a child. Office for National Statistics (ONS) statistics have further highlighted the struggles faced by this silent generation of carers with over a quarter now facing depression and stress. The impact of dementia for employers means encouraging open door policies at work, where no one should have to put on the pretence that they're getting by; it also means

having flexible working hours in place and a carers policy which clearly enshrines the rights of our workforce carers.

> "Firstly, we need to understand what dementia is at its most literal level. As a neurodegenerative condition, it causes alterations to the brain which can lead to behavioural changes, memory loss and ultimately, death."

And what about the government's clarity around dementia? In a clear lack of compassion and understanding of the true scale of dementia faced by society, the long-awaited Social Care Green Paper has been marred by yet more delays. It is hoped that this document will introduce ways to narrow the widening gap between the separate health and social care systems. Many people with dementia have their complex needs addressed by the healthcare system when there is a growing body of evidence showing how early interventions through social care can lead to healthier, happier and longer lives. Dementia means that the government should be investing in care and support so that people facing the condition no longer fall between the social and healthcare gap.

If we truly want to overcome one of the greatest health issues of our time then we need a concerted effort across society; families, friends, employers and the government need to wake up to what dementia clearly means.

For anyone with any questions or concerns around dementia, please contact the Admiral Nurse Dementia Helpline on +44 (0)800 888 6678 or helpline@dementiauk.org . ■

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A life- and disease course approach to health protection and chronic care

Taking advantage of data and trustworthy collaboration is the way to go when it comes to a life- and disease course approach to health protection and chronic care, argues Prof Dr Freimut Schliess, Director of Science & Innovation at Profil GmbH

The first thing to say here is that the demographic transition is one of the main challenges for global societies. Although ageing is not a disease, older age in itself is the main risk factor for dying. Following the conception of personalised medicine, that means ageing dramatically affects the interpretation of traditional risk factors and conditions, as well as the definition of healthcare goals. Adding quality of life to the amount of life and adding function to chronic disease, therefore, become a higher priority.

The diversity of human beings in general and ageing societies in particular call for a combined life- and disease course approach. Innovative investments in health promotion, disease and frailness prevention, as well as person-centred healthcare should be adjusted to the individual's cultural habits, biological ageing and functional status, to only name a few relevant domains of life.

A life- and disease course approach to innovative investments in health promotion, targeted disease prevention, and person-centred healthcare

Healthcare can be considered a societal investment in the health of the citizens. Thus, society must seek to get the most out of this investment by dedicated efforts to bring citizens who fall ill as fast and as far as possible back to their normal level of function. The goal is to eventually restore the individual's contribution to society at the level it can be under the specific conditions.

Here, we propose a combined life- and disease course approach which fully acknowledges the wide spectrum of common risk factors and conditions, time and timing of risk exposure, the presence of pathogenetic signatures far before current diagnostic criteria are met, and the diversity of individual (pre)disease courses and susceptibilities to interventions. We also suggest that the interdependence between physical and mental vulnerability and functional decline related to universal ageing traits on the one hand, and chronic disease and comorbidity on the other should be fully acknowledged.

In the field of personalised medicine, the definition of personal health targets related to overall functioning and frailty, musculoskeletal and cognitive integrity and the presence of chronic diseases deserves special attention.

Ambitions in health promotion and management of disabling conditions

Western living and working environments are obesigenic and inherently pose health risks by promoting physical immobility and unhealthy food choices. There is a gap between medical knowledge and public awareness of disease-promoting behaviour. Education in how to prevent frailty and disability at an older age is underdeveloped.

Therefore, policies implementing the design of health-promoting anti-obesigenic living environments are needed. The potential of health promotion at work to reach a large part of the population, to positively synergise with individual health activities and to have a positive impact on the employee's families and communities should be exploited. Policies about food advertising and presentation should facilitate healthy food choices.

Ambitions in person-centred treatment of chronic diseases and comorbidity prevention

A curative therapy of most chronic diseases is still missing. Personalised disease modifying and regenerative therapies are currently under development and may be more broadly implemented during the next 20 years. Much earlier evidence-based concepts and companion diagnostics, as well as validated digital biomarkers will facilitate shared decision-making about personalised treatment targets and corresponding therapies. The patient needs to be empowered to act as a co-producer of his or her health. This will improve the patient's adherence to treatments and health-promoting

behaviour. Patients should be increasingly involved in defining/achieving R&D goals, drug approval and additional benefit evaluation.

Ambitions in multimorbidity-adjusted chronic disease management

Elderly people with chronic disease are the most heterogeneous in regard to physical and cognitive functionalities, morbidity and health outcomes. Individual functional reserves critically determine self-management capabilities, benefiting from single disease-specific interventions, and the likelihood of hospitalisation. Fortunately, clinical practice guidelines increasingly include evidence obtained from the stratification of trial results, balance risk and the benefit of interventions specifically in reference to health and living conditions of older patients.

It has been recommended that chronic disease management programmes should be replaced by a more integrated case management approach that is tailored to older people with chronic diseases. Case management programmes integrating chronic disease care could adapt elements of the Chronic Care Model (CCM), i.e. support a proactive release of care by interprofessional teams, strengthen the patient's self-efficacy and self-management, link the programme to scientific evidence and patient preferences, take advantage from a clinical information system, and mobilise coordinated community resources. Based on the identification of cost-intensive disability and multimorbidity patterns associated with a high risk of hospitalisation, case finding algorithms should be advanced which, for instance, using digital biomarkers for identifying people who most likely to benefit from dedicated case management programmes.

The telemedical consulting centre will have a role in ensuring high-quality care, especially in areas of rural depopulation with a high proportion of older people and a low density of general medical practices. Telemedical monitoring could be particularly effective in monitoring vulnerable patients, for example, those with heart failure, to detect early signs of disease deterioration Valuable business models may include a centrally controlled management of chronic diseases within the hospital and primary care provider networks.

Improving the sustainability of healthcare: the power of patient-generated data

Digital (medical) products and services relying on patient-generated data are considered to be key enablers for the provision of personalised health protection, disease prevention and chronic care. They will become gradually integrated as part of interconnected ecosystems combining digital health and social care. Here, sensor-based monitoring of health signatures and parameters reflecting patterns of everyday behaviour will produce a huge amount of real-world data which will be processed by self-learning control algorithms. The outcome will trigger a personalised adjustment of therapies, treatments and behavioural patterns which again, will feedback to the parameters captured from each individual patient. As highlighted in the recently published EIT Health Think Tank report on the use of existing data to improve healthcare [(1)], the advantages of big data analyses go beyond simply improving profit margins and reducing resource wastage. Big data will also be of value in predicting epidemics, improving the quality of life, providing better outcomes, and avoiding preventable deaths, particularly from chronic diseases.

The power of collaboration

There is no single (type of) organisation able to solve the urgent healthcare problems resulting from the demographic transition. Public-private partnerships having a reasonable budget and forcing collaboration between key stakeholders including citizens and policymakers to provide attractive innovation environments. For example, the European EIT Health knowledge and innovation community leverages the expertise of more than 140 leading organisations spanning key areas of healthcare, such as pharma, MedTech, payers, research institutions and universities [(2)].

It is only together that we can tackle the complex cross-sectional issues related to the societal acceptance for digital health products and services. The curation of innovation endeavours integrating R&D, education and training and entrepreneurship is the path towards effective products, services and business models. Making a tangible impact on the health of the citizens while improving the sustainability of healthcare systems is the ultimate measure of success for innovation communities like EIT Health.

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The importance of an ageing demographic

Graham Armitage MBE puts the ageing demographic in the spotlight to highlight their importance to society, in this analysis

Demographic ageing is a huge triumph for mankind, which has delivered great benefits economically and socially, but it is also a powerful driver for change. It is changing the shape of our society, and if we are to continue to benefit and address some of the accompanying challenges, we must respond with real innovation, to create a world which is efficient, effective and good to live in at all stages of life, despite a very different age profile from previously.

Recognising this, in late 2014, the UK Government announced the intention to establish a National Innovation Centre to respond to the global challenge of ageing. In 2015, funded half through the Medical Research Council and half by Newcastle University, the £40 million National Innovation Centre for Ageing was established in Newcastle upon Tyne. The Centre is rooted in the 25-year record of ageing research in Newcastle now co-ordinated by Newcastle University Institute for Ageing, but it brings together experts and knowledge from globally leading science, nationally and internationally.

Older people are a large under-served proportion of consumers whose needs and wishes are a major area for potential economic growth. With good health and the right support, they rare a social asset, whether working for longer, volunteering, taking on caring roles or merely as consumers. They also have a great deal of knowledge and understanding of ageing from their own experience and that of friends and loved ones. Yet, this is not a group which has been highly visible in innovation. The National Innovation Centre for Ageing hosts VOICE, a unique organisation comprising citizens who contribute experience, ideas, insights and vision to research and innovation, to provide that opportunity.

> "Our unique access to expertise drawn from a wide range of academic disciplines, business and industry, and ageing adults means that we are aware of market trends, health and social care challenges, and the latest innovations in the industry."

VOICE volunteers work with universities and external organisations to:

- Improve the focus, quality, relevance and impact of research
- Stimulate and shape social and technological innovation
- Enjoy lifelong learning and become research and innovation active citizens
- Make a positive difference to the lives of older people across the globe

The involvement of VOICE members in research helps to focus academic knowledge, creativity and expertise on finding solutions and innovations that will make a difference to and have an impact on people's lives.

The National Innovation Centre for Ageing works with government and corporate organisations, SMEs and innovators and with other centres of innovation, to ensure that new products and services are driven by evidence and by the needs and aspirations of the public.

Our areas of focus include:

- Living better for longer – helping us all stay as healthy, well and engaged as possible as we age.
- Age-friendly places – adapting our built and social environments and creating homes and communities where we can live and work for longer, so that we can maximise the quality of our later years.
- Inclusive design – ensuring that products and services meet our needs and aspirations, whatever our age or ability.

From 2020, we will be based at our iconic new building at the heart of Newcastle's city centre Helix research and innovation area. Funded by Newcastle University, the Medical Research Council, and the Department for Business, Energy and Industrial Strategy (BEIS), the building will also house the National Innovation Centre for Data and the National Institute for Health Research Innovation Observatory, together with key research and innovation projects and businesses.

This will bring together world-leading scientists, business and industry, health and care providers, and the public in a unique space that is designed to lead on innovations that improve all aspects of life for our ageing societies.

Our unique access to expertise drawn from a wide range of academic disciplines, business and industry, and ageing adults means that we are aware of market trends, health and social care challenges, and the latest innovations in the industry. Our focus on horizon scanning ensures that we are always one step ahead. Our international linkages and projects will ensure that the innovations we support can be globally relevant supporting ageing throughout the world.

The National Centre provides a variety of mechanisms for engagement with ageing in support of innovation, including training, consultancy and is able to organise and support collaborative and commercial research, working with its academic partners. We are keen to work with a wide variety of partners to assist them to design, develop, and deliver at scale new products and services which will:

- lead change in the way that we experience ageing,
- Create economic growth,
- Extend healthy life expectancy.

If you would like to work with the National Centre, in developing your own responses to ageing we welcome approaches via ageinnovation@newcastle.ac.uk and would be happy to explore how we could help you with your projects.

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Huntington's disease (HD): Is there hope on the horizon?

Dr Gerry Morrow shares his thoughts on the rare, progressive neurodegenerative illness, Huntington's disease (HD)

Few people predicted a cure for the rare, progressive neurodegenerative illness Huntington's disease (HD). It is one of a range of pathologies caused by multiple repeating three base sequences. Specifically, HD is an autosomal dominant disease caused by an expanded CAG repeat in the first exon of the huntingtin gene (HTT) on chromosome 4. HTT is vital to the viability of neurons. In HD, mutant HTT (mHTT) aggregates in neurons leading to the expression of long glutamine tracts, a cellular proteinopathy, which ultimately causes cell death predominantly in the striatum and cortex of the brain.[1]

Sufferers undergo progressive neurocognitive and psychiatric sequelae, including behavioural and mood changes, movement deficits, choreiform movements and ultimately death.[2]

Age of disease onset is inversely proportional to the length of the CAG repeat meaning that people with a higher burden of CAG repeats are diagnosed under the age of 20, defined as juvenile Huntington's disease. Juvenile HD is invariably more severe, and usually fatal within 20 years of diagnosis. Juvenile HD often presents with parkinsonian type rigidity, dystonia and bradykinesia, seizures and declining educational attainment.[3]

The prevalence of HD is approximately 10 per 100,000, meaning that in the UK there are approximately 6,200 patients living with HD. Of these roughly 5% have juvenile HD, which translates as approximately 300 patients under the age of 20 years.

The diagnosis of HD is made on clinical grounds using the Unified Huntington Disease Rating Scale and subsequent genetic testing.[4]

Previous efforts to treat HD focussed on the pathophysiological pathway with the aim of developing therapies to ameliorate symptoms. Sadly, these have met with limited success.[5] The current focus of research is on a disease modification approach, with the prospect of halting the decline and a potential cure.

Given that the underlying pathology is ascribed to a gene fault, researchers have seized on the possibility of either reducing the volume of mHTT circulating in the cerebrospinal fluid or even preventing the production of mHTT at source.

"The prevalence of HD is approximately 10 per 100,000, meaning that in the UK there are approximately 6,200 patients living with HD. Of these roughly 5% have juvenile HD, which translates as approximately 300 patients under the age of 20 years."

The first of these approaches has reached the phase 3 stage of a clinical trial with a medication called RG6042, which is an investigative antisense oligonucleotide treatment. RG6042 is a complementary molecule to HTT mRNA, which binds to the mRNA and signals protein destruction. Patients in this planned randomised controlled trial will have regular intrathecal administration of the RG6042 medication for two years.

Results from previous trial phases of 46 adults with early-stage Huntington's demonstrated a reduction of mHTT in cerebrospinal fluid (CSF) by up to 60%. This difference corresponds to an estimated 55% to 85% reduction of mHTT in the brain cortex and 20% to 50% in the caudate (a deep region) of the brain.[6] Reducing mHTT should translate into a commensurate reduction in disease impact in HD.

The second option entails a technique called gene silencing. Gene silencing of mHTT involves epigenetic modification of the expression of the mHTT gene. This

Dr Gerry Morrow

leads to inactivation of the mechanism of toxic proteins, which cause the death of neurons. This therapy then prevents the manufacture of abnormal HTT protein.

A gene-silencing treatment called AMT-130 is at an early stage of development. AMT-130 is an artificial microRNA, which targets HTT mRNA. Early results demonstrate effectiveness in animal models of the widespread localisation of AMT-130 in the brain and spinal cord, following a single injection. Phase 1 and 2 studies of this therapy are about to commence shortly.

These interventions of destroying abnormal genetic material and gene silencing, offer the prospect of a perspective shift towards the prospect of cure and that there may be hope on the horizon for patients and families of people with HD. ■

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Providing a path to advanced degrees in biomedical fields

The NYU Sackler Institute of Graduate Biomedical Sciences aims to train the next generation of scientists to make breakthroughs and advances in society at large, explains Naoko Tanese

Becoming an accomplished researcher requires an inquisitive mind and perseverance. It calls for hands-on research experience and active mentorship. Sackler students receive rigorous training to become independent scientists. We also instil in them a strong sense of social and ethical responsibility through interactions with our diverse research community.

PhD programme

Students matriculating at NYU Sackler Institute of Graduate Biomedical Sciences begin their training in an Open Program. While some students enter graduate school with a speciality in mind, in the Open Program students are encouraged to explore multiple fields. First-years wait to select a training discipline until they have taken several courses, completed two or three laboratory rotations, and selected a faculty mentor for their PhD thesis work. They have a full year to make final decisions.

We recently expanded the scope of our program to include new training tracks in Biomaterials Science, Biostatistics, and Epidemiology, in addition to all of the existing traditional disciplines in biomedical sciences. As we recruit students interested in the new tracks, we are faced with balancing the unique background of each student with the spirit of the Open Program. How can the curriculum of an Open Program satisfy students with varying interests and backgrounds?

To address this challenge all incoming students are required to take the course Introduction to Research, which starts immediately after Orientation with an immersive lab experience called Research Adventure. The Introduction to Research course is intended to not only help incoming students begin graduate school with the same basic knowledge, but also to provide them with a sense of community.

The Research Adventure is an intensive, week-long, hands-on research experience, where students working in a team carry out a structured project in a faculty's lab on a topic different from their previous research. This exposes them to new possibilities that perhaps they may not have considered. We continue to evaluate best practices to keep the spirit of the Open Program alive while accommodating the different interests and backgrounds of our matriculating students.

Career

In higher education, there is an increasing trend for PhD students to pursue alternative careers (non-academic positions). For this reason, we strive to prepare them for any career. We emphasise how PhD training teaches students to be critical thinkers, problem solvers, productive team members, collaborators, independent workers, and effective leaders. These are qualities useful to any career path.

NYU's centre for career development offers services such as resume and cover letter preparation as well as networking and interviewing practice sessions. Students participate in many job and internship fairs. We also invite alumni back to give career talks and meet with students to discuss their experiences.

Our students also take advantage of a variety of workshops and courses offered by the postdoctoral affairs office. To improve their career training, they actively engage in career planning while assessing their personal values and translating them to individual goals. They are introduced to all the diverse career opportunities outside of academic research. For those interested in teaching, students learn how to design and implement courses both at the college and post-graduate level. Communication is another skill critical to any career. We host workshops and seminars to help our students with their communication skills, both written and oral, to a variety of audiences.

Inspiring the next generation

The future of our society depends on training the next generation of highly capable scientific workforce. For this

Participants of the Sackler Institute's Summer Undergraduate Research Program

reason, we place a great deal of effort in mentoring young people interested in pursuing careers in science. We are increasingly wary of losing students' interests in STEM – Science, Technology, Engineering, and Mathematics. We are also concerned that not enough young people from diverse backgrounds are entering the STEM field. The current makeup of scientists in biomedical fields does not reflect the composition of the US population.

Numerous studies have reported the benefits of a diverse research community in advancing scientific endeavours. We are committed to making this happen by reaching out to students from diverse racial, ethnic, and socioeconomic backgrounds. One mechanism that has been in place at the Sackler Institute is our Summer Undergraduate Research Program (SURP).

Established in 1990, the SURP has been one of the cornerstones of minority recruitment for MD, PhD, and MD/PhD programs. The purpose of SURP is to give students who have the interest in biomedical sciences an opportunity to conduct research at a major medical centre. Over 700 students have participated in this program and >95% of the participants subsequently entered graduate or professional degree programs. We make an effort to provide a supportive community where students from all backgrounds feel at home. This is critical to our mission to promote diversity and inclusion at the Sackler Institute.

In many ways, STEM training needs to start earlier than college. We have been reaching out to students in nearby high schools to introduce them to scientific research. It's never too early to show them what it's like to be a grown-up scientist. We have visited local schools to give presentations and met one-on-one with young students. We have invited them to research laboratories to observe scientists at work, and in some cases perform experiments as student interns.

Ambitious and determined students commit to commuting long distances for these hard-to-find opportunities to satisfy their curiosity and challenge themselves to unfamiliar but exciting tasks. Some students never give up looking for a chance to enter research labs. This makes it worthwhile to mentor and see them thrive in a new environment. Scientific discoveries are made by following one's passion. We are here to inspire young people to find their passion in the biomedical sciences.

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Healthcare in Hong Kong: A focus on elderly health services

Image: © Lei Xu | Dreamstime.com

The priorities of healthcare in Hong Kong are explored here, with a special focus on the delivery of elderly health services in the country

According to the Department of Health of the Government of the Hong Kong Special Administrative Region, the pursuit of health is essential for the overall development of the community, as well as the well-being of the individual citizen. The Department of Health is the government's health adviser and agency to deliver health policies and statutory functions and as such, it plays a key part in the country's healthcare system. Dr CHAN Hon-yee, Constance, JP Director of Health from the Department offers her thoughts on the health care priorities of Hong Kong.

"We safeguard the health of the people of Hong Kong through promotive, preventive, curative and rehabilitative services as well as fostering community partnership and international collaboration.

"We are committed to providing a quality client-oriented service. We also attach great importance to fostering partnership with the community and other health care professionals and bodies, both local and worldwide, in the joint effort to promote the health of the people of Hong Kong." [1]

Elderly health services

By way of background, it's worth noting that The Elderly Health Service consists of 18 elderly health centres and 18 visiting health teams. [2] Their mission is nothing but providing quality primary health care services that promote the health of their elderly population. [3]

This analysis will focus on an aspect of the Department's work, the Elderly Health Service which provides primary health care to the elderly, which, in turn,

"We are committed to providing quality client-oriented service. We also attach great importance to fostering partnership with the community and other health care professionals and bodies, both local and worldwide, in the joint effort to promote the health of the people of Hong Kong."

Image: © Rafael Ben Ari | Dreamstime.com

improves their self-care ability, encourages healthy living and strengthens family support in order to minimise disability and illness. The services offered include:

1. Public health & administration

To analyse and collect information on the elderly's health status in Hong Kong to provide a timely health intervention programme.

2. Elderly health centres

The elderly health centres in the country seek to detect diseases earlier and identify health risks to enable timely intervention and prevention of complications. Those aged 65 or above can enrol as members of elderly health centres, where they are provided with a health assessment, counselling, health education and curative treatment services.

3. Visiting health teams

Visiting health teams deliver health promotion programmes free of charge in the community to increase the elderly's self-care ability and health awareness. By making use of the train-the-trainer approach, visiting health teams provide training programmes for carers to improve health knowledge and skills when it comes to caring for the elderly. [4]

The ageing and elderly healthcare landscape in Hong Kong

The Elderly Health Service is of the opinion that ageing is a necessary stage in life, indeed with an optimistic attitude in place they believe that one can live a fruitful life and enjoy their later years.

An important point to add here is that the elderly in Hong Kong who require help with their daily lives is on the rise. As such, we know it is really important that caregivers apply the proper skills of 'lifting and transfer' to avoid repetitive strain injury. Of course, this approach instils a sense of security in the elderly person and ensures a smooth and safe transfer. This approach is vital when assisting the elderly with everyday tasks such as getting up from bed or transferring them to the wheelchair or with toileting. [5]

Other areas on the website are extensive and include issues such as healthy ageing, mental health, self-care, home safety plus common health problems such as

bones and joints, cancer, dementia and diabetes to name a few. If that was not enough, there is even a very helpful section for carers, with useful details concerning dementia care, swallowing and diet, wound care and stress management, amongst many others.

Osteoporosis

Taking one of these areas, let's focus now on a common health problem, osteoporosis, which is a metabolic disease of the bone that results in a reduction in bone density. Certainly, the affected bones become thinner and are more likely to break (fractures) which may result in pain and other complications, including a loss of independence.

While osteoporosis produces no symptoms on its own, if an osteoporosis-related fracture occurs, there may be localised pain over the fracture sites. An osteoporotic fracture often includes the site of the thigh bone near the hip joint, spine (vertebrae) and the forearm close to the wrist. While hip fracture may occur after a minor fall, the spine can fracture without any associated trauma. In addition, a vertebral fracture can result in a decrease in body height, a hunched-back and sometimes, back pain. The website of The Elderly Health Service also provides further details in this vein, such as tips on what to do if you are suffering from osteoporosis and if it is preventable. [6]

Low back pain (LBP)

Looking at another highlighted area, we know that low back pain (LBP) today is a very common medical problem. While there are many causes of LBP including injuries, diseases and degeneration, poor posture accelerates degenerative changes of the spine, so the importance of proper posture cannot be emphasised enough. Certainly, good posture helps to prevent unnecessary fatigue and injuries that can occur when the body is not in proper alignment. Those who suffer from LB should see a doctor, who can assist with individual treatment plans and can, of course, identify a specific source of the pain.

Staying on this topic, we know that the central portion of the back is composed of a bony spinal column surrounded by muscles and ligaments. Tips include standing, which is quoted below but you can also find out more about sitting, lying and many other areas in this vein. We also learn here that appropriate exercise helps to maintain general fitness and back health.

"While standing, keep your body straight with ears, shoulders and hips vertically aligned. Your shoulders should not be rounded inwards or tilted forwards. Your hips should not be flexed or hyper-extended. Tuck your abdomen in. Make sure your chin is not held too high and your head is not dropping. Use your abdominal

muscles to keep your chest lifted and your back supported." [7]

The importance of activity

Finally, let's look at just one of the many areas highlighted on The Elderly Health Service's website that concerns activity. Here, we learn that activities are an integral part of our lives and become more important for the elderly who find themselves with more leisure time after they retire.

Some elderly people think that they might be too old for joining activities but taking part in them can provide many benefits like becoming healthier by taking part in physical activities, such as tai chi, as well as dancing and swimming which both benefit coordination, mobility and cardiopulmonary function. Another example is cognitive training, which can include playing computer games, chess or board games that can improve cognitive reserve and exercise the brain.

It is said that activities like going to restaurants, singing and watching movies can help older people to express their emotion and relieve anxiety, which of course, makes them feel better. It's well worth a look at the Ministry's additional tips for engaging activities that the elderly can take part in, such as group activities, learning new things or promoting and maintaining ability in self-care. Let's leave the last word to The Elderly Health Service who explain how confidence can be increased in this valued and important group of people in society.

"Participation in voluntary work can increase confidence and offer sense of satisfaction. Elders can choose to participate in activities, such as calligraphy, painting, handicrafts according to their own interests, through which, they can make good use of their creativity and talent." [8]

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[4] https://www.dh.gov.hk/english/main/main_ehs/main_ehs.html

[5] http://www.elderly.gov.hk/eindex.html

[6] http://www.elderly.gov.hk/english/common_health_problems/bones_and_joints/osteoporosis.html

[7] http://www.elderly.gov.hk/english/common_health_problems/bones_and_joints/pain.html

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Research about Hong Kong's rapidly ageing population

Professor Timothy Kwok, Director of the Jockey Club Centre for Osteoporosis Care and Control at the Chinese University of Hong Kong, provides a fascinating insight on the challenge of the city's rapidly ageing population

Hong Kong is facing a rapidly ageing population in the coming decades. Alongside population ageing, the incidence of hip fracture, the most disabling of common fractures in old age, has been rising steadily. In 2009, the incidence was 341.7 in men and 703.1 in women, per 100,000 people aged 65 years or over per year (Chau et al., 2013). The direct costs to the public hospital were estimated to be $10,400 in 2017 (Su et al., 2018). The indirect costs which are expected to be more substantial have not been comprehensively studied. In Taiwan, the indirect costs of a hip fracture were $1760, $480 and $173 for nursing home, caregiver and outpatient clinic annually in 2010 (Chan et al., 2017).

A cross-sectional study of 2914 fragility hip fracture patients in six hospitals in Hong Kong showed that the average age of hip fracture patients was 82.1±8.6 years. One-third of them were men, and 73.7% were community-dwelling before fracture (Leung et al., 2017). Most, if not all older people with a hip fracture have osteoporosis as defined by dual energy X-ray absorptiometry (DXA), and drug treatment for osteoporosis has been consistently shown to reduce hip fracture incidence by 40% (Kanis et al., 2013). It is, therefore, possible to prevent hip fractures if all older people are screened for osteoporosis and receive osteoporosis drug treatment. Yet in Leung's study, only 4.2% of hip fracture patients were diagnosed and treated for osteoporosis before the fracture. According to the profile of patients in our osteoporosis clinic which is the largest in Hong Kong, only 29.2% in 2017 were 70 years or more. These suggested that very few older people have DXA screening, despite the availability of DXA services in the private sector (Kwok et al., 2017).

A major reason for the very low take-up rate of DXA screening in older people in Hong Kong is the lack of specific public funding support. In collaboration with other local professional bodies, our centre is advocating the use of public funding support for a universal osteoporosis screening programme to benefit older people in Hong Kong. Universal osteoporosis screening by DXA for women aged 65 years and men aged 70 years or more has been recommended by professional bodies in the U.S., UK and European countries, and this strategy has been shown to be cost-effective for governments (Dell et al., 2010). Some Asian countries e.g. Japan and South Korea also provide funding support for osteoporosis screening (Mithal et al., 2013). With the availability of effective affordable generic drugs for osteoporosis, it is feasible to leave the long-term management of osteoporosis to primary care doctors who are mostly in private practices in Hong Kong.

Another major reason is the lack of awareness of fracture risk among older people. Osteoporosis is a common but most neglected disease (International Osteoporosis Foundation, 2000), especially in men (Haas et al., 2007). A randomised trial in the UK showed that the postage of a hip fracture risk questionnaire (FRAX) to women aged 70 years or more, together with training of primary care doctors in osteoporosis management resulted in more osteoporosis diagnosis and drug treatment and a 28% reduction in hip fracture incidence over five years (Shepstone et al., 2018). Our centre has been running a prospective cohort study of 4,000 older men and women to examine the risk factors of fractures in older people since 2001. According to our data, the combination of FRAX and a validated five-item questionnaire for sarcopenia increased the sensitivity for hip fracture incidence from 58.7% in men and 69.9% in women to 80% in both sexes (Su et al., 2019). The widespread use of this questionnaire in older people in the community may prompt more older people to seek DXA screening.

Most hip fractures occur after a fall, and fall history is a risk factor for a further fall, and can independently predict fracture in older men (Scott et al., 2007; Woo et al., 2009; Wu et al., 2013). The prevention of falls, especially in those who have fallen and

those with osteoporosis is another effective means to prevent hip fracture in older people. Randomised trials of balance exercise including Tai Chi have shown reduction in fracture incidence in those with osteoporosis and among older fallers (Gillespie et al., 2009; Sherrington et al., 2011). Fall risk assessment should, therefore, be a routine for those who are diagnosed to have osteoporosis and have had a fall within twelve months.

In a project funded by the Hong Kong Jockey Club, our centre has assessed over 1,300 community-dwelling older people who have had a fall over the past few years. Their fall risk was systematically assessed by a validated procedure PPA (Lord, Menz, & Tiedemann, 2003). According to this assessment, 36.6% were found to have moderate to severe instability. Apart from balance exercise group, we offer a home-based balance exercise programme "LIFE" which has been shown to reduce the number of further falls (Clemson et al., 2012). We have further improved on the programme by adding in- home safety assessment by an occupational therapist, which has also been shown to prevent falls (Chu et al., 2017). A randomised trial of the modified "LIFE" programme is on-going.

Last but by no means least, according to Leung's study, 26.3% of hip fracture patients were nursing home residents. Nursing home residents are at high risk of hip fractures and osteoporosis (Leung et al., 2017). Osteoporosis drugs are potentially useful in preventing hip fractures. But there is a practical problem in performing DXA in people with mobility problems, and because of disabilities and limited life expectancy, the risk and benefit of osteoporosis screening and drug treatment are finely balanced and should be assessed individually. Our centre is collaborating with Caritas College in identifying clinical risk factors of fractures in nursing home residents.

All in all, hip fracture in older people is a preventable condition. There is a lot of evidence that treatment for osteoporosis and fall preventive measures can prevent hip fractures (Chau et al., 2013, Kanis et al., 2013). But a more proactive and systematic approach directed by the government is required to translate knowledge into real impact on the incidence of hip fractures.

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Critical care nursing: Leveraging technology and innovation to improve care delivery

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group offers her thoughts on the challenges around critical care nursing, focussing on leveraging technology and innovation to improve the delivery of care

The process of decision-making in critical care nursing is particularly challenging today, especially with patients experiencing life-threatening conditions and/or complex chronic conditions. Such complexity requires an approach that takes into consideration a number of important factors related to the patient's physiological, psychological, sociocultural and developmental needs (Palomar-Aumatell et al., 2017). Therefore, a collaborative care approach is vital to help students to develop critical thinking and problem-solving skills and to integrate the knowledge acquired in class into today's clinical care systems.

Opportunities and solutions

Critical care nursing is expected to play a greater responsibility role in the near future. Efforts to address the growing demand for nursing care lie in a more efficient and effective care delivery that also implies the engagement of clinical professionals and patients with technology. A comprehensive description of multiple skills not only restricted to care delivery but also focused on patient observation in critical care nursing appear as a critical action (Alastalo et al., 2017). These patient observation skills basically consist of information acquisition and processing, as well as decision-making and

cooperation skills to act according to the patient's needs. Patient observation, leveraging professional skills and advanced technological developments are highly relevant in both clinical practice and nursing education as a framework for orientation in complex learning environments to increase both clinical and professional competence.

Technology impact on nursing

Nursing trends

According to Frost & Sullivan (Das, 2018), future skills prioritisation should involve on-site internal assessment with various healthcare companies' departments and stakeholders in order to understand on-going initiatives and potential human resources gaps regarding new technologies. Similarly, the most relevant technologies and trends impacting the industries must be assessed and discussed in order to set-up operation plans to address present critical care nursing challenges. Once the skills are identified, a talent nursery roadmap can be built in order to score best-suited academia, universities and organisations to source the best candidates highlighting typical career tracks and profiles for each of the identified skills.

Technology convergence

The past decade has evidenced many technological advances associated with clinical care, including enhanced diagnostics and monitoring. Although nursing skills go beyond monitoring devices, technology inventions, such as tablet computers and mobile electronic charts, to radio-frequency identification (RFID)-enabled devices, wearables, they play a decisive role in making the nursing field more advanced and efficient, as well as being better adapted to the needs of the patient.

Therefore, modern critical care nursing involves an in-depth interaction with smart technology. Smart healthcare represents a more universal approach to healthcare that integrates cutting-edge technologies to deal with healthcare data management and utilisation. Data can be analysed, visualised, and shared in real time; thus, improving clinical outcomes (Van Cauwenberghe, 2016). Cost-saving and time-effective collaborative relationships among patients, physicians, clinicians, managers, insurers, and healthcare organisations, in general, are promoted. Communications are integrated into a single, consolidated infrastructure; thereby, empowering communities and individuals with the necessary tools and knowledge to make more informed decisions. In fact, the transition from a conventional healthcare system towards a more integrated, interoperable, and flexible connected system requires highly skilled nursing professionals. Inter-cooperation among nursing and medical professionals to access critical information from any place using any kind of devices, such as a desktop, mobile, or tablet platform will be crucial to improving care delivery. ■

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Diabetes: Organising globally, acting locally

Adrian Sanders, Secretary-General of The Parliamentarians for Diabetes Global Network (PDGN) reveals how organising globally, acting locally is a sound approach when it comes to tackling diabetes

On 2nd December 2013 at the first Parliamentary Diabetes Global Network (PDGN) meeting in Melbourne, Australia, attended by invited parliamentarians representing 50 countries, a declaration on diabetes was agreed and signed.

It called for urgent action to address the diabetes pandemic and committed the signatories to work across parliaments to help prevent the incidence of diabetes, ensure early diagnosis and improve the treatment of people with the condition.

PDGN was the first global network of parliamentarians for a specific medical condition formed to create a platform to raise the profile of diabetes and its comorbidities within governments across the world.

It fills a missing gap where there is cross-national communication among medical professionals, pharmaceutical companies, health ministers and patient groups but nothing for parliamentarians who can set the agenda, influence budgets and vote for policies.

Through the communication of ideas and best practice and the encouragement of action within parliaments around the world, we can move towards that tipping point where the allocation of resources and effort to prevent, diagnose and treat diabetes is no longer questioned.

The urgency required cannot be overstated given the rising tide of diabetes across all continents and countries rich and poor. Already, the scale of the challenge threatens the health care budgets of most countries and the economies of many.

In the UK, expenditure on diabetes has reached 10% of the NHS budget. According to Diabetes UK, more people than ever have diabetes and if nothing changes, more than 5 million people will have the condition in the UK by 2025.

There are two main types of diabetes: Type 1 and Type 2. Only around 10% of people with diabetes have the non-preventable Type 1 where people don't produce insulin and have to inject it for the rest of their lives. The much more common Type 2 affects around 90% of people with diabetes and can be controlled by tablets and diet, and even reversed in a minority of cases. There are also other rarer types like, MODI, monogenic and gestational diabetes.

"In the UK, expenditure on diabetes has reached 10% of the NHS budget. According to Diabetes UK, more people than ever have diabetes and if nothing changes, more than 5 million people will have the condition in the UK by 2025."

All types of diabetes run the risk of the same long-term complications resulting from damage to various organs including the eyes, kidneys, heart and skin, often requiring expensive interventions including hospitalisation and ultimately, reduced life expectancy.

In human, as well as financial terms, the burden of diabetes is enormous which is why PDGN exists to build coalitions of advocates for action to tackle the pandemic at local, regional, national and trans-national level. Our focus is on raising the matter in parliaments and assemblies across the globe to spread better understanding and awareness of diabetes and the urgency with which it needs to be addressed.

Since its creation in 2013, cross-party groups linked to PDGN have formed in legislatures across the world. From Australia to Zimbabwe, parliaments and

Adrian Sanders, Secretary-General of The Parliamentarians for Diabetes Global Network

assemblies have endorsed or debated the Melbourne Declaration, taken up ideas and campaigns, introduced legislation, amended budgets and held national governments feet to the fire where World Health Organization (WHO) and UN Sustainable Development targets are concerned.

The network now has 270 members across 71 countries with active groups in over 20. Advice and information are sought and given across a variety of diabetes-related issues in a diverse range of counties; from sugar taxes in Bermuda and Morocco, to national diabetes plans in Australia and Malta.

It is a great honour to be tasked with running the network and helping MPs and other policymakers to shape and influence national policies to ensure we prepare our health care systems for the challenges of the 21st Century.

Adrian Sanders is the Secretary-General of PDGN. He was MP for Torbay from 1997 to 2015 and for 17 years chaired the UK All Party Parliamentary Group for Diabetes. He has lived with Type 1 for nearly half his life. PDGN is a registered charity in the UK. www.pdgn.co.uk . ■

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Metabolic data key to individualise diabetes therapy

Peter Robins, from Metabolic Health Solutions (MHS), describes how a new clinical management tool can help individualise treatment of obesity and Type 2 diabetes

The number of people diagnosed with diabetes in the UK has doubled in the last 20 years and is responsible for 26,000 early deaths per year alongside serious complications such as blindness, amputation or stroke.

According to NHS Digital, the cost of prescription medication in 2018 exceeded £1 billion, an increase of more than £420 million since 2008. However, the cost of medication represents only a small fraction of the total burden (>£14 billion), such is the devastating and expensive complications associated with the disease[1,2].

Approximately 90% have Type 2 diabetes (T2D), a progressive condition characterised by diminished rates of fatty acid oxidation in the fasting state and the inability to efficiently switch to glucose oxidation in the post-prandial state[3]. This phenomenon, which invariably associates with excess weight, has been termed metabolic inflexibility[4,5] and results in insulin resistance together with a steadily progressive beta cell defect.

I have used an ECAL machine in my General Practice for 1 year in a total of 35 patients with significant obesity, pre-diabetes and diabetes. It is now an invaluable tool, I would now not wish to be without...

Patients are significantly more motivated than when discussing weight, bloods or waist alone. Through dietary change and regular tests patients immediately see and track the effect on their ability to burn fat which is directly related to insulin and insulin resistance...

I can see huge potential for this in the health service.

GP – Dorset, UK

Her ECAL results indicated a high RQ i.e. carbohydrate was being used as her primary fuel source, increasing her insulin resistance over time. I advised some dietary changes, to increase her fat utilisation.

"In 26 days, I have lost over 11 pounds and my body shape has really started to change too. I would encourage anyone who is 'stuck' to take this approach – you won't be disappointed!"

DR. Nutritionist UK

Recent studies including DiRECT[6] have demonstrated that through restrictive diets, remission of T2D is possible with the added potential benefit of significant weight loss.

Some examples of the restrictive diets used to treat T2D include:

- Very low calorie – 830 calories per day (DiRECT)
- The ketogenic diet
- Low carbohydrate – Healthy fat (LCHF)
- Intermittent fasting (Dr Michael Mosely 5:2)

These dietary interventions have all demonstrated some success up to 12 months, but longer-term results have yet to be determined and these strategies are unlikely to be overly successful unless permanent lifestyle changes that improve the underlying metabolic dysregulation are maintained.

It is also increasingly recognised that an individualised approach to diabetes management may result in greater long-term success for many patients. Given the importance of weight loss for diabetes outcomes, effective management should consider individualised nutrition and exercise advice alongside pharmacology. In 2018 Diabetes UK updated its nutrition guidelines to reflect this requirement for an individualised approach to therapy[7].

This may involve a sustained focus on lifestyle strategies, personalising individual dietary programmes, refining and auditing exercise strategies for both short and long term outcomes and finally reviewing the adequacy and relevance of continued prescribing, given measured lifestyle adaptations. The challenge for public health is that individualised care is costly to implement and often difficult to evidence; however, these challenges could be lessened if there was a better understanding of the metabolic dysregulation of the patient at the start of and through the therapeutic process of diabetes management.

ECAL highlighted high RQ (0.99) – patient reduced carbohydrate and optimised protein intake. Weight which was stuck at around 110-112kg dropped to 105.4kg in 6 months. Patient is less tired, has more energy and is more active.

ZC. NHS Dietitian – UK

For example, measuring metabolism using indirect calorimetry and pathology provides significant information regarding the level of energy requirements and fat oxidation of the individual[8]. This immediately provides the opportunity to identify calorie load and perhaps more importantly tailor the macronutrient composition for the diet to support improved fat oxidation. Regular body composition measurements can then assess whether the weight loss is from endogenous fat stores or from lean tissue.

It is well understood that patients metabolise fat and carbohydrates differently. Their ability to switch between the fuels is impaired in diabetes and in many other common chronic diseases. Individualisation is called for but this is difficult to achieve without evidence from the patient. This evidence cannot be assumed or determined by population-based approaches; it must be measured.

MHS have commercialised low-cost metabolic measurement technology to better clinically individualise a patient's metabolic profile. This device (ECAL), validated against existing research-grade equipment is certified as a medical device in the European Union and elsewhere.

Unlike traditional approaches, ECAL provides a number of key parameters that allows clinicians and health practitioners, for the first time, to individualise therapy for patients, based on the measured metabolic need. These parameters include:

- **Resting metabolic rate**
  - The base daily energy requirement of the patient

- **Respiratory exchange ratio (RER/RQ)**
  - What proportion of daily energy is derived from fats and or carbohydrate? Therefore, an indication as to how metabolically flexible a patient is

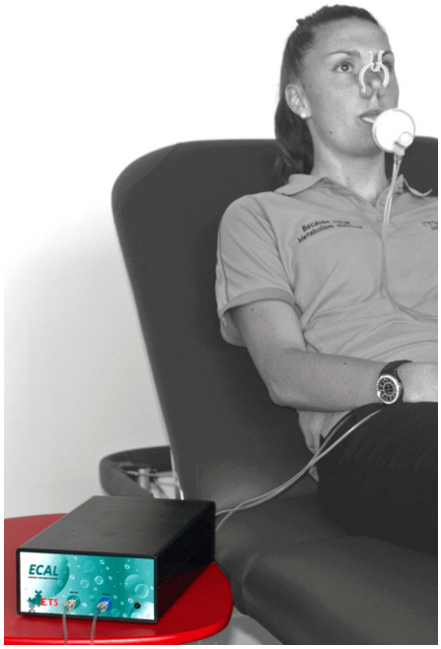
- **Mitochondrial efficiency**
  - A measure of how efficient and fit their cells are at generating energy

Standard practice is to estimate one of these parameters and ignore the other two. This is because, until recently, this information has not been readily available for clinical and allied health use as current technology is too complex, cumbersome, expensive and time-consuming.

However, measuring these parameters can now be conducted via an affordable, simple, 5-8 minute breathing test. Each person's profile is highly individual and this information allows the practitioner to give the patient tailored advice on the amount and makeup of their diet to ensure they lose weight in a healthy manner. Regular testing over time allows the practitioner to validate results, adjust diet and exercise prescription to suit the patient.

Test results are provided in an easy to read and understandable format with graphical representation to help the client understand their individual metabolism which can be motivating. For example, how they have reacted to dietary change? Are they metabolising more of their body fat and how is exercise improving their weight loss and health?

Measuring a patient's metabolism allows the health care professional to individualise treatment and embed



permanent lifestyle change for their clients to manage their weight and metabolism over time.

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Weighing up the costs of Type 2 diabetes remission in the UK

Dr Elizabeth Robertson, Director of Research at Diabetes UK weighs up the costs of Type 2 diabetes remission

Type 2 diabetes is the epidemic of our time. There are now 3.8 million people in the UK living with a diagnosis of diabetes; with 90% of these living with Type 2, and a further one million thought to not yet be diagnosed, it's fair to say we have a crisis on our hands. Diabetes costs the NHS around £10 billion every year, with a large proportion of that funding dedicated to treating devastating complications associated with the condition, such as cardiovascular disease, sight loss and amputations.

That said, the management of Type 2 diabetes has greatly improved in recent years. Particularly since the landmark UK Prospective Diabetes Study highlighted the need to control blood pressure and glucose levels to reduce the risk of diabetes complications[1]. While medications are available to help manage Type 2 diabetes, only 65% of people in the UK are able to meet their blood glucose targets[2].

Remission from Type 2 diabetes offers an alternative approach, with people previously diagnosed with Type 2 diabetes achieving blood glucose levels within the range needed to lower the risk of complications, without the need for diabetes medications. Bariatric surgery has been shown to result in remission in 30-60% of cases, with reports of remission lasting for up to 15 years[3,4]. However, an intervention to achieve remission without the need for surgery is desperately needed.

To explore the potential to put Type 2 diabetes into remission through lifestyle changes, Diabetes UK funded DiRECT, the Diabetes in Remission Clinical Trial. Led by Professors Mike Lean and Roy Taylor at the University of Glasgow and Newcastle University, the trial involves 298 people with Type 2 diabetes, testing a low-calorie weight management programme delivered through GP practices.

Dr Elizabeth Robertson

The programme is composed of three parts: 12-20 weeks of meal replacements to support significant weight loss, support from a nurse or dietitian to introduce healthy foods into the diet, and long-term support to maintain weight loss. The one-year DiRECT results showed that 46% of those who took part were in remission, with two-year data soon to shed further light on this approach to remission[5].

The results led to a global shift in the conversation around Type 2 diabetes; perhaps remission is possible through weight management for significant numbers of people living with Type 2 diabetes. The prospect of reducing medications and the risk of expensive complications – both for the individual and health services – for millions of people across the world is an inviting one.

But questions, of course, remain as to the feasibility of such an approach, and, in particular, the costs involved.

We do not have all of the answers yet, but the 2018 health economic analysis of the first year of DiRECT, published in the Lancet Diabetes & Endocrinology, is an important first step[6].

> "Remission from Type 2 diabetes offers an alternative approach, with people previously diagnosed with Type 2 diabetes achieving blood glucose levels within the range needed to lower the risk of complications, without the need for diabetes medications."

The analysis suggests that the rollout of a Type 2 diabetes remission programme within the NHS could cost £1,067 per participant in its first year. The Glasgow team responsible for the analysis took into account the costs of healthcare professional training, the formula diet, clinical reviews, supporting literature, and routine healthcare – including primary and community care, hospitalisations and medications for Type 2 diabetes or blood pressure.

Factoring in the 46% remission rate seen 12 months into DiRECT, the team estimated that each case of remission would cost £2,564. The most recent comprehensive analysis in 2010 cited the cost of managing Type 2 diabetes at, coincidentally, £2,564 – rising to £2,801 with current inflation.

While this latter figure additionally includes the costs of treating serious complications and covers all stages of Type 2 diabetes throughout an individual's lifetime, it raises an important question as to the relative cost of making remission a reality.

As a relatively inexpensive treatment option, when compared to managing Type 2 diabetes, and one which may reduce the risk of diabetes complications, long-term remission could result in significant cost savings to the NHS. It is of course too early to know for certain; more research into the long-term impact of remission on the rates of complications is very much needed, as are further assessments of the health economics involved. But this data will emerge, both from the continuation of the DiRECT study and the recently announced pilot remission programmes committed to by NHS England and Scotland[7,8].

While understanding the economic implications is vital, we must not forget the impact of remission on a far more personal level, enabling individuals – and their families – to live healthier lives, This will not be a catch-all solution for everyone with Type 2 diabetes, particularly due to the complexity of both the condition and society more widely. As such, we have a responsibility to make remission an option for those who can benefit now, while we continue to strive for better outcomes, through further research and healthcare innovation, for all those affected or at risk. ■

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Proper diabetic retinopathy (DR) monitoring improves health and saves money

Petri Huhtinen from Organisation Optomed OY Ltd argues that proper diabetic retinopathy (DR) monitoring improves health and saves money

The World Health Organization (WHO) has estimated that diabetic retinopathy (DR), which is an eye disease caused by diabetes mellitus, is responsible for 4.8% of global blindness [1]. It affects up to 80% of those who have had diabetes for 20 years or more [2]. At the same time, it has been estimated that at least 90% of new cases could be reduced with proper monitoring and treatment of the eyes [3]. Furthermore, several studies have shown, that proper and well-organised management of DR would also be cost-efficient [4]. So, one can conclude that proper management of DR would both improve the health of the diabetic population and create savings on health expenditure. Still, a great majority of the world's diabetic population do not receive the recommended eye examinations [5].

DR screening should be portable, non-mydriatic, reliable and easy-to-use

The relevance of proper DR management can also be assessed based on the Wilson and Jungner criteria for screening [6]. The 10-step screening criteria evaluates disorder based on its importance as a health problem, the availability of screening and diagnostic test and treatment, and the economic effects; i.e. is it cost-saving to screen and diagnose proactively, instead of treating it based on visible symptoms? To recap, screening should improve health and save costs. [6] DR is a school-book example of a condition that should be screened for, as it meets all the screening criteria. Therefore, it is inevitable that DR screening should be made available for all, to maximise health benefits and overall cost savings.

DR screening can and should be organised so, that it meets the local needs and regulations. It means that there is not one correct technology or

infrastructural set-up for screening. With that said, Pasquel and colleagues concluded that the ideal screening technology should be portable, non-mydriatic, reliable and easy-to-use [4]. Optomed has been designing and manufacturing mobile fundus cameras for more than ten years, and the latest fifth generation camera, Optomed Aurora®, meets all the camera-related specifications of ideal screening technology as listed by Pasquel's group.

Optomed offers a holistic DR screening solution

In addition to cameras, Optomed also provides telemedicine and information management solutions for screening. This makes Optomed a one-stop-shop for DR screening programmes seeking for reliable clinical outcomes and optimised efficiency. Optomed Screen® is a screening management solution that automates the screening process completely. Once the data of the screening population is downloaded into the system, Optomed Screen® schedules screenings and sends out invitations. The screening data; i.e. the images; are stored in a server that can be accessed by specialists responsible for image analysis. The analysis could also be automated using artificial intelligence (AI)-based analysis tools. The third option for analysis is a combination of human grading and AI-analysis. So, each screening programme can organise the analysis to serve best the programme set-up and match the resources available. Optomed Screen® also provides tools to monitor and optimise the efficiency of the programme. The programme coordinator can follow the statistics of each screening site, to find out if the population is being screened, and to assess the performance of individual screening centres. This feature can be very useful especially when allocating resources and assessing training needs. The solution is cyclic, meaning that new invitations are scheduled based on the findings and specialist comments. Thus, once screening population data is downloaded, the process really is automated.

It is widely acknowledged that DR should be screened for, and proper screening management would both improve the health of the diabetic population, and generate savings on overall health expenditure. However, it is regrettable that too low a proportion of the diabetic population is being screened regularly. One of the main reasons being poor accessibility of the screening centres. Optomed is doing its share to solve the accessibility issue by providing a solution consisting of a mobile non-mydriatic camera, and screening management system. The solution brings DR screening to people and at the same time generates efficiency through automated processes, telemedicine and even AI-based analysis.

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Diabetes: The patients' perspective

Jenny Hirst MBE, Co-Chair of the InDependent Diabetes Trust shares her expertise on diabetes from the patients' perspective

The InDependent Diabetes Trust (IDDT), a UK registered charity, was formed 25 years ago for people living with diabetes and by people living with diabetes. Including 'independent' in the name demonstrates that the Trust does not accept pharmaceutical industry funding, so is uninfluenced by this powerful group.

Global insulin production is by three large pharmaceutical companies, Novo Nordisk, Eli Lilly and Company and Sanofi Aventis. This monopoly is largely responsible for the high cost of insulin, making it unaffordable in some low/medium income countries. Even in high-income countries such as the United States, cost forces some people to limit their insulin use, putting their health at risk.

Type 1 diabetes is an autoimmune condition where the pancreas no longer produces insulin, therefore, treatment is always with insulin by injection or pump therapy. In Type 2 diabetes, the body either does not use the insulin it produces effectively or does not produce sufficient insulin and is often associated with obesity. The two types of diabetes are different but are often confused, however, both can lead to complications affecting the feet through damage to the nerves with an alarmingly high rate of amputations, the eyes, kidneys and the heart. Treatment is to try to maintain blood glucose levels as near normal as possible to reduce the risk of complications. Understandably, people with diabetes and their families live with the fear of long-term complications and with the day-to-day struggle to maintain target blood glucose levels.

When one person in a family has diabetes, other family members are affected. They have views and needs which may be different from those of the person with diabetes, but nevertheless, are important. For example, for people with Type 1 diabetes the avoidance of hypoglycaemia is a daily source of worry for them and their family members who may have to handle severe hypoglycaemia. This involves dealing with comas, seizures, violent or unusual behaviour all of which are frightening for the family carer, especially when they are not included in doctors' consultations or educational courses to learn about diabetes.

The lack of education also applies to people living with Type 2 diabetes. IDDT's helpline frequently hears from people who have been given little information but are simply told to "cut out sugar" or "eat healthily" leaving them confused and worried. The lack of resources for the National Health Service (NHS), particularly in primary care, is short-sighted and risks future increased complications. To try to combat this, IDDT provides free information booklets in non-medical language.

NHS 10 year plan launched in January 2019

Considering that diabetes costs more than 10% of the NHS budget, it is surprising that there are only three relatively short paragraphs entitled 'Diabetes' in the NHS 10 year plan. With the exception of continuous glucose monitoring (CGM) for pregnant women, it is striking that there are no milestone dates for delivery. For diabetes, it is all in 'the future', so when can people with diabetes expect care and treatment to improve?

The FreeStyle Libre

The availability of the flash glucose monitoring system free on the NHS varies geographically because decisions are made locally by Clinical Commissioning Groups (CCGs). However, on World Diabetes Day, NHS England announced that from April 2019, the system will be free on the NHS for all patients with Type 1 diabetes who qualify for it in line with NHS clinical guidelines.

This was greeted with great relief by people with Type 1 diabetes – the safety of knowing glucose levels as many times a day as necessary and an end to years of painful finger-prick testing several times daily. However, scepticism crept in:

- What are the relevant guidelines for eligibility?
- Why are people with Type 2 diabetes taking insulin or other anti-hyperglycaemic agents being excluded from availability?
- Can central government force CCGs to fund the system or will patients have to continue to do battle?

As April looms, we still do not have the answers.

'Items which should not routinely be prescribed in primary care'

At the time of writing, this NHS England consultation is ongoing and is calling for GPs to prescribe cheaper, equally effective alternatives of:

- Blood glucose test strips for people with Type 2 diabetes and;
- Needles for pre-filled and reusable insulin pens.

It refers to 'deprescribing' but for patients, changes in prescribing must focus on evidence of quality, safety, accuracy and choice with education and support to meet each person's needs.

For people with diabetes, arguably the most important considerations are the comfort, convenience and quality of life. We fear that these are not on the list of priorities for today's decisionmakers and question if the NHS basic principles of patients' rights to an informed choice of treatment are being eroded. ■

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Technology and diabetes: How can innovation address the mounting challenge?

Barbara Harpham, Chair of the UK-based Medical Technology Group, explains the role that technology can play in reducing the financial and societal burden of diabetes

Diabetes is the most significant health challenge facing the world today. Almost one in ten (8.5%) adults over 18 are affected by the condition, with an estimated 1.6 million directly-attributable deaths in 2016 and a further 2.2 million caused by high blood glucose, making it the seventh leading cause of mortality. [1]

The problem is growing. The number of people with diabetes has almost quadrupled since 1980 [2] and experts predict prevalence to increase to over 600 million people worldwide over the 25 years. [3]

The global burden of diabetes

Apart from the human cost of diabetes and its associated complications, the condition delivers a major economic blow to healthcare systems and economies. In England for example, diabetes costs the NHS £10 billion every year. That's £1 million every hour, or 10% of the total annual budget. Worldwide, diabetes and other non-communicable diseases (NCDs) are predicted to cost over $7 trillion between 2011 and 2025. [4]

According to Professor Nam H Cho from the International Diabetes Federation: "Diabetes threatens to overwhelm healthcare systems and hinder economic growth in many countries."

Type 1 and Type 2 Diabetes

To appreciate the role of technology in managing diabetes, it's important to understand the distinction between the two main forms of the condition: Type 1 and Type 2.

People with Type 1 represent between five and 10% of the total number affected. Its cause is unknown, and currently, it is unpreventable. People with Type 1 diabetes do not produce insulin to regulate their body's blood sugar levels. Symptoms include excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision changes, and fatigue. Regular administration of insulin is needed to survive.

Type 2 affects around 90% of people with diabetes. It results from the body's ineffective use of insulin. Symptoms can be similar to Type 1, but as they are often less marked, the disease can go undiagnosed for years and is often only detected after complications arise. Type 2 is largely the result of excess body weight and lack of physical activity.

With both Type 1 and Type 2 diabetes, patients can experience damage to the heart, blood vessels, eyes, kidneys, and nerves. Adults with diabetes are up to three times more likely to have a heart attack or stroke, [5] while diabetes is a leading cause of kidney failure, lower limb amputation, and blindness.

The role of technology

Managing diabetes is a major priority for many governments. Prevention of Type 2 diabetes through education programmes and policies to improve lifestyle, including smoking cessation and physical activity, as well as improved diet is vital.

Effective control of blood glucose levels is a major factor in avoiding complications and reducing healthcare costs. Medical technology can play a key role. For people with Type 1 diabetes who need to monitor their blood glucose levels and administer insulin several times per day, options range from simple test strips to insulin pumps and continuous glucose monitors.

Insulin pumps, worn outside the body, allow the user to programme their background insulin needs and have it delivered steadily around the clock and as

needed with food. The benefit over injections is the ability to increase or decrease dosage according to each day's changing circumstances. Uptake in some countries, including the UK, has been slow though, despite evidence that they can save millions in healthcare costs. [6]

Recognition of the value of continuous glucose monitoring (CGM), and flash glucose monitoring technology is also growing. Both provide more information than finger-prick blood tests and enable the user to make better treatment decisions by reading levels of sugar in interstitial fluid and sending the results to a reader or smartphone.

Point of care innovations for people with Type 2 include glucose meters paired with applications and devices to enable people to manage their medication more effectively. Self-management and prevention support also comes in the form of mobile health technology, helping people improve their lifestyle or diet. [7]

From artificial pancreas to AI

Research teams across the globe have been developing the artificial pancreas for some time. The technology combines CGM with an insulin pump, using an algorithm to mimic the function of a human organ. Some devices have already been approved, while clinical trials continue on others. Primarily designed to manage Type 1 diabetes, work is also underway to find ways the technology can support glycaemic control among people with Type 2.

Looking further ahead, we can expect to see new developments in microtechnology and implantable devices, as well as 3D tissue printing, which could reproduce pancreatic cells for transplant. Artificial intelligence (AI) will also become more important, as machine learning improves blood glucose control via wearable or implantable devices.

Improving lives and reducing costs

The United Nations has set a target to reduce premature mortality from NCDs, including diabetes, by a third by 2030. Achieving this goal requires a joined-up approach that includes policies for tackling prevention, as well as innovative treatment approaches to reduce the toll on healthcare budgets and society as a whole. According to the World Health Organization (WHO), every dollar invested NCDs returns to society at least $7 in increased employment, productivity, and prolonged life expectancy. [8] The case for the increased uptake of cost-effective technology is powerful. ■

The Medical Technology Group (www.mtg.org.uk) is a not-for-profit coalition of patient groups, research charities and medical device manufacturers working together to improve patient access to effective medical technologies.

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Diabetes and low blood sugar: Taking a more precise approach to managing hypos

James Cotterell, Director at BBI Healthcare, argues that prescribing products that treat low blood sugar with a precise and measured dose of glucose can improve patient outcomes, reduce patient anxiety and save the NHS money

For people with diabetes who have previously relied on sugary food and drinks to treat low blood sugar, the sugar tax introduced in the UK on April 2018, has resulted in confusion and concern.

Managing and preventing low blood sugar is part of daily life for people with diabetes. Most people with Type 1 diabetes have episodes of low blood sugar (when their blood glucose level drops below 4mmol/L) often, around twice a week.[1]

One of the first things people learn after they have been diagnosed is why hypos happen and what to do about them. Common symptoms are: feeling shaky, sweating, hunger, tiredness, blurred vision, pins and needles around their mouth, finding it hard to concentrate, headaches, feeling tearful, increased heart rate, and becoming stroppy or stubborn. When this happens many people with diabetes eat or drink something sugary – for example, a sugary drink, such as fruit juice or an ordinary (non-diet) fizzy drink.

The sugar tax has implications for people with diabetes

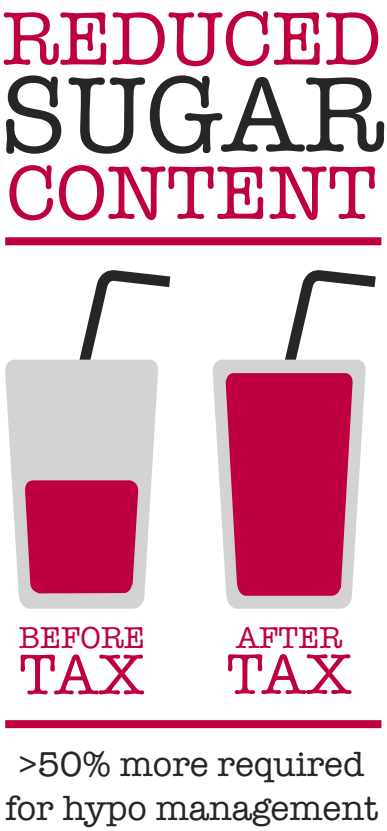
The sugar tax applied to soft sugary drinks, introduced in April 2018, has caused concern amongst people with diabetes. Previously able to rely on the amount of glucose in a bottle of drink, such as Lucozade, the sugar content in sugary drinks is being reduced by 50%. In real terms, this means that people with diabetes have to consume more of these drinks to receive the same amount of glucose. Another complication is that old and new formulations of these drinks may sit side-by-side in shops during the transition period.

> "The sugar tax may lead people with diabetes to doubt the amount of glucose they are absorbing."

Diabetes UK supports sugar reduction, but the charity is aware that these measures have caused concern for people who may use sugary food and drinks to treat low blood sugar. Diabetes UK states: "It won't always be clear if and when companies have reduced the sugar content of their food and drinks, and they may not publicise any changes. When a company changes the sugar content, there may be a time when both old and new recipes of the same product are on sale at the same time, as the old recipe sells out.[2]

Anxiety about low blood sugar is a serious problem for 25% of people with diabetes[3]

Of course, it would be unwise to have no fear of hypoglycaemia at all – it's a dangerous situation, and fear obviously plays some role in avoiding it.



>50% more required for hypo management

The effects of low blood sugar can be frightening, embarrassing, uncomfortable, unpleasant, or in their worst cases, fatal. But anxiety and fear about low blood sugar can result in people with diabetes deliberately running blood sugar levels higher than usual, which can result in elevated HbA1c and further complications and costs for the NHS.[4,5] In fact, the majority of diabetes-related conditions such as heart disease, nerve damage and amputation, and vision problems – occur as a result of uncontrolled blood glucose levels, particularly elevated blood sugar over a prolonged period of time.[6]

Low blood sugar has a significant negative impact on patient outcomes, healthcare resource use, and expenditure[7]

Whilst most hypos are mild, some can be severe. If improperly treated, low blood sugar can cause seizures and result in people collapsing or passing out.

In 2015, the mean cost per hospital admission for severe hypos in England was shown to be £1,034, and it is estimated that severe hypos currently cost the NHS £13 million a year.[7] Effectively managing and treating low blood sugar with a measured and specific amount of glucose could prevent more serious complications and reduce the burden on secondary care.

Ensure people with diabetes have the right amount of glucose when they need it most

Having access to the right amount of glucose to confidently self-treat and self-manage low blood sugar levels are crucial for anyone living with Type 1 diabetes.

15-20g of fast-acting glucose is recommended to treat a hypo.[8] GlucoGel contains a precise, measured, fast-acting glucose to help rapidly raise blood sugar levels and is recommended by NICE[9] and the Joint British Diabetes Societies (JBDS) for hypo management.[10]

The Gluco range also includes a juice (GlucoJuice contains precisely 15g of fast-acting glucose) and dextrose tablets (GlucoTabs contain 3.7g of fast-acting glucose per tab) which are readily available at pharmacies and provide a measured alternative to the more traditional energy drinks and bars that are used to manage blood sugar levels.

25% ARE ANXIOUS ABOUT LOW BLOOD SUGAR

Conclusion

The sugar tax may lead people with diabetes to doubt the amount of glucose they are absorbing. With anxiety about low blood sugar being a serious issue for people with diabetes, prescribing GlucoGel – a precise and measured dose of glucose – could help alleviate some of this concern and potentially reduce complications and costs arising from people with diabetes deliberately running blood sugar levels higher than usual.

Low blood sugar can result in serious complications if improperly managed, leading to poorer patient outcomes and ultimately increasing the burden on the NHS. An estimated £14 billion is spent a year on treating diabetes and its complications[11], with the cost of treating complications taking the largest slice of the pie. By prescribing a precise and measured dose of glucose for people with diabetes, and taking a more precise approach to hypo management, we could improve patient care and save the NHS money.

For more information about the benefits of prescribing GlucoGel go to Getglucogel.co.uk

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Tackling the biggest challenges in diabetes care – together

John Grumitt, CEO of Changing Health and Chair of IDEAL Group highlights the importance of tackling the biggest challenges in diabetes care – together

With diabetes diagnoses rising rapidly across the UK, providing effective care for the nearly 4 million people who live with the condition is one of the biggest challenges facing our healthcare system.

To contain what could soon become a major national health crisis, the NHS has made vast investments in diabetes care; UK spending on the condition totals 10% of the total healthcare budget, amounting to some £10 billion per year. The majority – around 90% – of people with diabetes live with Type 2, and consequently, 80% of all diabetes care funding is consumed by treating complications which are largely avoidable.

Over the period spanning 2017-18 and 2018-19, an additional £80 million has been allocated to improving access to structured education on diabetes, providing more interventions to achieve better blood glucose, blood pressure and cholesterol levels, offering better access to multidisciplinary foot teams when necessary, and increasing access to diabetes specialist nurse support when in hospital (NHS Long Term Plan, 2019).

Equally important, is the Diabetes Prevention Programme (DPP), launched in 2016 and now available across 100% of England – the first such nationwide programme in the world. Over a quarter of a million people have already been referred to the DPP, with higher attendance rates among individuals from Asian, Afro-Caribbean and other ethnic groups, and equally high attendance among individuals from the most deprived compared to the least deprived communities – all of whom have historically been difficult groups to reach (Zeh et al, 2018).

Initiatives like the DPP show much promise and additional funding is, of course, welcome news. Yet consistency in standards of diabetes care processes and equal health outcomes, throughout the country, remain a goal, not a reality.

Diabetes prevalence in the UK can be anywhere between 6.5% and 11.5% depending on location – with communities with more socioeconomic challenges almost invariably seeing a higher prevalence of Type 2 diabetes.

Some areas, meanwhile, may have similarly sized diabetes populations but see very different numbers of hospital admissions for hypoglycemia and other complications, suggesting a postcode lottery also exists in individuals' level of ability to self-manage their diabetes.

The iDEAL group, comprised of professionals with a wide range of backgrounds – from primary care and pharmacy to tech and academia, and bringing both personal and professional experience of diabetes to the table – was founded to review current NHS practice and recommend ways to reduce this variation.

We have identified four challenges to be addressed:

1. Introducing robust Key Performance Indicators (KPIs) for adult diabetes care

The NHS has seen considerable success in introducing KPIs for paediatric diabetes care. The Best Practice Tariff (BPT) for Diabetes was created in 2012-13 (and updated in 2017) and sets the standard of care required for every child or young person with diabetes under 19 years old.

Since the BPT was introduced, diabetes management among this group has improved for seven consecutive years. In 2011-12, only 17.4% of children and young people with diabetes had an HbA1c of <58 mmol/mol

(<7.5%); by 2016-17 this figure had risen to 28.9%. The case, then, for introducing such a tariff for adult diabetes care is clear.

2. Providing and sharing models of best practice

One of the most effective ways to reduce variation in diabetes care processes may also be the simplest: sharing successes. Several CCGs have already developed models of excellence on increasing engagement with diabetes education and consequently, increasing the ability of people with diabetes to self-monitor their blood glucose accurately, at scale.

Sharing these models of excellence with other NHS organisations could drive a marked improvement in clinical, psychosocial and financial outcomes at very little if any, financial cost.

3. Increasing access, availability and uptake of structured diabetes education

Giving people with Type 2 diabetes the skills and the knowledge to manage their condition effectively is paramount to reducing the likelihood of complications. While 77.3% of people with Type 2 diabetes are referred to structured diabetes education, typically delivered in group-based classroom sessions, attendance rates have been a challenge.

Average uptake in England, according to the National Diabetes Audit, is just 7.4% – less than one in ten of those offered support. Clearly, a new approach is needed. The solution, as in many facets of life, may be found in our pockets: mobile health. Unlike classroom-based support, digital education on diabetes, delivered via a smartphone app, can be completed anytime, anywhere, removing a key barrier to access.

4. Optimising blood glucose management

Understanding how diet, stress, sleep and exercise impact on diabetes management can be the most valuable 'tool in the box' for people with Type 2 diabetes. Self-monitoring of blood glucose (SMBG) devices give users this understanding – yet only a minority of those who live with the condition are offered SMBG, and of those who are, the importance of understanding and making use of the data isn't always made clear to them.

People with diabetes tend to report using SMBG so their health professional can advise them how to act on that information, but healthcare professionals tend to report prescribing SMBG as a tool to improve the individual's own self-management. This suggests a gap in understanding and potentially, a lack of necessary support.

Crucially, SMBG devices commissioned by the NHS should be independently verified for quality and accuracy and prescribed alongside education and support to ensure each individual knows how to make use of SMBG technology.

Conclusion

Ultimately, delivering more effective diabetes care across the board can be achieved only one way: by bringing together all of the numerous stakeholders in diabetes care. That's why the iDEAL group is engaging with NHS commissioners, primary care professionals, policymakers, advocacy groups, research bodies and others, to reach a consensus on enacting change.

The way forward is clear. We, that is, all of us involved in diabetes care, must share more of our knowledge, insights and experiences – CCGs with each other, front-line health professionals with patients, and groups like our own with our colleagues in the NHS and beyond – to better understand how we can help people with diabetes live longer, happier, healthier lives.

The iDEAL group is supported by an educational grant from Ascensia Diabetes Care. Follow us on Twitter @iDEALdiabetes or visit our website: http://idealdiabetes.com . ■

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From diabetes prevention 1.0 to Prevention 3.0

Digitally enabled pathway personalisation is leveraging actionable data insights and dynamic intelligence to drive better outcomes as part of the Prevention 3.0 agenda

When it comes to the case for diabetes prevention, we know that the rising global prevalence of Type 2 diabetes has placed acute strain on healthcare budgets, attracting the attention of US and UK policymakers.

The US National Diabetes Prevention Program established credible evidence linking lifestyle change with reducing risk of Type 2 diabetes onset, leading policymakers in the UK to establish the NHS England Healthier You Diabetes Prevention Programme.

Early provision, or prevention 1.0, was geared to helping those identified with elevated blood sugar levels to create a lifestyle change plan in face-to-face settings.

Prevention 2.0 built on this by leveraging telehealth and nascent digital-enablement to reinforce face-to-face provision with remote support.

Pushing the boundaries of the possible

Hitachi's diabetes prevention journey started in 2010, when the company developed its first digitally-enabled service to support its employees in meeting their wellness goals. Hitachi's programme attempted to move provision towards telehealth and digital-enablement, or prevention 2.0.

By bringing together a blend of telehealth coaching and digital tools, Hitachi was able to personalise the provision of care, while giving its employees the means to effectively self-manage their lifestyle changes.

Since 2010, the solution has been rolled out to other Japanese corporates and used as a foundation for Hitachi's collaborations with the NHS in England, aimed at leveraging clinical expertise, remote telehealth and digital solutions to create a new model of provision, or Prevention 3.0.

Actionable data insights and dynamic intelligence

Hitachi's Smart Digital Diabetes Prevention solution, underpinned by its Prevention 3.0 vision, firmly establishes data as a critical enabler for improving service performance and patient outcomes. Developing an appropriate data lake consisting of cohort, progress and engagement data (to be described in the forthcoming OAG e-book due to be published in October 2018) is the first step towards delivering dynamic intelligence.

The next step is to surface data insights through advanced analytics and combine these with qualitative analysis, using user-centric design methods and a co-creation approach with commissioners, digital teams and frontline NHS health advisers to identify opportunities and strategies for service improvement.

Service personalisation

Actionable data insights and dynamic intelligence allow Hitachi and its clinical partners to help support personalised service provision, so that appropriate support is provided to patients at the right time. This helps to ensure that patients' needs and preferences drive health adviser engagement and coaching, providing patients with the best opportunity to achieve positive outcomes (reduction in risk of Type 2 diabetes onset), while furnishing the service with the intelligence needed to ensure constrained resources are targeted to those with the greatest need.

Examples of how Hitachi's Smart Digital Diabetes Prevention solution has leveraged actionable data insights and dynamic intelligence to support service personalisation include:

- Personalisation of patients' lifestyle change goals based on cohort and presenting needs data captured through an online self-assessment and processed with algorithms.
- Personalisation of the health adviser dialogue with their patients based on cohort and progress data, such that it focuses in on the greatest areas of need.
- Personalisation of the pathway based on population-level cohort insights, such that patients who require more intensive health adviser

support receive it at the right time, while allowing those who can self-manage do so.

Hitachi's Smart Digital Diabetes Prevention solution leverages actionable data insights and dynamic intelligence to help support personalised service provision at patient and population level to improve health outcomes and optimise allocation of resources to support defined areas of need.

Service improvement

Actionable data insights and dynamic intelligence allow Hitachi to better understand how patients engage with digital tools, allowing an agile continuous service improvement agenda to be implemented. The latter includes enhancement to both the digital tools and the coaching and education delivered by health advisers, to respond quickly to needs identified at population, cohort and patient levels. Examples of how Hitachi has leveraged actionable data insights and dynamic intelligence to support service improvement include:

- Evolving health adviser and patient dialogue from a transactional to transformation dialogue, whereby the dialogue is focused on addressing the individual lifestyle needs rather than a mere description of lifestyle habits, thus ensuring patient support is as personalised as possible.

- Ensuring that minority cohorts (such as those with limited access to digital tools and limited IT literacy) can engage with the pathway and receive additional support where appropriate.

- Evolving the digital tools to promote active patient engagement while in service. This includes the design of new features, auto-generated behavioural prompts and signposting to appropriate and tailored structured lifestyle information.

Hitachi's Smart Digital Diabetes Prevention solution leverages actionable data insights and dynamic intelligence to enhance the scope and impact of continuous service improvement activity to help ensure that support offered to patients continues to evolve in line with best practice and patients' engagement with the digital service.

Commissioning of services at population level

Commissioners at national, regional and local levels are eager to ensure the services they procure address population needs, while remaining flexible to meet needs at more discrete levels. While 'hard' clinical data offered by service trials and clinical studies continues to be the gold-standard for decision-making:

- Commissioning organisations are finding it increasingly difficult to commit both the funding and resources required to deliver them.

- The timescales prohibit rapid delivery of data insights in what is a very fast-moving digital healthcare economy.

This means that commissioners are turning to both qualitative and quantitative data-points established through patients' engagement with digital tools, thereby allowing them to access dynamic intelligence at lower cost. Hitachi's Smart Digital Diabetes Prevention solution provides data insights that can help commissioners realise these objectives:

- Providing access to dynamic intelligence that identifies opportunities for developing new and integrated services and/or transforming existing service offerings to ensure maximum reach and outcomes for patients.

- Allowing dynamic intelligence to be accessed throughout the service management lifecycle, allowing commissioners to ensure that services evolve with the regional and/or local healthcare economies.

- Informing both the 'hard' and 'soft' metrics commissioners build into future service contracts to ensure they are meeting the needs of their populations at optimal cost.

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Tackling tuberculosis (TB) in Africa

Some of the priorities for tackling tuberculosis (TB) in Africa are detailed here

In a previous edition of Open Access Government, Dr Wilfred Alexander Chalamira Nkhoma from the World Health Organization (WHO) Office for the Africa Region detailed the priorities for tackling infectious diseases in Africa, including tuberculosis (TB). Here, we discover that while the region of Africa has made progress in reducing the burden of communicable diseases slowly but steadily, it is still one of the places in the world with the highest TB rates.

"People infected with TB bacteria have a 10% lifetime risk of falling ill with TB. However, persons with compromised immune systems, such as people living with HIV, malnutrition or diabetes, or people who use tobacco, have a much higher risk of falling ill."

By way of background, we know that TB is spread from person to person when germs are propelled into the air, for example, through coughing, sneezing or spitting. Only a few germs need to be inhaled before a person becomes infected.

"About one-third of the world's population has latent TB, which means people have been infected by TB bacteria but are not (yet) ill with the disease and cannot transmit the disease.

"People infected with TB bacteria have a 10% lifetime risk of falling ill with TB. However, persons with compromised immune systems, such as people living with HIV, malnutrition or diabetes, or people who use tobacco, have a much higher risk of falling ill.

"When a person develops active TB disease, the symptoms (such as cough, fever, night sweats, or weight loss) may be mild for many months. This can lead to delays in seeking care, and results in transmission of the bacteria to others. People with active TB can infect 10–15 other people through close contact over the course of a year. Without proper treatment, 45% of HIV-negative people with TB on average and nearly all HIV-positive people with TB will die."

According to WHO, TB is a curable and treatable disease. We know that TB can be treated with a standard six-month course of four antimicrobial drugs that are provided with information, supervision and support to a patient by a trained volunteer or health worker. Such support is essential to stop the disease spreading but the good news is that most cases of TB are curable when medicines are supplied and taken in the correct manner. WHO believes that an estimated 49 million lives were saved through TB treatment and diagnosis between 2000 and 2015.

In closing, we know that the WHO response includes their "End TB Strategy" which is a blueprint for countries to end the TB epidemic by lowering TB deaths, incidence, as well as eliminating catastrophic costs. The intention here is in terms of global impact, to reduce TB deaths by 90% and to cut new cases by 80% from 2015 to 2030. In addition, we know that ending the TB epidemic by 2030 is among the targets of the Sustainable Development Goals of the United Nations. Having said this, WHO has ambitiously gone the extra mile by introducing a 2035 target of a 95% reduction in deaths and a 90% decline in the incidence of TB. ■

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Enhancing One Health surveillance systems

Researchers from SACIDS Foundation for One Health discuss the importance and implementation of event-based community surveillance using a One Health approaches in East and Southern Africa

The Sokoine University of Agriculture in collaboration with the National Institute for Medical Research through the SACIDS Foundation for One Health has developed and deployed a digital technology branded AfyaData to enhance community-based disease outbreak early detection and prompt response in East and Southern Africa. This work, funded by the Ending Pandemics, is led by the One Health Sciences Community of Practice (OHS CoP) Coordinator, Professor Esron Daniel Karimuribo. The CoP operates under four pillars namely: One Health surveillance systems; Ecosystem Health; One Health Policy; and Agri-Health systems.

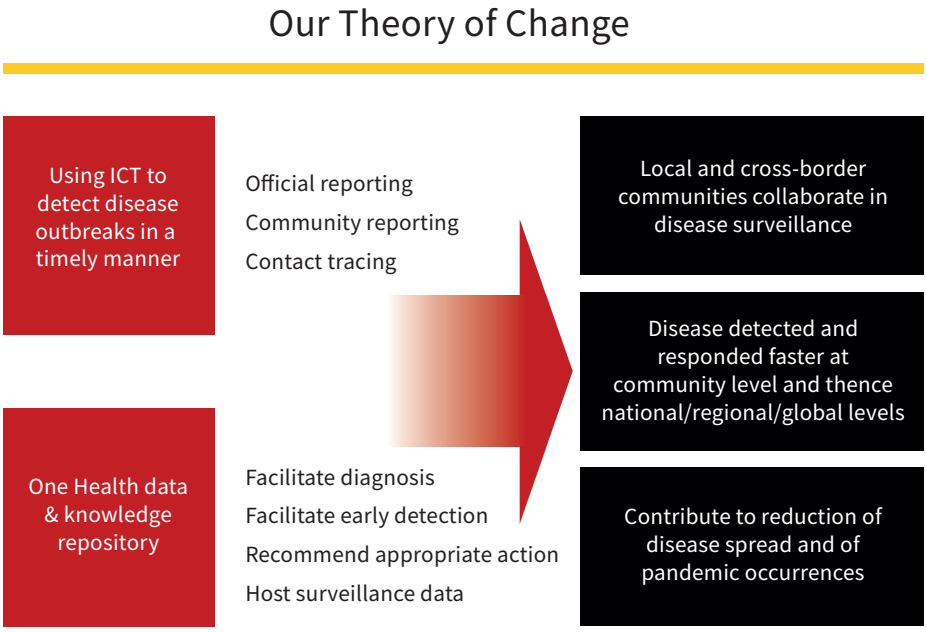


Figure 1: SACIDS theory of change's diagram

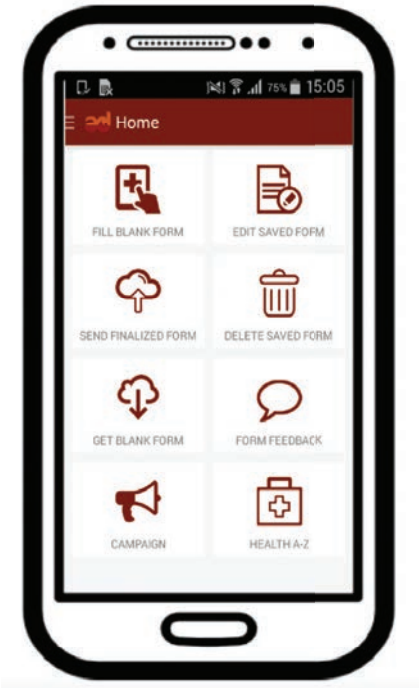
The growing body of evidence shows that about three-quarters of human infectious diseases have an animal origin. This observation suggests that One Health approach is considered to be the most effective strategy for managing infectious diseases and the associated risks. Scanning through the event-based surveillance systems in human and animal health sectors in Tanzania, we learnt that the systems faced some challenges including inadequate engagement of community, untimely capturing and submission of reports on health events from the primary sources, lack of feedback loops, difficulty in contact tracing and intra- and inter-country inadequate inter-sectoral information sharing. We have observed that disease outbreaks typically erupt at a community level and hypothesised that community-based participatory disease surveillance could enhance early detection, timely reporting and prompt control. Furthermore, we have realised that most vulnerable communities are located in hard to reach areas with poor infrastructure, which motivated us to think about the fit-for-purpose innovative approaches to strengthen event-based surveillance (EBS) in Tanzania and beyond.

Our approach

Participatory event-based surveillance (EBS) is driven by our theory of change summarised in figure 1, to work across human and animal health sectors to fight disease epidemics, to develop ICT tools to support data capture, reporting and feedback at health facility and within the community (feed into the official national human and animal health information systems), and to strengthen cross border collaboration to fight epidemics in shared ecosystems. We seek to link the EBS data from community to district, regional (provincial), national and global scales.

About AfyaData

AfyaData is an open source digital disease surveillance tool that eases the collection, analysis, documentation and feedback of public/animal health events. It is a set of two applications – a mobile Android based client and a web-based application acting as a server. The mobile client is used for collecting and submitting surveillance data, and receiving and/or tracking



- **Basic Configuration**

A = Strictly Human Diseases

B = Strictly Animal Diseases

C = Shared Diseases = Zoonoses

D = Specific Disease active surveillance/vertical system

- **Configuration for Public Health = A + C**
- **Configuration for Animal Health = B + C**
- **Active specified human disease = D**
- **Active specified animal disease = D**

www.sacids.org

feedback from various levels. The server component caters for data storing/hosting and management.

How it was designed

AfyaData was designed in 2010 as a collaborative partnership between SACIDS and ministries responsible for human and animal health in Tanzania. Collaborative designing was extended to regional animal and human health epidemiologists, Information, Communication and Technology (ICT) specialists and community representatives through EpiHack event convened in Arusha, in December 2014, which was attended by 66 specialists (medical, veterinary and ICT programmers) from 14 countries.

Basic configuration of AfyaData

Its basic configuration comprises four strands namely (a) strictly human diseases, (b) strictly animal diseases, (c) diseases transmissible between animals and humans (zoonoses), and (d) specific disease active surveillance/vertical system.

How it functions

AfyaData toolset has the capability to manage entire data collection lifecycle, from managing users, loading forms, collecting data in the field, sending collected data to a server, and viewing data on the server and providing feedback to data collectors and/or persons of interest. The app is designed to collect georeferenced data online or offline in locations without internet and data can be submitted later when one is at a location with internet. It supports prompt analysis, visualisation and presentation of data in different formats including graphs and maps. Its dashboard provides a quick overview and reflections of the programme trend/achievement in intervention strategies/measures. It can integrate data from multiple sources and is enhanced with an early warning short message service for notification to decision makers on health events through their mobile phones.

AfyaData is powered by One Health Knowledge Repository (OHKR), which is a decision-making system with expert-authored content that helps to support the prediction of likely disease conditions based on the reported signs and symptoms. It can be used for sample tracking and communication of test results between different points/sections of the health care delivery system using barcode feature. It supports multiple languages and can be customised based on different clients' needs including language, surveillance, data integration needs.

AfyaData deployment strategy

Prior to its deployment in the selected areas, consultative meetings were held with ministries responsible for human and animal health and the President's Office Regional Administration and Local Government in Tanzania to identify the specific needs and agree on the areas and deployment strategy. From the national level, we the consulted district officials responsible for human and animal disease surveillance and draw up the

specific area deployment strategy based on the identified local needs. The local leaders and officials working in human and animal health sectors at the community level were actively engaged in the identification and recruitment of Community Health Reporters (CHRs) who were subsequently trained on the use of AfyaData in EBS.

Scope of AfyaData deployment

Between March 2017 and December 2018, the focus has been on the rolling out of AfyaData using One Health disease surveillance model to support capture of health events in human and animal populations and their environment at a community level in selected areas. So far the rolling out has been completed in Kilosa, Malinyi, Ulanga, Ngara and Wete districts of Tanzania. During the period AfyaData was used to enhance capture of cholera suggestive cases and environmental risk factors, as well as sharing of laboratory results between different points/sections of the health care delivery system. This was implemented using a specific cholera surveillance model in selected areas, which included Morogoro Urban, Mvomero, Kilosa, Kinondoni and Temeke districts of Tanzania.

Afyadata has been used to support official animal disease surveillance in selected areas in Tanzania. It has been used to collect information of the health status of animals at slaughter houses/premises in selected areas.

There are currently over 460 users of AfyaData at community level in Tanzania. Moreover, AfyaData has been used to collect baseline data on the functionalities of event-based surveillance in the communities of selected cross-border ecosystems in East Africa to inform the strengthening strategies between the countries. Within the next 18 months we plan to roll out AfyaData to others areas of Tanzania and neighbouring countries to enhance linkage of health events from community to the formal disease surveillance systems.

AfyaData has been introduced to the Ministry of Health of the Democratic Republic of Congo to support surveillance of Ebola Virus Disease (EVD). The training of trainers and the digitization of various surveillance forms to be used in EVD monitoring and evaluation have been conducted. Plan is in place to deploy AfyaData at community level and other potential levels in DRC.

We have initiated collaboration with the Food and Agriculture of the United Nations (FAO) and Ministry of Livestock and Fisheries in Tanzania to link data being collected from community level using AfyaData with EMA-I (an FAO disease surveillance tool deployed at district level). This collaboration strategy heightens the linkage of health events from community level to global level. In addition, we have successfully put up a proposal to support Africa CDC surveillance; an initiative that will enhance event-based surveillance in 55 Africa CDC member countries.

Data access

The collected data are strictly kept confidential and accessed near to real-time and owned by the relevant authorities (Ministries of Health, Livestock and Local Government Authority and others as defined by the relevant authority) through specific access code. AfyaData enhances linkage of human and animal health events from community level to district, national, regional and global levels.

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"SACIDS Foundation for One Health" against "Southern African Centre for Infectious Disease Surveillance (SACIDS) Secretariat".

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The advancement of cancer research for the public benefit

European Association for Cancer Research's Chief Executive Officer, Jane Smith, explains why the advancement of cancer research is purely for the public benefit, as well as the importance of collaboration in the field

The European Association for Cancer Research (EACR) is a membership organisation for those studying and working in cancer research. In 2018 we celebrated our 50th anniversary. Since its inception in 1968, the Association has grown into a community of more than 10,000 members around the world. Our aim, and that of each one of our members is simply the advancement of cancer research for the public benefit. When the EACR was founded, cancer was feared, treatments were in their infancy, survival rates were low and the importance of prevention was only just beginning to be understood.

Today, prevention and early detection are as much a part of cancer research as the quest for new treatments. We have also seen a shift from cancer treatments being one size fits all, to today's focus on treatments truly personalised to the individual depending on their genome, age, lifestyle and a myriad of other factors.

Despite this progress, there were 9.6 million deaths from cancer worldwide in 2018 and it is predicted there will be 27.5 million new cancer cases worldwide each year by 2040 if recent trends in incidence of major cancers and population growth are seen globally in the future.[1]

Our members know that today's science is tomorrow's medicine but the crucial early research is often unseen by the public and its importance under-appreciated. Each year, we ask our members for their views on the challenges they face and the research topics they think the EACR should prioritise for the coming year. From the 2018 survey, we know that the greatest obstacle our members face is funding: the constant need to apply for funding, the time taken away from research in order to apply, and the difficulty in being successful, even if the project is excellent, due to the lack of funds available. Even when successful, the short-term nature of many grants also makes it difficult for some researchers to take on ambitious projects and is almost certainly affecting the quality of the research that is being conducted. It is also having an impact on research careers because it makes it difficult to formulate long-term plans. Some might become so discouraged that they give up research altogether.

"Today, prevention and early detection are as much a part of cancer research as the quest for new treatments. We have also seen a shift from cancer treatments being one size fits all, to today's focus on treatments truly personalised to the individual depending on their genome, age, lifestyle and a myriad of other factors."

To respond to this issue, we work alongside other organisations in cancer policy, to raise the profile of cancer research and the need for funding. Collaboration is a way of life for us and our members. Cancer knows no boundaries and, despite the difficult political situation in Europe, we are committed to the concept that science has no borders; where a researcher is based should not make a difference to their ability to conduct research. One of the EACR's main reasons for existing is to encourage collaboration among cancer researchers, across Europe and also globally. One of the ways we do this is through conferences. Such conferences enable researchers to learn from and interact with each other at small, high-quality, focused scientific meetings. Meeting Bursaries help those without funds to attend. In 2019, three of our conferences will be on the topics of genomics, liquid biopsies and immuno-oncology. These topics were identified as key by our members and reflect those three strands of prevention, detection and treatment.

Beyond our own immediate community of cancer researchers, collaboration is also vital as the lines between the laboratory and the clinic continue to blur. To this end, the EACR seeks to work with like-minded organisations whenever we can. We are partners in the ESMO 2019 Congress, seeking to bring together researchers and oncologists to learn from each other's expertise and try to bridge the gap between research and treatment. We work closely with the American Association for Cancer Research (AACR), to bridge the U.S.-Europe divide, and we also work with organisations with a narrower focus – for example on lung cancer or metastasis – recognising that the breadth of cancer research is huge and ever-changing.

We are a founding member of World Cancer Research Day, established through the collaboration of organisations, associations and researchers from around the world. This initiative is designed to contribute to the objectives of the World Cancer Declaration in promoting cancer research and keeping its momentum going. We encourage organisations and individuals to join us in supporting World Cancer Research Day and communicating the importance of scientific research in the global fight against cancer. ■

1 https://www.cancerresearchuk.org/health-professional/cancer-statistics/worldwide-cancer/incidence#heading-One

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Immunoscore®: From the science to the clinical evidence in colon cancer

Jérôme Galon, Director of Research and Head of the Laboratory of Integrative Cancer Immunology at INSERM, explains Immunoscore®, an in vitro diagnostic test that predicts the risk of relapse in colon cancer patients

The past two decades witnessed the placement of the immune system amongst the critical components shaping cancer progression. Alongside the recognition of the key role of specific immune cells, most notably T lymphocytes, came the realisation that monitoring and measuring their levels within tumour lesions could hold prognostic information, which could be leveraged in routine clinical settings.

In 2006, Dr Galon and colleagues demonstrated the importance of the type, density, and location of immune cells within human tumours in predicting colorectal cancer (CRC) patients' survival and clinical outcome, regardless of tumour progression and invasion[1]. He defined the so-called "immune contexture", the most relevant immune-related parameters determining cancer evolution. This previously undescribed strength of the immune reaction changed the understanding of cancer evolution and has important consequences in clinical practice. Indeed, an immune-based theory of cancer evolution was demonstrated[2] and the importance of intra-tumour immune T-cells for the patients' clinical outcome was shown in the primary, as well as metastatic solid tumours[3]. At the same time, the realisation of the limited accuracy of the current cancer classification, the TNM staging system, which of note doesn't take into account the immunity of cancer patients, warranted the quest for better prognostic tools.

Surgical removal of the malignancy represents the main or first treatment of colon cancer that has not spread to distant sites (Stage I-III). Chemotherapy is sometimes used after surgery as an adjuvant treatment. Nonetheless, cancer recurrence occurs in a significant percentage of patients and often is found at distant anatomical sites throughout the body (metastases; stage IV). These observations highlight the limitation of the current staging system.

This is the context that led to the development of the Immunoscore®, an *in vitro* diagnostic test that predicts the risk of relapse in colon cancer patients.

By measuring the density of T lymphocytes populations bearing specific cell surface markers (CD3+ and CD8+) in the centre and at the periphery of the tumour, Immunoscore® represents the first immune-based prognostic tool, which is more powerful than the current TNM classification. The basic concept is simple: a high Immunoscore® reflects high tumour-associated immune cell densities.

Following the first World Immunotherapy Council meeting in 2012, the decision was taken with the Society for Immunotherapy of Cancer (SITC) to initiate an international Immunoscore® consortium featuring 14 centres in 13 countries from North America, Europe and Asia[4]. The aim of the consortium was to develop, evaluate and validate the consensus Immunoscore® assay in patients with Stage I-III colon cancer. The results of this work were recently published in *The Lancet*[5].

Overall, 2681 colon cancer patients were included in this study. A significant positive correlation was found between the T cell densities in each tumour region and survival, with patients having a high Immunoscore® showing the lowest risk of tumour recurrence. Another scientifically and clinically striking result was that patients with a high Immunoscore® had the longest survival. The analysis of the relative contribution to the risk showed the clear superiority of Immunoscore® in predicting survival compared to all clinical parameters, including TNM and microsatellite instability status (MSI) (Figure 1).

When investigating the strength and dependency of all clinical parameters to predict survival using multivariate analysis (MVA), Immunoscore® and TNM stage were the only significant risk parameters. Thus, the authors supported its implementation and concomitant introduction of an immune component "I" to the TNM (hence becoming TNM-I) cancer classification[4].

Figure 1

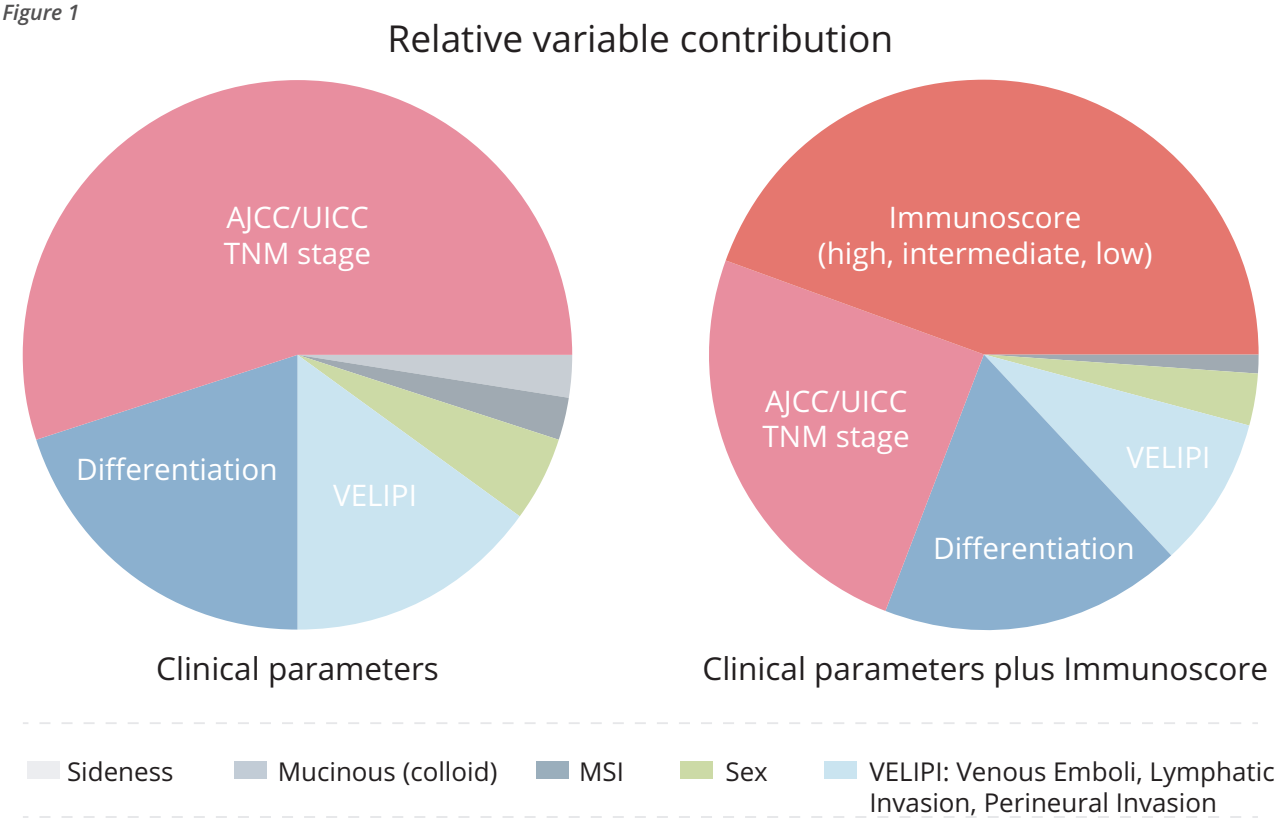

Image: © Pagès et al. Lancet 2018

The consensus Immunoscore® significantly predicted the risk of recurrence and survival in the subgroup of Stage II colon cancer patients. Furthermore, subgroup analysis on high-risk Stage II patients[6], showed that nearly 70% of these patients with high-Immunoscore® had a recurrence risk similar to the low-risk patients. This observation reinforces Immunoscore® clinical utility to guide treatment decisions in Stage II patients and to identify patients who could be spared from chemotherapy.

Immunoscore® was further validated in several randomised phase III clinical trials including N0147 study, where it was judged as prognostic in over 1600 stage III colon cancer patients[7]. The performance of Immunoscore® has today been validated in multiple clinical studies, including more than 5,000 patients, and it's currently used in routine practice for Stage II and III colon cancer patients. The wide use of Immunoscore® will constitute a step forward to the rightful recognition of the pivotal role played by the immune system in cancer control.

To promote the clinical translation of these findings, Dr Galon co-founded an Immuno-Oncology (IO) diagnostics company, HalioDx, with headquarters in France, and a U.S. subsidiary, HalioDx Inc., for American patients. HalioDx successfully validated the Immunoscore® for in vitro diagnostic use (CE-IVD for European Community countries, and performed in CLIA-certified laboratories). HalioDx was awarded the *Seal of Excellence Certificate* by the European Commission and with the first-place prize in the *Worldwide Innovation Challenge*.

Thanks to Immunoscore® and a further set of powerful IO diagnostic tools, HalioDx is now at the forefront of the IO field, thus, leveraging on the recognised role of the immune system in shaping cancer progression. In the future, Immunoscore® should be implemented in clinical decision-making for post-surgical treatment both to refine prognostication and potentially to predict the efficacy of immune checkpoint inhibitors.

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Insights into the mechanisms of primary brain tumour invasion

Thomas Daubon, Clotilde Billottet and Andreas Bikfalvi at the Angiogenesis and Tumor Microenvironment-INSERM U1029, Université Bordeaux provide insights into the mechanisms of primary brain tumour invasion

Glioblastomas (GBMs, WHO grade IV gliomas) are brain tumours derived from astrocytes or from oligodendrocytes (Kotliarova and Fine, 2012). GBMs are aggressive tumours that are characterised by a high proliferation rate, an abundant immature vascularisation, a necrotic core and infiltrative areas. The median survival of patients after diagnosis is very low, around 14 months despite surgery and radio/chemotherapy (Stupp et al., 2005). Anti-angiogenic therapy using Bevacizumab (Roche) led to a decrease in vascularisation and a shrinking of the tumour mass but overall survival was not significantly improved (Gatson et al., 2012; Weller and Yung, 2013).

Single-cell RNA sequencing identified different cell clusters within the tumour (Patel et al., 2014) and regional heterogeneity is also observed (Aum et al., 2014). Tumour evasion and relapse can originate from tumour cells infiltrating the normal brain parenchyma outside the subventricular zone or from the sub-ventricular zone. Spiteri et al (2019) performed whole-exome sequencing of multi-region samples from infiltrating tumour margins or the sub-ventricular zone. Phylogenetic reconstruction indicates residual tumour subclones may arise early and, thus, infiltration of the brain by tumour cells may arise at a very early stage.

Another line of investigation is to unravel the mechanisms that are operating at the level of the tumour cell. Recently, my laboratory has made some progress into this direction by focusing the attention on two molecular pathways including chemokines and extracellular matrix molecules (Fig. 1).

Chemokines are important mediators of cell signaling that operate both on normal cells and tumour cells and in the immune-cell compartment (for ref: Billottet et al, 2013). Among the chemokine receptors, CXCR3 mediate diverse biological functions and comes in two major isoforms the A and B isoforms. Promoting activities are generally associated with CXCR3A, while the B isoform is inhibitory. In a recent study (Boyé et al, 2017a), we found that ligand affinities and conformational changes are very different for the A and B form.

We have recently elucidated the role and mechanism of CXCR3A in GBM invasion (Boyé et al, 2017b). We demonstrated that agonist stimulation enhances *in vitro* cell migration and invasion in GBM cells. A major finding was that CXCR3A forms a complex with the trafficking receptor Lipoprotein-related receptor-1 (LRP1). We found that LRP1 enhances the trafficking of CXCR3A via a clathrin-dependent mechanism and retrograde recycling. Silencing of LRP1 leads to an increase in the magnitude of ligand-induced conformational change with CXCR3A focalised at the cell membrane, leading to sustained receptor activity and an increase in the migration. This was also clinically validated. Our study defines LRP1 as a new regulator of CXCR3 and indicates that targeting CXCR3A in GBM may constitute a promising strategy to halt tumour cell invasion.

The extracellular matrix (ECM) has morphogenic roles in tumours. Important ECM components are the matricellular proteins, called thrombospondins, a family composed of five members (THBS1-5) (Adams and Lawler 2011). THBS1, the most studied thrombospondin, may impact both, tumour cells and the microenvironment (Resovia et al 2014). It has been proposed that the effects of THBS1 on tumour cells are mediated indirectly through TGFβ activation via its type 1 domain, by mobilising its active form from the Latent Activating Protein (LAP) (Murphy-Ullrich et al, 2000). Another possible route for THBS1's morphogenic effects is direct interaction with α6β1 or α4β1 integrins or cell surface receptors including CD36 and CD47 (Sid et al, 2004). How THBS1 is itself regulated, is also not known.

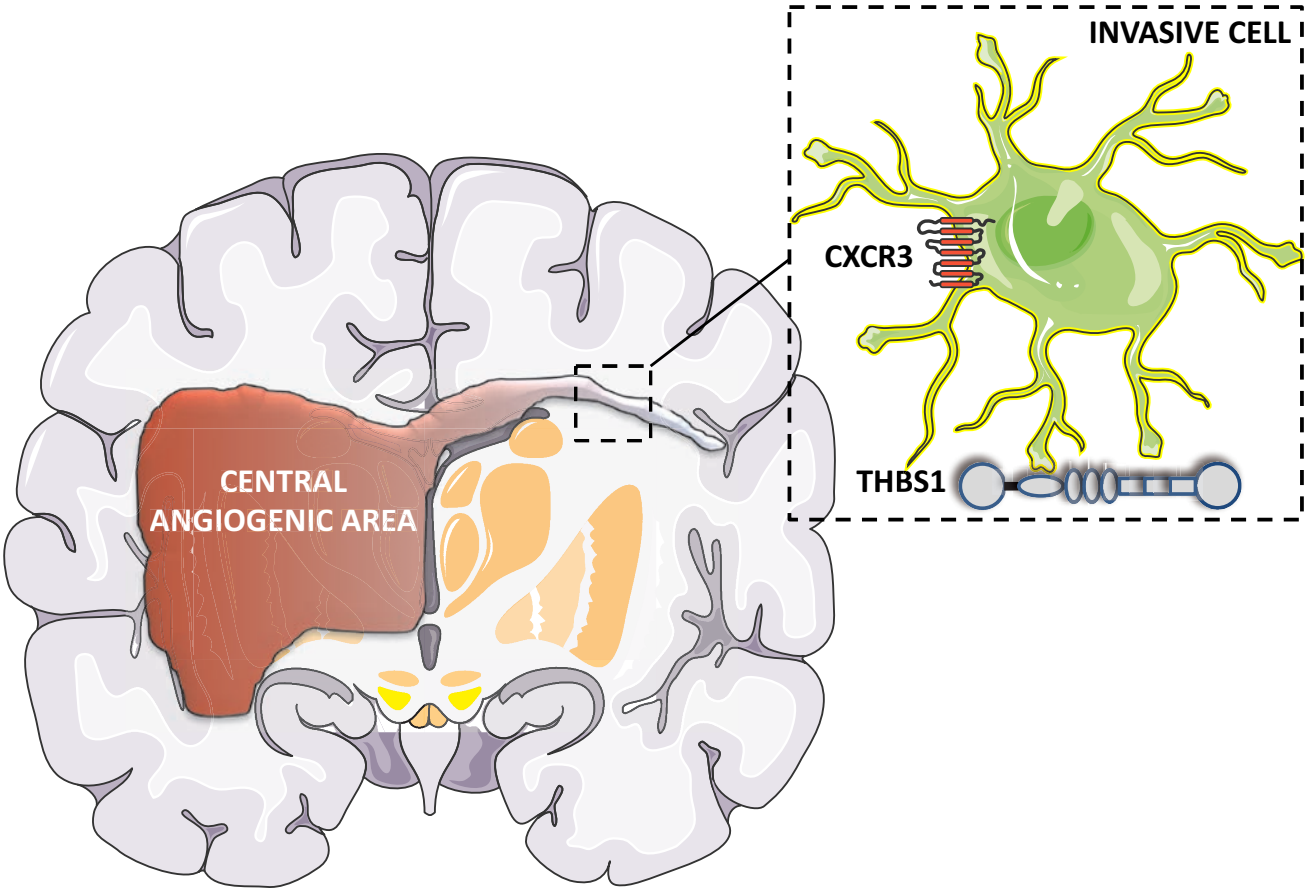

Figure 1

We recently elucidated the complex role of THSB1 in GBM invasion (Daubon et al. 2019). Global expression analysis revealed that THBS1 is up-regulated in GBMs and associated with a poor prognosis. We, furthermore, demonstrated that THBS1 did not activate TGFβ in GBM but that TGFβ1 induced the expression of THBS1 *via* SMAD3.

Furthermore, *in vitro* and *in vivo* GBM invasion is compromised when THBS1 is silenced in tumour cells. Thus, our data clearly shows that THBS1 is not only involved in the regulation of angiogenesis in GBM but also impacts the invasive behaviour of glioma cells by interacting with a molecule called CD47 expressed on the surface of GBM cells. RNA-sequencing after microdissection of central and peripheral tumour areas in a human PDX model demonstrated that THBS1 was the gene with the highest connectivity in the peripheral invasive tumour areas. Taken together, these data indicate that THBS1 plays important role in the infiltrative process in GBM.

GBM is one of the best-characterised tumours at the genetic level, but treatment options are still limited. Thus, additional mechanisms, such as microenvironmental cues, including cytokine- or matrix- dependent mechanisms must be explored for finding better treatment options to improve the clinical outcome. Our work constitutes a step towards this direction.

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Towards Precision Oncology in Breast Cancer: Predicting Response to Neoadjuvant Chemotherapy Using Tumor Vasculature Characteristics

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Breast cancer is a model disease in precision oncology, leading the way in the development of both targeted therapy and prognostic and predictive biomarkers. However, predictive biomarker based treatment selection remains an elusive goal in the management of many women with this disease. Our group has developed a modeling tool to predict the likelihood of response to neoadjuvant chemotherapy using patient specific tumor vasculature biomarkers. Here, we describe a novel integrated study based on a mathematical model utilizing tumor vasculature characteristics paired with patient data analysis to predict response to neoadjuvant chemotherapy in women with high risk hormone receptor positive, HER2 negative early stage breast cancer.

We have pioneered a semi-automated analysis method that allows for increased measurement accuracy and rapid throughput in rendering model predictions, with hundreds images analyzed for each patient (Figure 1). First, we applied a histology-based model to primary resected breast cancer tumors. Second, we then evaluated a cohort of patients undergoing neoadjuvant chemotherapy, collecting

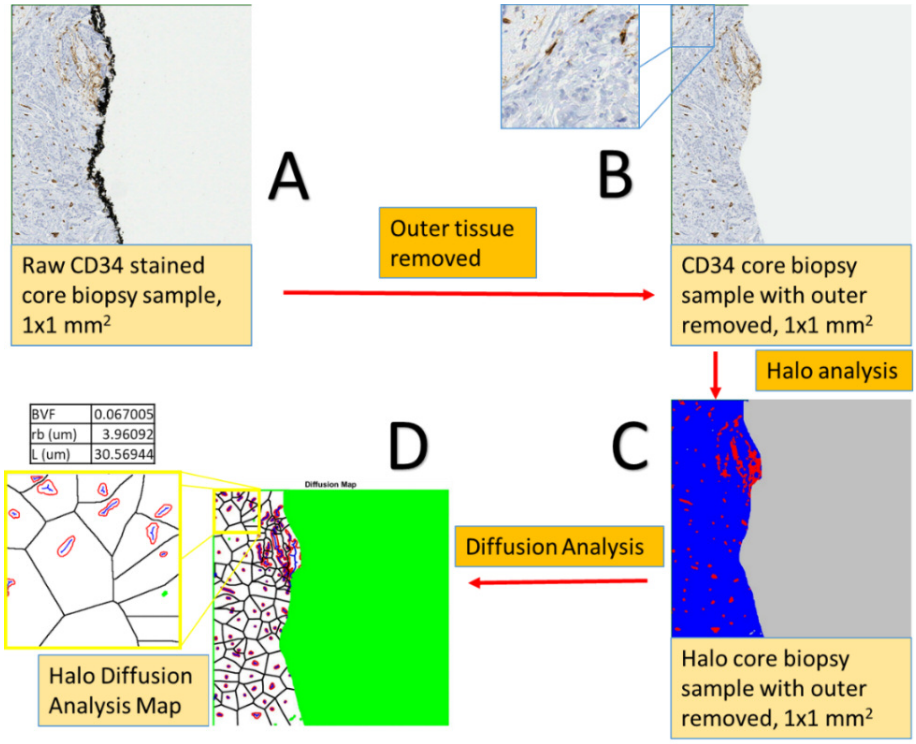

Fig. 1. Diffusion analysis workflow. **A)** *Shows the original CD34 (tumor vasculature) stained histology grid before any processing.* **B)** *Displays the same tissue region as in A, but with the outer inked portion removed due to the increased likelihood of false positives on the perimeter of core biopsy samples.* **C)** *Demonstrates a computerized version of B and differentiates between tissue CD34- (blue), vasculature CD34+ (red), and non-tissue regions (grey).* **D)** *Shows the diffusion analysis of image C, which was performed by code developed in Matlab. Parameters measured are: vessel radius (r_b), blood volume fraction (BVF), and diffusion distance (L). Vessels are outlined in red, and total area of blood vessels in a tissue region is blood volume fraction, BVF. Radius of blood vessels which are measured at each blue point inside of a vessel (outlined in red). An average of all vessel radii in each image analyzed is taken to be r_b (μm). The farthest distance nutrients or drug need to travel from a vessel to reach all tissue, the distance from that point to vessel in red is measured at each point in black, all distances averaged is the diffusion penetration distance, L, measured in μm. White is the tumor tissue region, all of which is considered for analysis. Green is the background/non-tissue region not considered for analysis.*

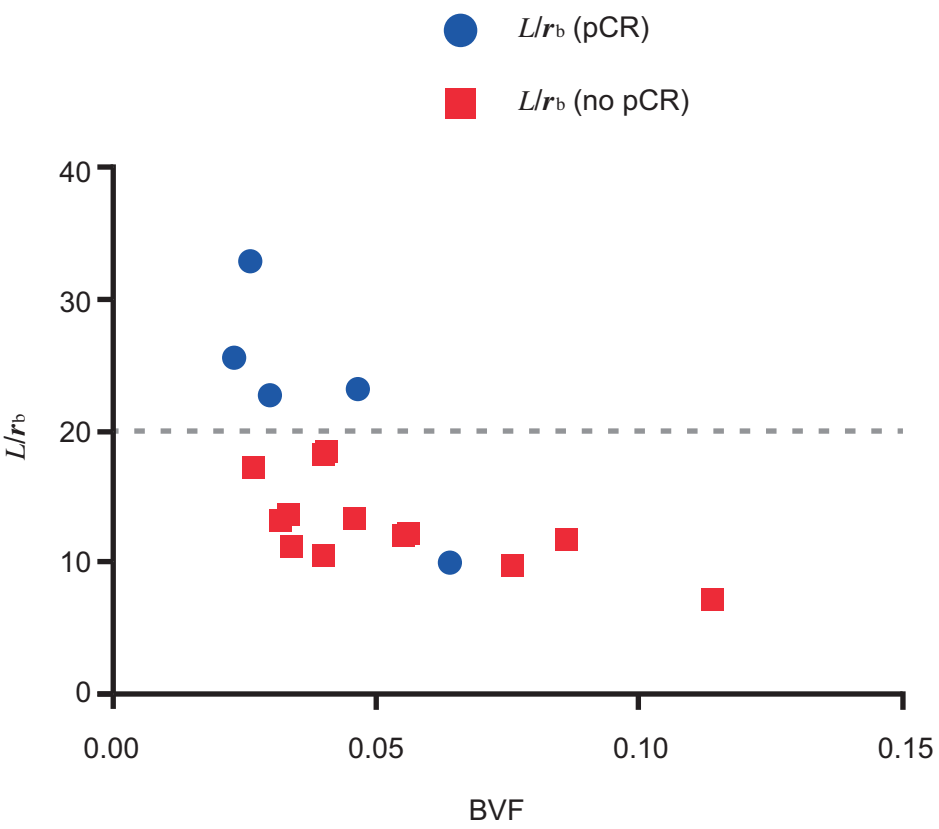

Fig. 2. Histological parameters and their correlation. pCR and L/r_b demonstrate a positive correlation. Dashed grey line separates patient groups with 80% accuracy.

clinically relevant data including pre- and post-treatment pathology specimens, and dynamic contrast-enhanced magnetic resonance imaging. We correlated predicted outcome based on our model with actual clinical outcome, including rate of complete pathologic response (pCR) following neoadjuvant chemotherapy. We found that core biopsy samples of primary breast tumors can be used with acceptable accuracy to determine histological parameters representative of the whole tissue region. We further correlated response to neoadjuvant chemotherapy with the pretreatment tumor vasculature biomarkers and model parameters. Analysis of histology parameters, specifically radius of drug source divided by diffusion penetration distance (L/r_b), a normalization penetration distance, and blood volume fraction (BVF), provides a separation of patients obtaining a pathologic complete response (pCR) and those that do not, with 80% accuracy (P = 0.0269) (Figure 2). With this predictive model, we are able to evaluate primary breast tumor vasculature biomarkers in a patient specific manner, thereby allowing a precision approach to breast cancer treatment.

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Book: "An Introduction to Physical Oncology: How Mechanistic Mathematical Modeling Can Improve Cancer Therapy Outcomes"

Opportunities and solutions for acute promyelocytic leukaemia (APL)

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group gives an overall perspective on the challenges and concerns around acute promyelocytic leukaemia (APL), a type of blood cancer

Acute promyelocytic leukaemia (APL), an aggressive subtype of acute myeloid leukaemia (AML), a type of blood cancer, is characterised by an increment in the number of immature blood-forming cells (promyelocytes) present in blood and bone marrow. The accumulation of promyelocytes drives to a deficiency in normal white and red blood cells and platelets in the organism. Therefore, among the most commonly observed symptoms of APL, an augmented risk to bleed and form blood clots is evidenced, accompanied by unnecessary exhaustion, pain, loss of appetite, and weight loss, among other signs.

Normally affecting middle-aged adults, APL can also be diagnosed during childhood. Its principal cause relates to a genetic mutation that involves a translocation between two chromosomes, evidencing the breaking off of a part of chromosome 15, to be then exchanged with a part of chromosome 17. This mutation precedes the production of the protein that causes blood cell development to get affixed at the promyelocytic stage.

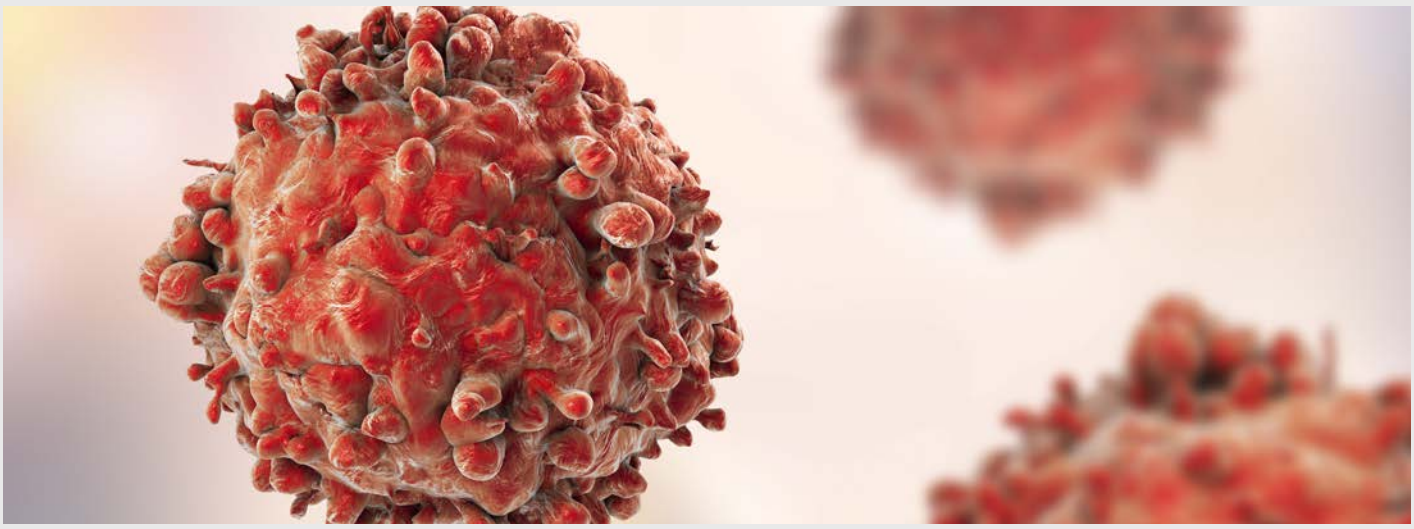
According to the U.S. National Institute of Health (NIH), APL accounts for about 5-15% of all adult leukaemias, represented by approximately 30,800 cases diagnosed yearly. Treatment is generally based on the use of all-trans retinoic acid (ATRA), a specialised form of vitamin A, and arsenic trioxide (ATO), in addition to anthracycline-based chemotherapy (Kayser et al., 2018). Indeed, ATRA represents an induction therapy capable of getting the patient into remission by shoving all promyelocytes into maturity. However, this therapy cannot cure the source of APL. Hence, patients are directed to consolidation chemotherapy (Pettit and Larson, 2018). The patient is then maintained with ATRA for another period, usually combined with other therapeutics. The reason is that present therapy for APL is refractory to initial therapy or eventually relapse in approximately 70% of cases due to the chemo-resistant nature of the leukaemic stem cells (LSCs).

Opportunities and solutions

During the past five years, novel anti-LSCs therapies begun to gain attention as new approaches to decrease relapses and improve survival in patients with APL (Singh et al., 2018). Both researchers and clinicians are seeing with interest in silico tests (computational modelling and simulation) to achieve a better prognosis of human APL LSCs gene expression signatures (Laverdière et al., 2018). These approaches utilise available datasets of drug-gene interactions to critically recognise those compounds expected to target LSCs gene sequences. Further, in vitro LSCs assays allow screening therapeutic candidates to treat APL (Cicconi et al., 2018).

The most relevant candidates resulting from these approaches belong to three drug families: antihistamines, comprehending astemizole and terfenadine; cardiac glycosides, including k-Strophanthidin, digoxin and ouabain; and glucocorticoids, comprising budesonide, halcinonide and mometasone.

A step forward is that the use of immunotherapy is rising as the promise for the treatment of hematologic malignancies, including APL. Chimeric antigen receptor (CAR)-T cells exploit the specificity of monoclonal antibodies (mAbs) to find and attach tumour antigens to complement the cancer cell killing ability of cytotoxic T-cells. The result is a new type of T-cell with the ability to identify a wide spectrum of tumour targets, hence dramatically enhancing the immune system. Multiple early-stage clinical trials investigating CAR T-cell therapy in treatment-refractory lymphoid malignancies have demonstrated meaningful antitumour effects, even leading to complete remission rates (Wiernik et al.,



2018). Nevertheless, when translating these approaches to targeted immunotherapeutic approaches for APL, the underlying biological heterogeneity of myeloid malignancies, in addition to the absence of accurately tumour-specific surface antigens, other routes need to be investigated.

"According to the U.S. National Institute of Health (NIH), APL accounts for about 5-15% of all adult leukaemia's, represented by approximately 30,800 cases diagnosed yearly. Treatment is generally based on the use of all-trans retinoic acid (ATRA), a specialised form of vitamin A, and arsenic trioxide (ATO), in addition to anthracycline-based chemotherapy (Kayser et al., 2018)."

Final remarks

The synergistic combination of computational modelling and simulation of stem cell gene expression signatures with in vitro screening assays is demonstrating to significantly help to identify novel compounds that target the chemo-resistant nature of LSCs being the underlying cause of relapse in APL.

This approach strongly facilitates the discovery and development of novel therapeutics that target LSCs without harming normal hematopoietic stem cells. CAR T-cell approaches are still being explored as potential therapy for APL. ■

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A technology platform: Point-of-care devices for therapeutic drug monitoring in cancer treatment and beyond

DiaChemo is a European project developing a platform technology for point-of-care devices for therapeutic drug monitoring in cancer treatment and beyond, reveals Dr Silke Krol, Head of the Translational Nanotechnology Lab and Coordinator of the DIACHEMO Project

Even today, the drug dose given to a patient for treatment is mainly calculated on the basis of easily accessible parameters like the body surface. This dose determination, unfortunately, does not take into consideration features, such as individual metabolism and, therefore, can lead to highly different concentrations of the drugs in the blood of the patient. The idea of treatment individualisation on the basis of drug concentration measurement, interpretation and subsequent dose adaptation was first introduced in clinical practice in the 1960s for the administration of the antiepileptic phenytoin. Since then, therapeutic drug monitoring (TDM) approaches have been progressively applied to a variety of drug classes among others antiepileptics, antidepressants, cardiovascular drugs, immunosuppressants or antibiotics. In principle, the concept of TDM aims to control for pharmacokinetic variability among patients which might otherwise lead to substantial variations in systemic drug exposure. Using drug concentrations to manage the treatment regimen for each individual patient is thought to optimise therapeutic outcome by improving treatment efficacy and/or reducing toxicity.[1,2]

TDM could be of particular value in anticancer therapy, considering the potentially fatal consequences of inappropriate drug administration in cancer patients where underdosing might be associated with therapy failure, whereas overdosing might increase the risk of serious toxic side effects. However, although the therapeutic outcome might be improved, TDM has been rarely implemented in cancer chemotherapy. Methotrexate is the only cytostatic where TDM is routinely used to adapt the dose of the antidote leucovorin. In acute lymphoblastic leukaemia trials, the activity of asparaginase has been monitored to detect immunological silent drug inactivation.[3,4]

Most obviously, successful implementation of TDM requires, inter alia, an established relationship between the drug exposure and its therapeutic and/or toxic effects which then culminates in the definition of a target exposure range. Establishing such a relationship is particularly difficult in cancer chemotherapy owing to an imperfect understanding of the pharmacokinetic (PK) and pharmacodynamic (PD) properties of many drugs, the long lag time between concentration measurement and therapeutic outcome or late toxicity, respectively, as well as the broad use of combination chemotherapy regimens.[5,6]

However, a critical limitation for obtaining meaningful PK/PD data constitute logistical requirements as the availability of appropriate equipment, assays and trained personnel. To make TDM work, correct sample collection, sample processing, as well as highly sensitive, accurate and precise analytical methods are mandatory. The avoidance of errors during these processes is fundamental for a valid analysis and interpretation of PK/PD data. Furthermore, analytical methods used for routine monitoring have to be fast, easy to use and widely applicable to facilitate the conduct of PK/PD studies and the transfer of TDM approaches in routine clinical practice.[3,5,7] These requirements are often not satisfyingly met by current analytical procedures which are frequently laborious and may involve well-equipped laboratories, the shipment of samples and complex sample processing steps. Nowadays, chemotherapeutic plasma concentrations are measured with standard time-consuming techniques, requiring sample preparation and specialised personnel.[12] In this scenario, an advanced technology allowing a real-time quantification of drug plasma concentrations may produce a dual benefit: to better clarify the threshold level and to promptly adjust the dose during the drug infusion. This would lead to overcome the difficulties that hinder the application of TDM in clinical practice, finally moving from

the standard chemotherapeutic drug dosing to a more rational therapy personalisation.

> "Prospectively, refined analytical technologies could also be of substantial advantage for the safe and effective use of novel targeted therapies which show long half-lives and a high risk of accumulation."

Doxorubicin, irinotecan, and paclitaxel are commonly used chemotherapeutics which exemplify some of the analytical difficulties that currently hamper drug monitoring in oncology but also underline the potential advantages arising from TDM. Therefore, we decided to focus on developing a platform technology based on a modular device in which by an exchange of some disposable modules, the device can be adapted to measure different drugs with the same hand-held device at the bedside of the patient. The modular approach also allows us to use the device for other drugs than chemotherapeutics. Thus, miniaturised, fast and easy to use bedside monitoring tests that allow obtaining reliable results from the smallest sample volumes without error-prone sample processing would meet a so far unmet need.

The gap in the technological development of adequate monitoring tests means that miniaturisation and delivery of the test to the point-of-care are currently addressed by the DiaChemo project that is funded by the EU Research and Innovation programme Horizon 2020 (Grant Agreement Number 633635). The DiaChemo project aims at the development of a point-of-care analytical device that will provide a fast and reliable determination of chemotherapeutic drug concentrations, thereby, supporting the conduct of pharmacokinetic trials and the implementation of TDM approaches in daily clinical practice. To achieve this goal three research institutions, two hospitals, two industrial partners and a professional EU project management agency joined a European partnership.

The technologies included in the device cover already patented technologies from small enterprises, as well as the engineering of novel modules during the project. The project takes into consideration differences in adults versus children or even newborns. Therefore, the clinical partner is a cancer hospital in Italy, as well as a children hospital in Germany. The close collaboration of partners with very different backgrounds such as engineering, medicine, chemistry, optics, and biology was the reason for the successful outcome of the project which will finish with a prototype for the measurement of irinotecan, doxorubicin, and most probably, also paclitaxel basing a novel technological development combining highly selective nanomaterials and liquid crystal technology.

Prospectively, refined analytical technologies could also be of substantial advantage for the safe and effective use of novel targeted therapies which show long half-lives and a high risk of accumulation.[13]

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DIACHEMO

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The role of heat shock proteins (HSPs) in cancer cells

Chester Medical School highlights the importance of heat shock proteins (HSPs) in cancer cells and how we might utilise them therapeutically

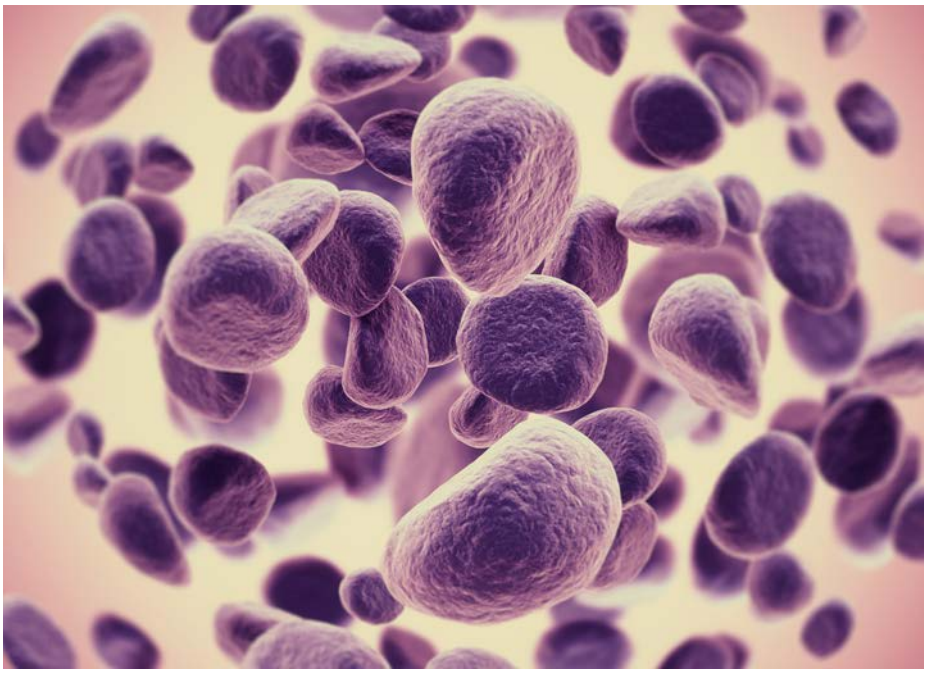
Heat shock proteins (HSPs) were originally identified as heat-inducible gene products that had a role in cell survival. We now know that many HSPs are not heat-inducible and that these highly conserved proteins have many roles in normal and stressed cells and are often referred to as molecular chaperones.

HSPs are involved in normal protein folding, re-folding partially denatured proteins, cell signalling and maintaining the conformation of receptor/signal transduction complexes. These are processes which are important in many diseases, such as Type 1 diabetes, Type 2 diabetes, Alzheimer's disease and cancer. As a result, there has been increasing interest in understanding cellular mechanisms so that we can see the potential for therapeutic interventions involving HSPs. The focus of this article will be the role of HSPs in cancer cells.

It has long been recognised that levels of HSPs tend to be elevated in cancer cells and as a result researchers have been interested in the role of HSPs in tumour development. Our work in Chester has helped elucidate some of the important mechanisms.

Targeting Hsp27 and Hsp70

Two of the HSPs, Hsp27 and Hsp72, have been shown to be important to cell survival under a variety of stress situations – for example, elevated temperature or heavy metal exposure.



Both of these proteins bind to partially denatured proteins and allow refolding, they are, therefore, antiapoptotic. One of the features of cancer cells is that they are resistant to apoptosis, so there is obviously potential for targeting Hsp27 or Hsp72. By using specific inhibitors or siRNA we have shown that targeting either Hsp27 or Hsp72 does reduce transformed cell line viability.

However, when applied to primary cells the picture is less clear, because we see a high degree of variability in the response, although it is less pronounced in chronic lymphocytic leukaemia (CLL) than in colorectal cancer. The response in colorectal cancer primary cells suggests a high degree of specificity in the dependency of the cancer cell to HSP depletion.

Targeting HSP90

Cancer research has been heavily influenced by the concept of 'The Hallmarks of Cancer' proposed by Hanahan and Weinberg in 2001 and then renewed in 2011. Hsp90 is a protein that has chaperone activity but also acts as a scaffold holding many receptor and signal transducer complexes in active confirmation. As many signal transduction pathways are highly active in cancer cells, Hsp90 is a target that may impact on many, if not all, of the hallmarks of cancer.

There are a large number of Hsp90 inhibitors and these do indeed kill cancer cells, whether used in isolation or in combination with other chemotherapeutic agents. However, we again find that the inhibitors are

"It has long been recognised that levels of HSPs tend to be elevated in cancer cells and as a result researchers have been interested in the role of HSPs in tumour development. Our work in Chester has helped elucidate some of the important mechanisms."

very efficient in transformed cells, but that there is greater variability in the response when using primary cells.

Extracellular HSP

We and others have shown that Hsp70 and Hsp27 are both secreted from cells, including those in tumours. Further, we have been able to demonstrate that these HSPs stimulate an immune response. This may provide a novel approach to treating cancer by targeting the HSP to a tumour, such that it is then in a position to specifically activate natural killer cells and cytotoxic T cells to attack the cancer cells.

Conclusion

When we examine the literature, we find that there is overwhelming evidence that HSPs have an important role in the initiation, development and maintenance of the tumour phenotype. Naturally, pharmaceutical companies have put considerable effort into the development of Hsp90 inhibitors. Many of these inhibitors have entered clinical trials only to be withdrawn. Some for a lack of clinical activity, others because they seem to increase metastasis. This latter effect may be related to the fact that Hsp90 inhibitors tend to induce heat shock factor activity and, therefore, stimulate Hsp27 and Hsp72 production – making cancer harder to kill!

We would argue that the HSP inhibitors should be used with the target patient in mind and that, as highlighted in other studies, we need a personalised approach to the chemotherapeutic strategy. Most research at present focuses on the genetics of personalised therapy, but we suggest that a chaperone/HSP fingerprint of an individual tumour may also be worth exploring to allow more specific targeting of a tumour.

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Japan: Driving forward cancer research through collaboration

The work of the Japanese Cancer Association in driving forward cancer research through collaboration is charted here, including a push on basic and translational research

For over 70 years, the Japanese Cancer Association has supported research into all forms of the disease based on national and international collaboration between scholars

The Japanese Cancer Association traces its roots back to the Japanese Foundation for Cancer Research, which held its first Scientific Convention in April 1908.

In 1935, the foundation resolved to establish a new, independent body that could capitalise on the rapid advances being made in cancer research and play a central role in promoting further study.

Following the decision by the society's board of directors to establish the Japanese Cancer Association in March 1940, President Mataro Nagayo told the 32nd Japanese Foundation for Research Scientific Convention at Tokyo Imperial University: "In consideration of the developments of recent years, I believe it is appropriate to newly establish the Japanese Cancer Association and hold meetings under that name.

"We think that by doing this cancer research in this country, [it] will be pushed further ahead by the united cooperation of scholars nationwide."

The JCA's first scientific lecture meeting was held at Osaka Imperial University on 5 April 1941.

Since then, the association has grown to comprise over 15,000 members specialising in a wide range of basic and clinical cancer research, as well as research on public health and social medicine, who exchange information.

The association's Annual Meeting is held every autumn and approximately 5,000 research and students, members of research advocators and various other stakeholders take part.

The JCA is actively promoting the globalisation of its work and since 2007, the Annual Meeting now includes an International Session featuring speakers from abroad, particularly neighbouring Asian countries.

In addition, since 1989, the JCA has held a joint conference every three years with the American Association for Cancer Research in the Hawaiian Islands. The last event, in 2016, was held under the title Breakthroughs in Cancer Research: From Biology to Therapeutics and was attended by around 570 participants from Japan, the U.S. and other countries.

Cancer research itself has, of course, made great strides over the years and has clarified the nature of cancer biology. Remarkable progress has been made in treatment of the disease, particularly in the area of molecular target therapy based on the genomic abnormalities of individual cancers. Genomic medicine, a type of precision medicine, will allow medical care to be tailored to an individual based on their genomic information.

Indeed, genomic medicine was one of the key issues under discussion at the 77th Annual Meeting of the Japanese Cancer Association, which took place in Osaka in September 2018.

Under the title, Diving Deeper into Cancer Research, the meeting discussed developments and emerging challenges in genomic medicine in light of President Barack Obama's Precision Medicine Initiative, announced in the 2015 State of the Union address, and the creation of Japan's Council for Promoting Genomic Medicine.

Another key topic for discussion was immunotherapy, which has emerged as a fourth therapeutic method for cancer following surgery, radiation and drugs, along with how cutting-edge research in areas such as artificial intelligence and genome editing are being used in cancer research.

Innovative thinking is, of course, crucial to the continuing development and diversification of cancer research, which is why the Annual Meeting offered a number of sessions aimed specifically at young researchers.

There was also a special symposium on Advances in Basic and Clinical Medicine in the Past 10 Years, which reviewed progress in research that would have been unimaginable just a few years ago.

However, while the development of new drugs is good news for patients, there are nevertheless concerns about the high prices for these treatments and what this means for the future of Japan's healthcare system.

With this in mind, the JCA is seeking the opinions of stakeholders, including patients, healthcare professionals, governments and related academic societies to provide recommendations for the public.

As in previous years, the three-day Annual Meeting featured International Sessions covering 12 selected topics, with discussions led by prominent researchers in each area.

As the remarkable progress in the treatment and prevention of cancer continues, the JCA remains as committed as ever to its goal of using collaboration to drive forward research.

President Hitoshi Nakagama says: "JCA will work more vigorously on basic and translational research, and develop human resources, including young researchers.

"We expect to establish and strengthen cooperative relationships with foreign researchers, so that we will contribute to the development of life sciences, promote the development of new cancer prevention and treatment methods, and contribute to society through the future promotion of cancer research." ■

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Nano DDS technology contributes to next-generation cancer immunotherapy

Dr Takashi Nakamura from Hokkaido University challenges the potential of nano-tech based drug delivery system (Nano DDS) in the development of next-generation cancer immunotherapy

The appearance of immune-checkpoint inhibitors (ICIs) such as the cytotoxic T-lymphocyte-associated protein 4 (CTLA-4) antibody and programmed cell death-1 (PD-1) has revolutionised the field of cancer therapy. Dr James P Allison and Tasuku Honjo who discovered CTLA-4 and PD-1, respectively, won the 2018 Nobel Prize in Physiology or Medicine. Cancer immunotherapy is currently the hottest field in the world.

However, positive responses by the current ICIs were observed only in a minority of the treated patients and tumour types, and several resistance mechanisms have been identified. The emerging focus is on improving the response rate and overcoming resistance. One possible solution is combination therapies, namely ICIs plus other immunotherapeutic materials or cancer therapies.

Nano DDS is an essential technology in the development of cancer immunotherapy

The leading candidates of immunotherapeutic materials for enhancing combination therapy are tumour antigens (proteins or peptides), adjuvants and nucleic acids (DNA, mRNA, siRNA etc.). However, they are easily degraded, are insoluble and have a low affinity for immune cells, resulting in a failure to induce effective responses. Nano DDS, namely carrier type DDS, can protect and deliver them by incorporating them. It is an era in which the world view in Fantastic Voyage, an SF movie in 1966, can be realised. Many cells and complicated mechanisms are involved in cancer immunity in both a good and bad way.

> "We believe that nano DDS largely contribute to overcoming the resistant mechanism and we are addressing a novel nano DDS system for achieving next-generation cancer immunotherapy."

Thus, restrict control of immunotherapeutic material trafficking is an important issue for inducing desirable immune responses. The protection and delivery of immunotherapeutic material by nano DDS have largely contributed to the promotion of antigen presentation to T cells, the activation of antigen presenting cells (APCs), targeting immune cells, targeting lymphoid organs, etc. We address the control of cancer immunity by original nano DDS technologies.

STING agonist loaded nano DDS drastically enhances cancer immune responses

Stimulator of interferon genes (STING) pathway functions as an innate immune sensor of double-strand DNA in the cytosol. The sensing induces the production of type I interferons (IFNs) that is important cytokine for the activation of cancer immunity. The STING pathway, but not other innate immune sensors such as Toll-like receptors, dominated the spontaneous immune responses against cancer. Therefore, agonists activating STING pathway (STING agonists) represent promising weapon as a cancer adjuvant. DNA and cyclic dinucleotides are STING agonists.

However, nucleotides are negatively charged, which hamper their transport into the cytosol. Thus, the use of STING agonists in cancer immunotherapy has been limited. To achieve the efficient cytosolic delivery of STING agonists, we loaded original nano DDS with STING agonist (we used a cyclic di-GMP). Our nano DDS is lipid nanoparticle (LNP) containing YSK lipids (YSK-LNP). YSK lipids show pH-responsible and high fusogenic activity, leading to efficient delivery of cargos into the cytosol. STING agonist loaded YSK-LNP (STING-LNP) succeeded in inducing type I IFN from APCs, activating APCs and antigen-specific killer T cells. In addition, the treatment of STING-LNP showed a drastic therapeutic effect in the lymphoma-baring mouse model.

On the other hand, some cancer cells escape from the attack by killer T cells by the loss/down-regulation of MHC class I expression. Against such tumours, for example, malignant melanoma, natural killer (NK) cells can be a major effector cell. The intravenous administration of STING-LNP activated NK cells and significantly decreased the number of tumour

Takashi Nakamura, Assistant Professor

colony of mouse melanoma lung metastasis. The antitumor effect was NK cell dependent.

Collectively, the successes are first reported and the STING-LNP promises to be a powerful adjuvant system for building strong cancer immunity. We are currently investigating the potential of STING-LNP in anti-PD-1 therapy-resistant tumours.

Nano DDS achieves siRNA-based functional control of immune cells

It is absolutely certain that controlling the function of immune cells at gene level represents high potential and powerful technology. Of course, also in cancer immunotherapy. Controlling gene expression by siRNA can be a promising and reliable strategy.

However, introducing siRNA into immune cells is quite difficult and the uses of virus vectors and special equipment are required. We recently succeeded in the effective gene silencing in mouse and human immune cells by using YSK-LNP. When siRNA was introduced into mouse dendritic cells (DCs), YSK-LNP achieved higher gene silencing than commercially-available siRNA transfection reagent (No. 1 share in the world) and the gene-controlled DC by YSK-LNP enhanced the antitumor effect.

"It is absolutely certain that controlling the function of immune cells at gene level represents high potential and powerful technology. Of course, also in cancer immunotherapy. Controlling gene expression by siRNA can be a promising and reliable strategy."

In particular, the commercially-available siRNA transfection reagents are ineffectual against human immune cells, even if cell lines. Nevertheless, the YSK-LNP succeeded in silencing a target gene in excess of 80% at a low dose range of siRNA. The capability to introduce siRNA of YSK-LNP represent at the top level. We are currently advancing research to apply the YSK-LNP to immune cell-based therapies or control immune cells via systemic administration.

Nano DDS strategy toward next-generation cancer immunotherapy

The response rate of cancer immunotherapy is largely dependent on the immune status in tumour microenvironment. For example, the patients show a good response rate in the case of tumour microenvironment having effector immune cells and without immune suppressions.

On the other hand, in the case of tumour microenvironment having less effector immune cells and with strong and complicated immune suppressions, the patients have a bad outcome. That is, we have to design cancer immunotherapy based on the immune status in the tumour microenvironment. The analysis of immune status in the tumour microenvironment has found a lot of resistant mechanisms against cancer immunotherapy.

However, the current technologies such as antibodies and low molecular drugs are a heavy load. We believe that nano DDS largely contribute to overcoming the resistant mechanism and we are addressing a novel nano DDS system for achieving next-generation cancer immunotherapy.

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How unfair prescription charges are putting people with asthma at risk

Asthma UK's recent report reveals the debilitating impact asthma prescription charges are having on people's health and wellbeing. Dr Samantha Walker, Director of Policy and Research at Asthma UK explains more

Asthma is a serious condition that affects 1 in 12 adults, leaving them struggling to breathe and at risk of a life-threatening asthma attack. Every day, three people in the UK die from an asthma attack. The best way for people to stay well is to take their life-saving medication, often for their entire life, but Asthma UK's new research shows there is a barrier preventing people from staying well and putting them at risk of a life-threatening asthma attack – the unfair cost of prescription charges.

Our report, 'Paying to breathe: why unfair asthma prescription charges must be stopped' includes research with over 9,000 people with asthma in England and the results are staggering. Three-quarters of people who have to pay for their asthma prescriptions have had to cut back their medication because of the cost. This is an estimated 1.3 million people in England who are putting their health at risk and exposing themselves to a potentially life-threatening asthma attack.

Worse still, a quarter of those people who cut back on their medication told us that they had had an asthma attack as a result, and more than 1 in 10 needed emergency treatment. Unfair prescription charges could cost lives.

People with asthma have to take their medication every day to stay well. They need to take what's called a 'preventer' inhaler every day to stop their airways getting inflamed and to prevent asthma attacks. They also need a 'reliever' inhaler to control symptoms if they get a sudden flare-up or if they are having an asthma attack. Many also need other prescriptions, such as allergy medication to prevent them from having an asthma attack or antibiotics to treat a chest infection.

But while people with other long-term conditions, such as diabetes and epilepsy (and those in the devolved nations) get their prescriptions free, people with asthma in England don't because asthma is not included on the prescription charges exemption list. How is this fair?

> "Every year, asthma costs the NHS £297 million in hospital admissions and GP appointments. If the government helps people to manage their asthma by removing barriers, such as prescription costs it would almost certainly help people avoid asthma attacks. This could reduce hospital admissions, A&E admissions and GP appointments, which are expensive for the NHS."

Prescription charges can carry a hefty price tag. Our research shows that people with asthma spend on average over £100 every year to pay for their prescriptions, but some are having to fork out as much as £400. This is a significant expense for people with asthma and hits people hard, especially those on lower incomes. According to our research, the squeeze is real, with three-quarters of people with asthma who have to pay for their prescriptions saying that they struggle to afford them.

Asthma is a growing problem. The number of adults with a lifetime diagnosis of asthma in the UK is increasing and the UK death rate from asthma is among the worst in Europe. With the NHS being stretched to the limit, surely it is more important than ever that people with asthma are supported to manage their condition, including taking medication which we know can keep them out of hospital and, more importantly, save their life?

Every year, asthma costs the NHS £297 million in hospital admissions and GP appointments. If the

government helps people to manage their asthma by removing barriers, such as prescription costs it would almost certainly help people avoid asthma attacks. This could reduce hospital admissions, A&E admissions and GP appointments, which are expensive for the NHS.

> "...a quarter of those people who cut back on their medication told us that they had had an asthma attack as a result, and more than 1 in 10 needed emergency treatment. Unfair prescription charges could cost lives."

The exemption list was created over 50 years ago and has only been reviewed once. In 2008, the government promised to eliminate the charges for asthma and other long-term conditions, but this never happened. But now, with our new research showing how unfair prescription charges are putting people with asthma at risk of expensive and life-threatening hospital admissions, the time is right for the government to add asthma to the exemption list.

That's why Asthma UK is encouraging people to support the campaign by signing the petition and tweeting their support to stop unfair asthma prescription charges. No-one should pay to breathe. To find out more, visit: https://www.asthma.org.uk/prescriptioncharges . ■

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Does disturbed cell-cell interaction cause asthma?

Michael Roth, Research Group Leader at University Hospital Basel asks if disturbed cell-cell interaction causes asthma and provides a fascinating response

Asthma is the most prevalent lung chronic disease and despite decades of research, the available therapies allow only symptom control but do no cure. Asthma attacks can be caused by inhaled pollen, dust mite faeces, cockroach faeces, mould spores, flour dust, hay dust, and animal dander through an allergic reaction. Other asthma triggers not directly linked to allergies are: smoke from open fires, cigarettes, industry, cooking, gas/oil heaters, or chemical fumes, organic dust from farming or thunderstorms, air pollution, strong perfumes, odours, or medications that affect the cyclo-oxygenase metabolism. Non-allergic asthma causes are sportive activities, anger, pain, fear or sudden changes in air temperature or humidity.

All these asthma triggers rapidly induce: i) airway constriction by muscle contraction; ii) inflammation, iii) infiltration of immune cells (Th-2 type), and iv) mucus production. In addition, the airway's epithelium is deranged, the basal membrane's thickness increased, sub-epithelial fibroblast rich tissue shows increased vascularisation and the bundles of airway smooth muscle cells are increased by cell size and number.

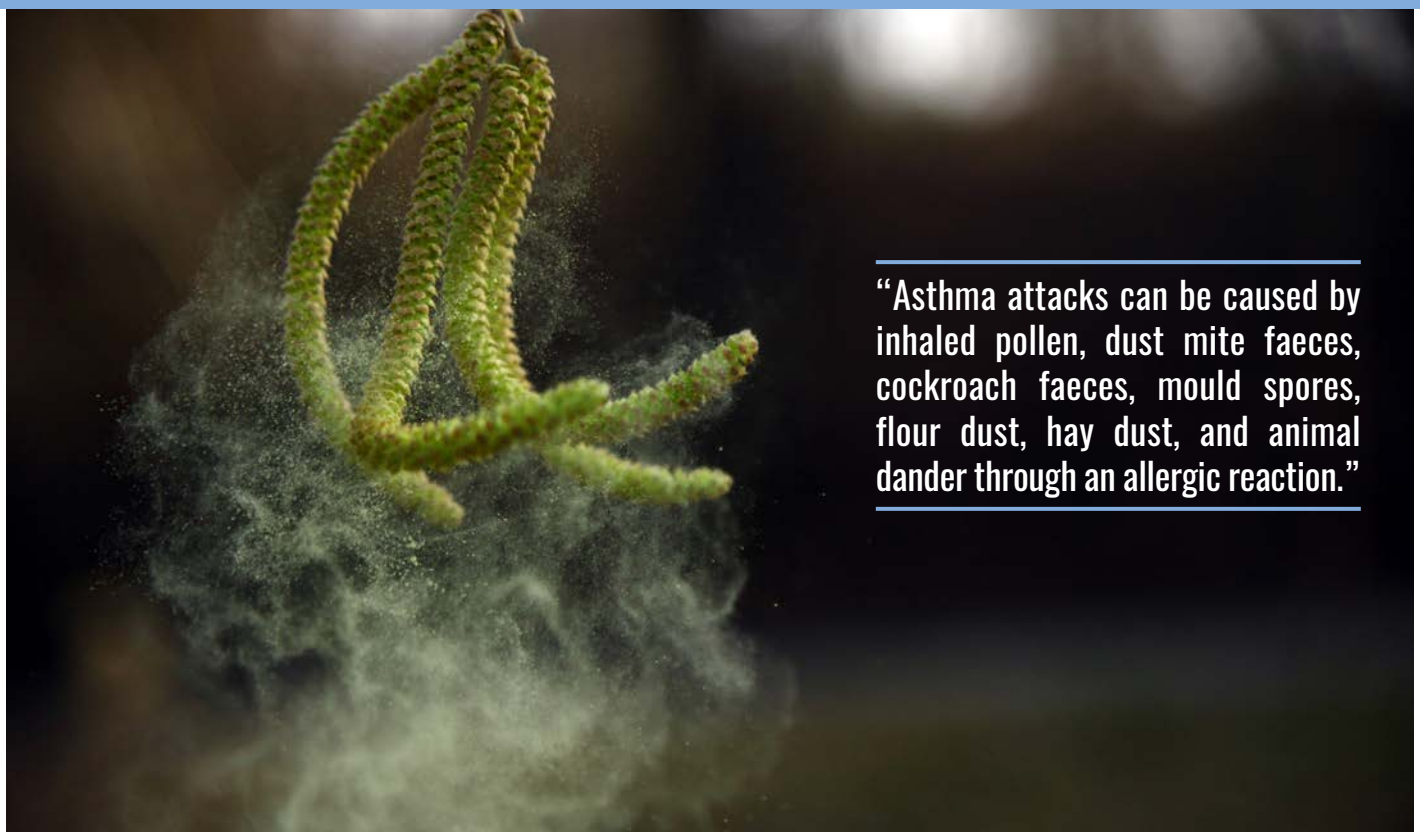
Inflammation in asthma can be well controlled by inhaled steroids, theophylins and humanised antibodies to IgE or specific cytokines. Muscle constriction is relieved by short or long-acting β2-agonists. In contrast, the structural airway wall changes are not affected by these therapies. Only short-term heat application by radiofrequency (bronchial thermoplasty), used to treat patients with severe asthma, reduced smooth muscle hyperplasia and hypertrophy. Bronchial thermoplasty lasting reduced exacerbation rate and hospital admission over more than five years. Tissue analysis showed reduced smooth muscle cell bundles, and regain a normal epithelium structure. These observations support the idea that the interaction of the airway wall cell types is disturbed in asthma, and may cause inflammation.

The airway epithelium is the first cell layer exposed to inhaled factors (pollen, dust, smoke etc). Inhaled particles are removed by tiny hairs (cilia) that cover the epithelial cells and all dirt is transported towards the throat where it is swallowed and removed from the body. In asthma, this mechanism works, but the epithelium allows some particles to penetrate into the tissue below where it causes inflammation.

In addition, epithelial cells express so-called "pattern recognition receptors" which respond to inhaled factors. Thereby, they stimulate the epithelial cells to secrete "danger proteins". This response sets cytokines free which activate dendritic and immune cells with the aim to remove the cause. In a healthy lung, this response may subside after the cause of inflammation has been removed, while in asthma it seems to continue for longer. Due to the lack of knowledge about these mechanisms in a healthy lung, we do not well understand what happens in asthma.

The importance of the epithelium for the proper function of our airway has been highlighted by the fact that pre-term born children show an immature lung structure at birth which is maintained for life if not treated with steroids. We know that the lung of a baby does not enter the last stage of development until the 36th week of pregnancy. Thus, the lungs are one of the organs that matures latest, moreover, its maturation continues through the first year of life. In the case of pre-term birth, the maturation of the lungs slows down or even stops. When untreated, this leads to asthma/COPD like symptoms in adolescence.

Lung maturation depends on the finely controlled interaction of epithelial cells with the underlying connective tissue fibroblasts, dendritic cells and smooth muscle cells. This interaction was termed the Epithelial-Mesenchymal-Unit (EMTU). In this concept, all tissue forming cells and immune cells act together to build and maintain the structure and function of the airways. Besides controlling the EMTU by secreted cytokines and growth factors, cells can exchange small



"Asthma attacks can be caused by inhaled pollen, dust mite faeces, cockroach faeces, mould spores, flour dust, hay dust, and animal dander through an allergic reaction."

molecules (peptides, microRNAs) through a "protein-tube" that links neighbouring cell to each other. If such mechanism(s) can be confirmed in asthma, they may present novel therapeutic targets and new therapeutic strategies.

Airway smooth muscle cells and fibroblast form the airway wall, control its constriction, elasticity, and stimulate or limit cell growth. These cells produce the extracellular matrix which clues the cells together. In asthma patients, these cells constitutively show increased secretion of pro-inflammatory proteins and, thereby, activated immune cells, as well as increased mitochondria activity and proliferation. These cell type-specific pathologies are maintained for weeks in the laboratory and can be studied, but not many laboratories have access to patient tissues. Genetic studies could not prove a single gene being responsible for asthma, and other mechanisms, for example, structure modification of the DNA, RNA or histones may explain the pathologies. In human asthma tissue, structural changes occur within less than one week in sensitive individuals, and it is unknown if these changes are repaired after the removal of the cause.

The fine-tuning of cell-cell interactions has to consider the extracellular matrix which glues the cells together. This cell-free component consists of collagens, fibres, sugars and growth factors. In a healthy lung, about 10% of it is remodelled every day. Some degradation products of collagens, statins, limit muscle cell growth and help re-epithelisation. In asthma, the metabolism of the extracellular matrix seems to be disturbed, but due to the complex interactions too little is known to understand the mechanism.

In the past, our research was focused on the effect of a specific drug, growth factor, or cytokine on the response of specific a cell type, without caring about what will happen in the neighbour cells. We know much about these specific responses, but we do not understand enough of the subsequent cell-cell interactions. Proteomic, transcriptomic and other –omics provide more information than we ever had before. However, like in earlier studies, this information only reflects the status of a cell or organ at this time point, it does not show – action et reaction.

In order to understand interactions and feedback mechanisms between cell types in health and disease expensive time consuming, more detailed studies are required to prove the claimed mechanisms are needed. Only then we will be able to progress and develop a cure for asthma and other diseases.

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Muscle wasting conditions: Transforming lives through research

Catherine Woodhead, CEO, Muscular Dystrophy UK explains how lives are being transformed through research when it comes to muscle wasting conditions

Sixty years ago when Muscular Dystrophy UK grew out of the Central Council of the Care of Cripples, research into muscle wasting conditions was largely neglected, the life expectancy for people living with Duchenne muscular dystrophy was around 14 years and attitudes towards people with disabilities were largely negative. Today, pioneering research has led to over 150 clinical trials globally, better support and care has seen life expectancy increase and equality legislation, combined with improved access, means that more people with muscular dystrophy and associated conditions have greater opportunities, visibility and aspirations than ever before. People with Duchenne muscular dystrophy are now living into their thirties and early forties', they are gaining PhD's, getting married, having children. And there is still a long way to go.

The race is on to develop potential treatments and ultimately cures not only for the 70,000 people in this country affected by over 60 known muscle-wasting conditions that are rare or ultra-rare but for their families as well.

There have been great advances that would have been unthinkable just 10 years ago. Thanks to its excellent clinical research base and the NHS, the UK is a natural location for the development and trial of new treatments and we have seen an explosion of clinical trials. However, researchers and clinicians are warning us that current systems and structures are not adequately prepared to meet the demand. As a consequence neuromuscular centres face having new trials turned down owing to a lack of capacity. We need to strengthen this and MDUK will work with our partners to ensure that the centres across the UK are able to support trials so that, ultimately, people can access potential therapies sooner.

Catherine Woodhead, CEO

We want to see more studies in ultra-rare neuromuscular conditions. Partnerships are key, so we work with international funders and charities to bring research skills from across the globe. International collaboration provides researchers with access to larger numbers of patients and speeds up the journey to develop new treatments.

If we're to succeed in finding treatments sooner, then we need to expand the existing pool of dedicated and talented researchers working in the field of muscular dystrophy. We already support fantastic academics (scientists, medics and physiotherapists) across the UK, but we want to ensure that there are sufficient neuromuscular researchers for the years to come. So we support researchers early in their careers, who may be

Assistive tech adviser Vivek Gohil tests a new controller

looking for exciting opportunities, and encourage experienced researchers from other fields to collaborate with neuromuscular scientists, bringing new expertise to the field.

There are obstacles of course. The high price tag on some treatments is deemed too high and the hope it offers families is taken away. Progress to influence regulators and biotech companies can be painfully slow and continued delays cause heartbreak for families. Through our FastTrack campaign, we are tackling delays to treatments and accelerating every step of the process for promising new therapies to ensure they reach those who urgently need them as quickly as possible.

In addition to insufficient access to treatments is the reality of managing daily life. People want access to specialist NHS care and better support for their psychological needs from the point of diagnosis and beyond. For example, parents who receive a diagnosis of a neuromuscular condition at birth can require a great deal of psychological support in order to be able to remain positive for their child.

Access to the right technology is important and people tell me how it helps them to manage their condition, improve their quality of life and remain independent. But it needs to be affordable technology that will enable them to take up employment and education opportunities and enjoy a good quality of life.

People with muscle wasting conditions are determined to change their communities so that the barriers they and others face to living independently are removed. That's why Trailblazers, our young people's campaigning group, press the rail companies to ensure disabled people can travel when and where they want to go, urge bus companies to ensure wheelchair users can travel safely and encourage the aviation industry to take accessibility seriously.

Whenever I speak to people they tell us again and again that they urgently want to see treatments that slow down or stop the progression of their condition. They need them now. They want better care, and the support to stay active, independent and connected, to be part of their community and to just get on with life – to be seen as a person, not defined by their condition! We're determined to make that a reality because for people with muscle-wasting conditions every day counts. ■

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Duchenne muscular dystrophy: A test case for gene-targeted therapy development in rare disease

Laura Hagerty, PhD, Scientific Portfolio Director at the Muscular Dystrophy Association, highlights strategies for gene correction to treat Duchenne muscular dystrophy

Duchenne muscular dystrophy (DMD) is a deadly genetic disorder characterised by progressive loss of voluntary muscle movement. Muscle weakness first occurs in early childhood (age 2-5), continues with loss of ambulation during adolescence (age 10-13), and ultimately leads to death in young adulthood (age 25-28) due to complications of cardiac or respiratory failure.

An X-linked recessive disorder, Duchenne primarily strikes boys with an incidence of 1 in 3,500 to 6,000 male births. Despite being rare, the societal burden is high with an annual cost of $787 million in the U.S.

Like most rare genetic diseases, Duchenne currently has no cure. But for the first time, new technologies offer the promise of replacing or correcting gene defects, which could fundamentally change the course of Duchenne and other genetic diseases.

A dynamic pipeline of gene-targeting therapies

Duchenne is caused by mutation of the *DMD* gene, the largest gene in the human genome. Due to its large size, many different disease-causing mutations are possible. These range in type from small point mutations to duplications or deletions of large sections of DNA, and they may be located anywhere within the *DMD* gene. Importantly, this mutational diversity has encouraged researchers to pursue a panoply of approaches to gene correction.

In recent years, drug developers have made great strides in advancing the technologies needed to target gene defects, and they are bringing these solutions to bear on the *DMD* gene. The following examples illustrate how researchers are targeting the *DMD* gene for correction, but similar approaches can and are being developed for other rare genetic diseases.

Gene therapy

Gene therapies are designed to introduce a new therapeutic gene as a functional replacement for a mutant gene. This technology leverages the ability of viruses to insert DNA into human cells. For Duchenne, researchers are using a virus called adeno-associated virus (AAV), which has been engineered to deliver a therapeutic *DMD* gene to muscle. Three companies (Pfizer, Sarepta Therapeutics, and Solid Biosciences) have gene therapies in clinical development for Duchenne. All have reported encouraging interim data from their first trials, but additional studies are needed.

Antisense therapy

In a subset of Duchenne patients, a mutation has caused misalignment and, therefore, jumbling of the genetic code within the *DMD* gene. Antisense therapies can be useful in such instances because they cause part of the gene to be ignored during manufacture of the gene product, and thereby induce realignment. This application of antisense technology is called “exon skipping.”

The exon-skipping approach is highly mutation-specific, and thus, each therapy is necessarily engineered to benefit a subset of Duchenne patients. One drug in this category has already won FDA approval: Sarepta Therapeutics’ Exondys 51 (eteplirsen), which is designed

Laura Hagerty, PhD

to benefit 13% of Duchenne patients. Four drug companies (Sarepta, Wave Life Sciences, Daiichi Sankyo, and NS Pharma) are developing therapies that collectively target five additional exons for skipping (exons 53, 52, 50, 45, and 44). If all are successful, these therapies will cumulatively target the disease-causing mutations for 43% of Duchenne patients.

> "Like most rare genetic diseases, Duchenne currently has no cure. But for the first time, new technologies offer the promise of replacing or correcting gene defects, which could fundamentally change the course of Duchenne and other genetic diseases."

Gene editing (CRISPR) therapy

Gene editing approaches, including CRISPR, are designed to delete a targeted section of DNA. Similar to antisense therapy, this approach is useful for restoring alignment to a gene and also, therefore, addresses mutations in a subset of patients. Importantly, unlike exon skipping, it is designed to permanently change a patient's genome and, therefore, raises greater safety concerns. Several companies (Exonics Therapeutics, Sarepta Therapeutics, and MyoGene Bio) are working toward the development of a CRISPR therapy for Duchenne, but these programmes are still in preclinical stage testing. Preliminary data from animal studies suggest that CRISPR may drive robust correction of the *DMD* gene, but further animal studies are needed to better understand the risks before moving into clinical testing.

Stop codon suppression therapy

Premature stop codons, or nonsense mutations, erroneously signal for the manufacturing of a gene product to stop midway, resulting in a missing or non-functioning gene product. These mutations can occur in any gene and are known to cause other genetic diseases, including cystic fibrosis. The Duchenne field has seen the European Medicines Agency (EMA) approval of one stop codon suppression therapy, Translarna (ataluren), which was developed by PTC Therapeutics.

The future of gene-correcting therapies

The Duchenne research field is leading the development of new technologies that are designed to correct disease-causing gene mutations. While these tools are currently being developed for correction of the *DMD* gene, critical lessons should later transfer to the development of therapies that target other genes. Thus, the solutions now emerging for Duchenne offer hope for the entire genetic disease community. ■

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A focus on musculoskeletal function research

In this interview, Professor Dr Martin Flück at the Laboratory for Muscle Plasticity at Balgrist University Hospital explains his fascinating research around musculoskeletal function, including the post-operation recovery of patients that have undergone surgery due to the rupture of a rotator cuff tendon

To set the scene, Professor Dr Martin Flück at the Laboratory for Muscle Plasticity at Balgrist University Hospital introduces us to the excellent research that takes place at the Department of Orthopaedics. He tells us that the main part of their work concerns musculoskeletal function, namely the muscles and as such, they are currently focussing on the post-operation recovery of patients that have undergone shoulder surgery due to the rupture of a rotator cuff tendon. They are also trying to identify biomarkers that may predict the existing and unsuccessful healing or a better response.

Martin then explains that this aforementioned approach is a unique one. In that context, what has been investigated involves the institutional factors of genetics which are important, as well as the influence of constitutional factors of genetics, such as fitness of the muscle. This, Martin adds, may improve recovery through a better nurturing and another major aspect of the Department of Orthopaedics work is their shoulder surgery team, as well as other projects which are in the planning stage. While the details of these cannot be revealed now, Martin can tell us that these concern the delay of injury where the knee is concerned. Certainly, he argues that the muscle must play a major role when it comes to stabilising the joint via direct and indirect. The key question is to figure out to what extent specific muscles, and the associated activity- dependent remodeling of the musculoskeleton, contribute to this.

Maintaining the highest standards of quality and performance

The conversation then moves to detail Martin's reflections on how as a privately owned university hospital, Balgrist University Hospital is committed to maintaining the highest standards of quality and performance. We know that Balgrist University Hospital represents the Department of Orthopaedics of The University of Zurich (UZH) and has a very good share of doctors and students, Martin notes. He then expands this point, focussing on the crucial role of research at the Balgrist Campus.

"Balgrist University Hospital invests in continuing education and collaboration with universities including the polytechnic school, ETH Zurich who perform research. Research is only performed internally in a competitive manner and is presented and evaluated for its merits and the Campus offers a platform to solve actual questions the patients have through that interaction.

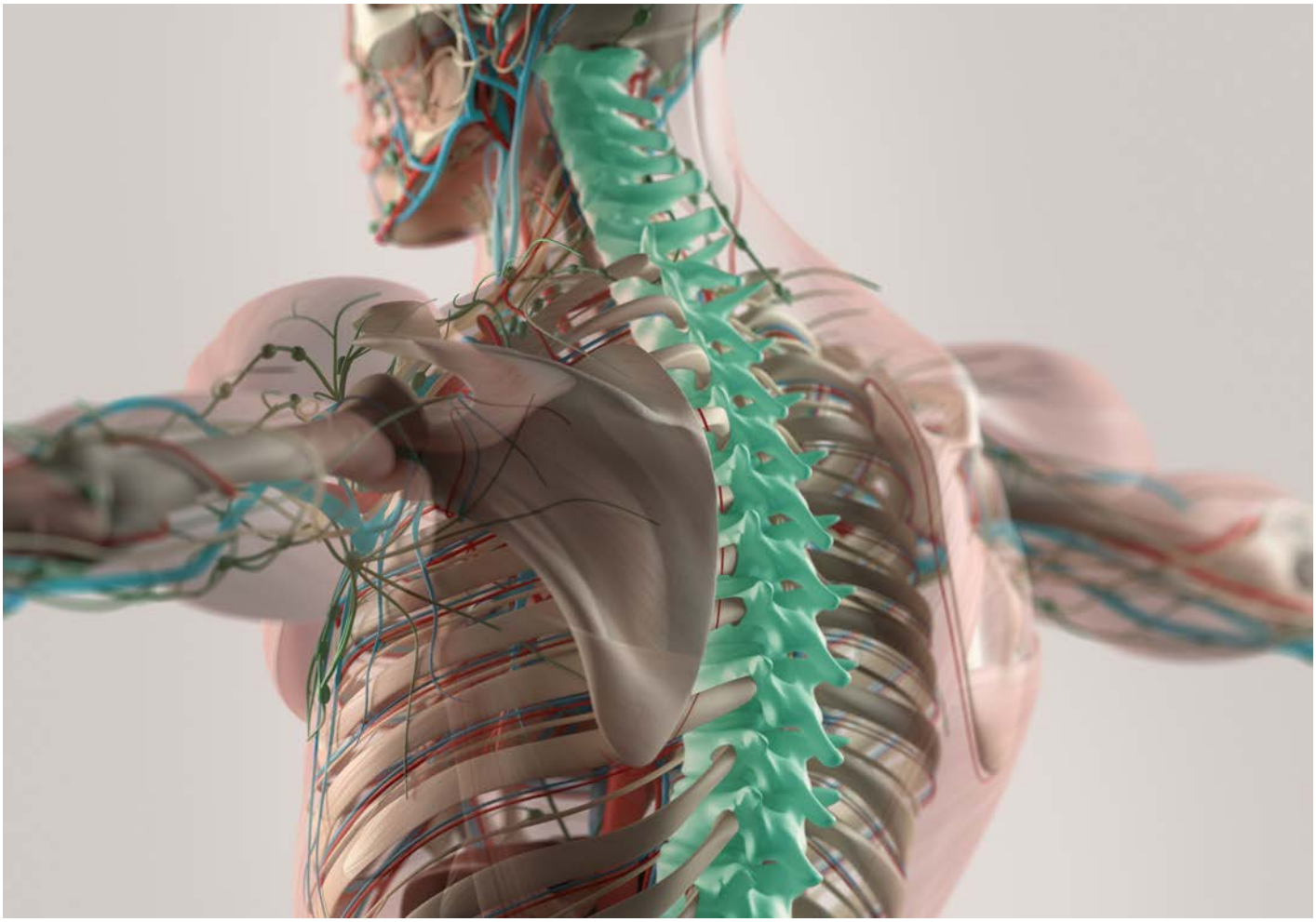
"Then there is a scientific board who is continually evaluating projects and these are also perceived through the congress participation that we all undertake as surgeons and students. However, I still identify with some topics that were underdeveloped but consequently, I have recently seen adaptations by recruiting a new professor. While the preventative aspects were not fully exploited but now it looks like we have initiatives to get that rolling in a much better way than previously."

> "While it is not yet accepted, which is in a way paradoxical, I do gene therapies and if you go to an international congress you can see that there is a very active part of research advocating biologicals as treatment."

A new generation of therapies for weak muscles

Martin then tells us about the research taking place at the Balgrist Campus into personalised interventions which are helping pave the way for a new generation of therapies for weak muscles. He underlines that the research here is divided into three areas.

"The first study MARK-GEROT focuses on the healing of the tendon reconstruction – there we try to identify markers that allow the personalisation and predicting of healing, which may change rehabilitation later on, such as



the duration or the conditioning of the muscle. This is one of the biomarkers, the muscle composition, which is the subject of unpublished results from the MARK-GEROT investigation but abstracts are available. There are two other topics, one concerns an accepted paper where we set out ways to help cardiovascular patients to improve during rehabilitation.

"This is quite interesting because much research has been done on this, and what these exercise paradigms that all patients do, which allow only some to respond and improve. Muscle is a very big ingredient of it because it allows them to be active and, therefore, to train, and then improve the quality of life and gain independence. We found in a recently published study that there are genetic markers that reflect muscle condition, which can be helped by training which is also modified by specific medications, so have a pattern of how we can then treat patients in the future (see Mathes et al- 2015).

"When we first wrote that report, the first patients showed quite a dramatic rehabilitation through personalised types of training (Fitze, Franchi, Popp, Ruoss, Catuogno, Camenisch, Lehmann, Schmied, Niederseer, Frey, Martin Flück, Concentric and Eccentric Pedaling-Type Interval Exercise on a Soft Robot for Stable Coronary Artery Disease Patients: Towards a Personalized Protocol, JMIR RESEARCH PROTOCOLS, in press). This is an interdependent research approach and now, we don't know how to apply it because it involves cardiovascular and rehabilitation individuals, as well as the work of basic scientists who are conducting the measurements to help us identify the markers. We will have to see how that develops in terms of if there are fruitful economic pipelines because they change paradigms."

This is a major challenge because it involves relocating patients to other hospitals, Martin stresses, and it is an issue when you consider patient numbers. In some instances, such an approach has worked in rehabilitation but not in the field of personalised medicine.

Martin then tells us that the third area of research entitled BACK-GENE to detail is where Balgrist University Hospital has patients from the chiropractic's who suffer from chronic non-specific low back pain, where a specific hypothesis is followed. The problem here is that such patients suffer from relative muscle perfusion where basi-

cally, the muscle dries out of nutrients (Valdivieso et al. 2018;). Martin adds that Balgrist University Hospital is close to completing a study on this, which includes functional tests for back muscle mobility, as well as mental and muscle aspects and how to relate these to genetics. We also find out that in an already published paper that alludes to this hypothesis, that the condition of the back muscles is already part of the prevention. But Martin notes that specific groups could be helped if they specifically trained the strength and perfusion of the back muscles.

The conditioning of skeletal muscle structure

The interview then goes on to reveal something about the work of the laboratory for muscle plasticity which investigates the mechanisms that underlie the conditioning of skeletal muscle structure and function during recovery from surgical interventions and rehabilitation. Martin responds by saying that a number of studies have been conducted during the past 20 years concerning healthy subjects and from these, they know the factors and the conditions necessary to maintain muscle. Martin explains more about this to us.

"These include muscle strength and endurance which interplays to help people conduct activities. We have been using that information in very extreme models to prove it as indicated in the work of published astronauts and in this very controlled situation we can show that it is the volume and intensity of exercise that directs strength and endurance (Rittweger et al. Sarcolab pilot study into skeletal muscle's adaptation to long-term spaceflight. NPJ Microgravity 4: 18, 2018. doi: 10.1038/s41526-018-0052-1,). On board the international space station, we can monitor every step taken, so this translates into a study we published in 2018 which follows people over 16 years after knee surgery (Flück et al, Knee Extensors Muscle Plasticity Over a 5-Years Rehabilitation Process After Open Knee Surgery. Front Physiol 9: 1343, 2018. doi: 10.3389/fphys.2018.01343.). Here, we showed that the response is relatively slow and varies but it really relates to measures on activity so the key factor is that if rehabilitation is not done sufficiently or intense enough, the duration may not be enough because it took them more than a year to recover to acceptable levels. For some markers of fitness, it took them more than a year to recover.

This indicates that the imbalance in the operated, respective to the non-operated leg, was related to muscle disuse.

"There was, therefore, a call for a very specific focus on training which is just not sufficient. In a way, that poses new social questions about how much people train? Those that train very hard will improve more but some are not used to doing that. The study is a retrospective and the current ways of rehabilitation are already better than what they were 16 years ago but still, there seems to be a very distinct lack of recovery when we talk about reducing the fitness of the muscle that persists for a year but people should consider themselves as professional athletes for at least a couple of months. Only under those conditions do they recover."

> "To some extent, gene therapy does not yet meet acceptance in the surgical field, which is a contrast to what we have seen in other areas before."

Martin then tells us about a non-complicated wrist fracture he suffered from in July 2018 when he was run over while riding his bike. Following the advice given by his doctor, Martin nearly recovered functionally just three weeks later. This was due to the load and volume of low-impact exercise on the wrist that Martin carried out which allows the bone and the muscle to maintain a minimum function, so aggressive training was possible. While it was a simple fracture, Martin believes this is a good case study to show how bone fracture works in athletes, but this is not a method of recovery that most people would normally accept. Nevertheless, there is really good expertise around, for example, when it comes to professional football players. Following on from an already published book (Muscle Injuries in Sports 1st Edition, Kindle Edition, by Hans-W. Müller-Wohlfahrt, Peter Ueblacker, William E. Garrett Jr, Lutz Hänsel, Thieme, ISBN-10: 9783131624710), Martin then draws our attention to how we find out here that the problem surgeons know about is that it will take most people a year to carry out such training paradigms, and as such, he calls for individual subjects who are willing to do so.

The emphasis of the research team

As this interview draws to a close, Martin speaks about the emphasis of the research team at the Balgrist Hospital Orthopaedics Clinics when it comes to the major musculoskeletal affections that exist. In terms of raw numbers, it is already known which fractures or musculoskeletal effects are present and not all of those are tackled at the Balgrist Hospital, Martin says before adding his concluding remarks.

"We tackle those that involve a very active joint that may be involved in movement or propulsion rather than posture control, so we look at the spinal aspects but not too much because the delicate interventions there are directed by the surgeon. So, our work involves the active joint that concerns the shoulder and the knee and all the attached muscles where we know that rehabilitation programmes are available and can be improved. This indicates that the muscle is a very active ingredient for recovery through the mechanical forces that it generates which allow the tendon and bone to grow correctly.

"While it is not yet accepted, which is in a way paradoxical, I do gene therapies and if you go to an international congress you can see that there is a very active part of research advocating biologicals as treatment. To some extent, and for obvious reasons of safety, gene therapy does not yet meet acceptance in the surgical field, which is a contrast to what we have seen in other areas before. We find that in models of Achilles tendon injury and repair in the rat, we can, in part, echo the problems of muscle reconditioning."

Martin concludes that this is a really important area to mention because it is really hard to find the perception for innovative approaches directed to personalise musculoskeletal rehabilitation when people are for economic reasons often resistant to resource-intensive applications but in contrast, this is a most active part of Martin's own research.

Laboratory for Muscle Plasticity

The Balgrist

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The Netherlands: Promoting physical and mental wellbeing

The Netherlands' Ministry of Health, Welfare & Sport is responsible for promoting physical and mental wellbeing, social infrastructure and active lifestyles through participation in sport, as this article details

The Netherlands' Ministry of Health, Welfare & Sport works to ensure people stay healthy as long as possible, those who are sick are restored to health as quickly as possible, and that people with a mental or physical limitation can participate fully in society.

The ministry's work centres on three policy areas:

Public health

The ministry encourages people to adopt healthy lifestyles, including exercising more, smoking less, drinking alcohol in moderation, practising safe sex and eating healthily.

> "If a patient's problems are too complex for a GP or general practice mental health worker to treat, they may be referred to a primary mental healthcare provider or referred directly to secondary care. Other medical professionals, like company doctors and paediatricians, can also refer people to either service."

It also works with health insurers, healthcare providers and patient organisers to ensure there are sufficient facilities available to people with health issues and that these people have sufficient choice.

Welfare

In collaboration with ministries focused on the economy, education, housing and the environment, the Ministry of Health, Welfare & Sport works to strengthen the social infrastructure that supports those who are not economically independent or who do not take an active part in society. Volunteer work and youth care are key elements of the Netherlands' social policy.

Sport

Sport is crucial in promoting health, providing social contact and contributing to self-development. The ministry's mission is to make it possible for everyone to take part in sport.

In addition, it funds top-level sports to help the Netherlands compete on the international stage.

Paul Blokhuis

Paul Blokhuis is the State Secretary for Health, Welfare and Sport. Born in Zuidhorn in November 1963, Blokhuis had previously worked as a Policy Officer for the Reformed Political Federation, later the Christian Union, in the Dutch House of Representatives from 1990 to 2006.

From 2006, he served almost continuously on the municipal executive of the city of Apeldoorn in Gelderland, where he was responsible for welfare, social care, healthcare, the implementation of the Social Support Act, volunteer services and youth care.

He became State Secretary in October 2017 in the third cabinet of Prime Minister Mark Rutte.

Focus on mental health

Under Blokhuis and his predecessors, mental health has been a key area for the ministry.

More than four in 10 Dutch people will experience mental health issues during their lifetime. To help, the government has set up a system of frontline support from GPs and primary and secondary mental health care.

Outpatient treatment is always preferred for people with more serious mental health problems. Admission, including involuntary admission, to a mental health institution is the last resort.

Since January 2014, GPs have received extra funding enabling them to work with other healthcare professionals, such as general practice mental health workers or advising psychologists, to treat people with mild mental health issues. The GP retains ultimate responsibility for the patient.

If a patient's problems are too complex for a GP or general practice mental health worker to treat, they may be referred to a primary mental healthcare provider or referred directly to secondary care. Other medical professionals, like company doctors and paediatricians, can also refer people to either service.

Primary mental healthcare providers deal with people suffering from mild to moderate mental health issues. Treatment may include counselling from a psychologist or psychotherapist or some form of online support (e-health).

Anonymous e-health

Sadly, one of the biggest barriers to treating mental health issues is overcoming the perceived stigma to reach out for help.

That is why, in 2013, the Dutch cabinet agreed to long-term funding for anonymous e-mental health, based on a proposal by then-Minister of Health, Welfare and Sport, Edith Schippers.

The system is designed to help care providers to continue to treat patients with psychological problems who require care yet are reluctant to seek help, perhaps because they feel ashamed or are afraid of how those around them will react.

Early identification and self-management have proved beneficial to patients with mental disorders. E-mental health is also considered a cost-effective form of treatment.

Community and involuntary care

Those with more serious or complex psychiatric disorders, such as ADHD or anxiety disorder, are referred to as secondary mental healthcare.

People suffering from serious and complex mental disorders are often admitted to a mental health institution. However, research has shown that they would

Paul Blokhuis, the State Secretary for Health, Welfare and Sport

prefer to be treated in their own environment and the government supports a shift towards community-based care wherever possible, such as receiving counselling from a specialised nurse on an outpatient basis.

By 2020, mental health institutions must reduce the number of beds by a third compared to 2008. Health insurers and providers are working together at a regional level to achieve this target.

However, where a person is a danger to themselves or those around them, they may be involuntarily admitted, or committed, to a mental health institution.

The process for involuntary admission is laid out in the Psychiatric Hospitals (Committals) Act, which applies to people suffering from a psychiatric disorder or intellectual disability and people with memory problems or dementia.

Under the act, only institutions designated by the Ministry of Health, Welfare & Sport may admit patients on an involuntary basis. Every patient who is committed to an institution is entitled to a clear description of the treatment they will receive.

New legislation on compulsory care has been put before parliament. If approved, the Psychiatric Hospitals (Committals) Act would be replaced by two new acts: the Compulsory Mental Health Care Act and the Care & Compulsion (Psychogeriatric & Intellectually Disabled Patients) Act.

The separate pieces of legislation have been introduced to better serve the different problems and interests of the two groups of patients currently covered by the Psychiatric Hospitals (Committals) Act: people with psychiatric problems and those suffering from intellectual disability or dementia.

The main elements of the Compulsory Mental Health Care Bill cover compulsory care in community settings, giving patients and their families more rights and a greater say in decisions about their care, compulsory care as a last resort and making aftercare a standard part of treatment.

The main aims of the Care & Compulsion (Psychogeriatric & Intellectually Disabled Patients) Bill are to make compulsory care possible if a person's behaviour is leading to a serious disadvantage to themselves or others, and to establish clear treatment guidelines for people receiving care at home who are subject to restrictive measures, such as locking doors at night to prevent them wandering.

"Paul Blokhuis is the State Secretary for Health, Welfare and Sport. Born in Zuidhorn in November 1963, Blokhuis had previously worked as a Policy Officer for the Reformed Political Federation, later the Christian Union, in the Dutch House of Representatives from 1990 to 2006."

Last year, working with the Ministry of Justice & Security, the ministry launched a number of pilot projects with care and safety houses to provide an intensive, person-specific approach to get a better picture of the most mentally disturbed people in their region who exhibit different degrees of aggressive, disruptive or dangerous behaviour.

This is a small group within the larger body of people with mental health issues, who do not pose any threat and only need care and treatment, and who require extra attention from all stakeholders, including the police, Public Prosecution Service, healthcare insurers, municipalities, the Dutch Mental Health Care Association and Care for the Disabled.

There is often no, or no longer, a basis in criminal law for the approach towards these people, who consistently refuse the treatment or care they need.

The approach is part of a multi-year plan for care and safety houses covering 2017 to 2020. The pilot projects will develop a personalised approach in which various stakeholders across healthcare, welfare and security collaborate more effectively to form a better picture of this complex group. Care measures can be scaled up or down depending on an individual's situation.

A "national known persons" check will also be implemented from next year, which will see care and safety houses work together to inform local authorities if a mentally disturbed person moves from one region to another.

The care and safety houses are being linked to the Continuity of Care programme being launched across the country in 2020. The programme includes a field standard lifecycle function, which is designed to bring stability to people in terms of their healthcare, living arrangements, work and daytime activities and debt restructuring.

The issue of monitoring people with severe psychological problems has been highlighted by the Hoekstra Commission's report into the 2014 murder of former Dutch health minister and pro-euthanasia campaigner Els Borst, who was killed by Bart van U, a man diagnosed with paranoid psychosis in the context of schizophrenia. The commission concluded there had been serious failures by police, the prosecution service and mental health services. ■

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Improving mental healthcare provision in the UK with new models of care

Jaime Essed, Founder and CEO of Oh My Mood sheds light on how mental healthcare provision in the UK can be improved with new models of care

Approximately one in four people in the UK will experience a mental health problem each year, but it is getting harder for people to access the treatment they need. A 'potent mix' of rising demand and cuts to the workforce have caused waiting lists to get longer. NHS Providers found that 80% of NHS trusts in England fear they cannot provide timely, high-quality care to the growing number of people seeking mental health support.

To prevent the system from coming to a standstill, NHS mental health trusts, clinicians and care professionals need to explore new ways of delivering high-quality mental healthcare.

Steps are being taken to improve the situation. For example, the NHS Long Term Plan includes 'a renewed commitment to growing investment in mental health services faster than the NHS budget overall for each of the next five years'.

However, the delivery of efficient, cost-effective mental healthcare requires a fundamentally different approach. Indeed, the Five Year Forward View for Mental Health report identified the development of new models of care as a priority. Such a new model should explore other, more efficient solutions to the long-term benefit of mental health patients.

The role of eHealth

eHealth is increasingly put forward as an alternative solution to cope with the increased levels of mental healthcare demands. But is it the new model of care that will transform the mental healthcare delivery?

There is evidence that eHealth can reduce psychiatric complaints, such as depression, anxiety and alcohol dependency. But besides these areas, the number of evidence-based eHealth interventions is limited. There is also evidence that eHealth promotes autonomy and self-determination, which will be to the benefit of the service user even after treatment has ended. However, most eHealth interventions are standalone and highly standardised, with clinicians having no or just a marginal role.

In comparison, during face-to-face sessions clinicians can make adjustments to meet the individual needs of a service user. Not being able to make adaptations to the eHealth intervention prevents clinicians from offering eHealth-based treatment plans to most of their patients.

Another, equally important issue is that it has been unclear what the government's vision is for eHealth, that is how it will be incorporated into the mental healthcare system, and how providers will be financially compensated? This leaves the healthcare provider uncertain of eHealth's return on investment. As long as this barrier has not been removed, eHealth as a new model of care is unlikely to be the panacea for the problems we are facing.

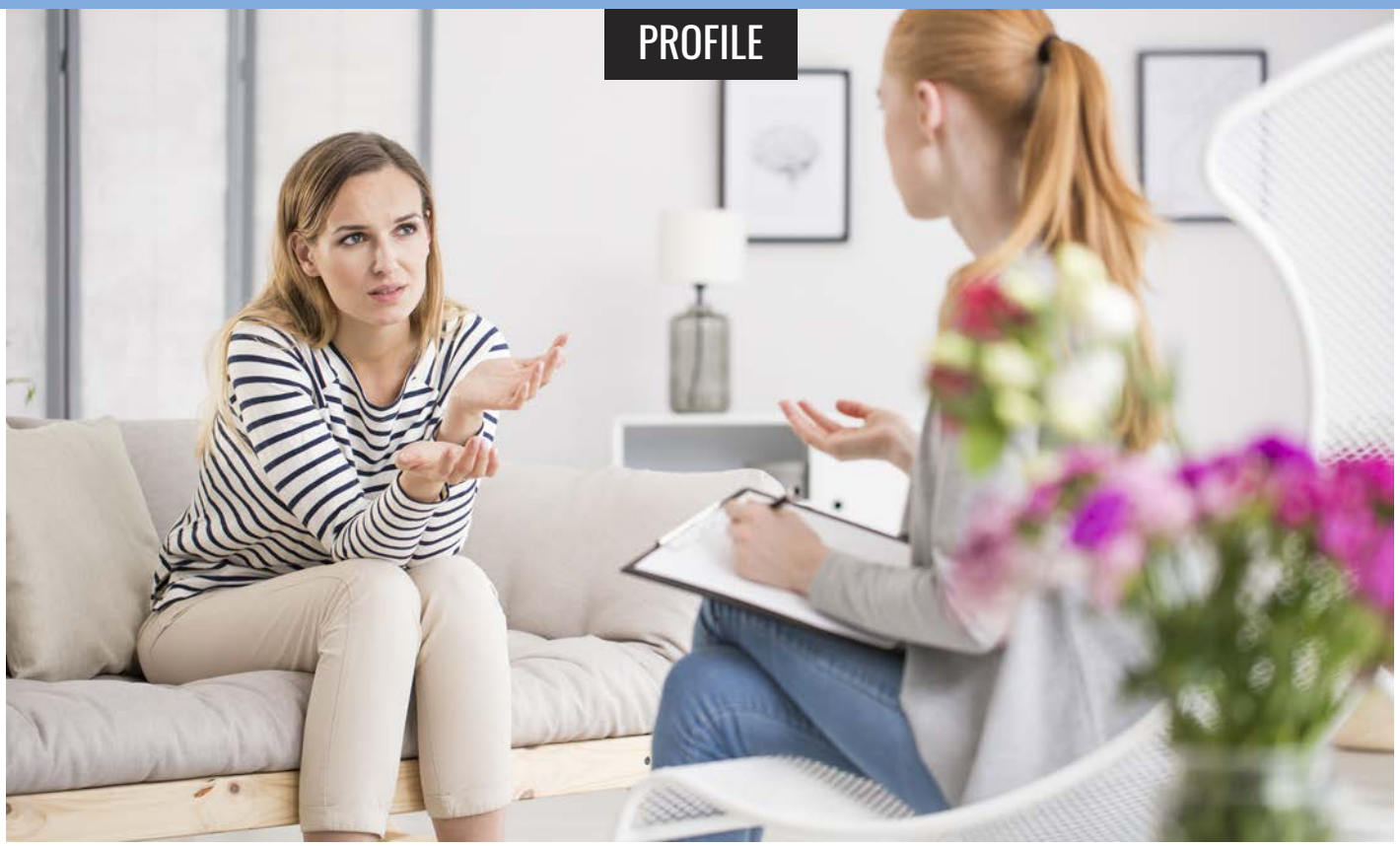
Blended care is the best of both worlds

eHealth has a transformative role to play if it is a viable component of the care model – not a stand-alone solution. When eHealth methods are combined with traditional therapies, we talk about blended care. Blended care can be conceptualised as a new model of care in which traditional face-to-face health services and eHealth are integrated into the care procedure to make for a rational and personalised mental healthcare plan.

An important prerequisite of blended care is the notion that treatment methods:

1. Should complement each other;
2. Should be tailored to the specific needs of the service user;
3. Should be cost-saving.

Because of its Internet-based facilities, a blended care treatment programme can be representative of a mix of treatment services provided by a



range of healthcare providers. It supports a change in how traditional medicine is practised, as the knowledge and skills of different disciplines are blended into one integrated healthcare process. Blended care enables an integrated treatment of service users.

Modern society has made it clear that it is no longer considered appropriate to dictate a mental healthcare plan to a service user. Shared decision making should be applied to personalise the care pathway and focus on patient outcomes. It is known that blended care encourages the participation of service users in their own healthcare. Not only because they can access a wealth of care information on the Internet, but also because of the possibility of easy access to a therapist to help them sort things out and apply learnings to their daily lives. Collaboration between the two increases programme fidelity and patient outcomes.

Although a relatively new concept, blended care could well be the most promising new model of care for patients and therapists alike. It is supportive of the delivery of personalised care – one of five major, practical changes that the NHS Long Term Plan aims to deliver over the next five years – and ensures a more efficient delivery of mental healthcare, which eases the strain on care practitioners without adding pressure on NHS budgets. It is value-based because it encourages the continuous improvement of the quality of care while delivering more value for money. A blended care approach can prove to be a win-win situation for everyone involved.

Jaime Essed is the Founder of mental health interventions provider Oh My Mood, which is on a mission to shake up mental health provision with its proprietary blended care method that makes support more effective and accessible to service users.

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The time is now for mental health research

Research Director at MQ: Transforming Mental Health, Dr Sophie Dix argues the time is now for mental health research

One in four adults in the UK is directly affected by mental illness each year. This is a huge number of people experiencing conditions that can have very significant, very personal impacts on their day to day life, and yet we have so little in the way of explanation.

We have gaps in knowledge about why some people develop mental illness and some don't. We don't know the best treatment for each individual. And we don't know enough about how to identify those most at risk so we can intervene earlier.

The sad truth today is that getting an accurate diagnosis can take years. Even then, a painful period of trial-and-error often follows until the most appropriate treatment is found. We simply don't know enough to personalise treatments, both medicines and talking therapies, so that people get the right treatment at the right time.

The good news is that mental health is high on the agenda, like never before. The growing public dialogue around mental health has been exceptional. Members of the royal family have begun campaigning on the issue, successive governments have made mental health a priority, and powerful personal experiences are being shared globally. The days of unspoken conditions are, slowly but surely, giving way to an

Dr Sophie Dix, Research Director

open and honest conversation about mental health. Providing people with space and the confidence to speak out and tackle stigma.

This is a fantastic first step in the journey of taking on mental illness. This is, however, just a first step. The key to real, lasting change is research.

We know that research has the power to transform lives, as seen so clearly when we look at physical health. Survival rates for cancer have been increased exponentially and HIV is no longer the death sentence it once was. A better understanding of an illness and the opportunity to explore treatments, and even cures, is only possible when we invest in research.

The potential to make this happen for mental health is real. The UK is a world leader in the mental health research field and technologies are providing newer, faster way to make advances.

However, a lack of funding and prioritisation of research means that too many opportunities are being missed. Despite affecting 23% of the population, only 5.8% of UK health research is spent on mental health. At the moment, mental health research currently receives 22 times less funding than cancer research per person affected – a stark differential that lets down generations of people living with a mental illness.

At MQ, we're working hard to change the picture. We support over 41 projects internationally, investigating a huge range of conditions: depression, anxiety, schizophrenia, bipolar disorder, eating disorders and more.

We're an example of an organisation that is funding research to make an impact now and for future generations. We know that 75% of mental illness begins in young people, so we're investing in a flagship programme to understand what puts young people at risk and identify new ways of intervening early.

By focusing on areas of huge potential, like data science, we are utilising a wealth of information to stimulate new answers to some of the most pressing challenges in mental health. And we're connecting researchers internationally to share learnings and deepen understanding.

Critically, to deliver the long-term shift needed in mental health research, we're also building an unprecedented movement of public support – working with people affected scientists, businesses, government and members of the public to make mental health research a national and international priority.

Progress won't happen overnight. But the stories we hear every day about the challenges they face in getting the right help for their mental health demonstrates why the prize is worth fighting for. And with more and more people demanding better, now is the time for research to give hope in the future. ■

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Mental health in Germany: A focus on ward-equivalent treatment

Laura Kirschbacher, Corporate Communications Manager at Pfalzklinikum AdöR talks about ward-equivalent treatment (WeT), a special kind of hometreatment, where a multi-professional team visits the patients at home. She accompanied WeT social worker Linda Seez to find out more

Ward-equivalent treatment (WeT) is a complex psychiatric-psychotherapeutic treatment in the patients' home environment in times of acute diseases and is, thus, an alternative to an in-patient stay. WeT, "Stationsäquivalente Behandlung (StäB)" in German, is modelled after international home treatment approaches, like Crisis Resolution Team (CRT), Assertive Community Treatment (ACT), Case Management (CM), Community Mental Health Team (CMHT). Ward-equivalent treatment has been possible at Pfalzklinikum since January 2018, after the cost unit and the German Hospital Society agreed on an action framework for home care[1] which should reach patients who, for various reasons, cannot or do not want to be treated in a clinic.

The S3 guideline "psychosocial therapies in case of severe mental diseases" also recommends team-based, multi-professional and out-patient treatment in a community.[2] So, WeT closes a gap between the hitherto exclusively in-patient complex treatment and out-patient healthcare. At Pfalzklinikum Klingenmünster, a multi-professional team is daily on duty for WeT and currently visits five patients within a radius of approximately 10 kilometres.

The basis for the WeT service is an in-patient indication and, therefore, the duration of treatment is limited as it is on a ward. The cooperation with the wards is close. In most cases, employees of the nursing service work partially on a ward, as well as for WeT, thus, knowing both methods of work. In Klingenmünster, WeT is a specialised group under the umbrella of the out-patient and outreach services and benefits from the experience gained here in terms of the in and out-patient work. By integrating the new treatment offer into the existing psychiatric-psychosocial healthcare structure, the duration of treatment of mentally ill persons shall be reduced and their life quality will be improved.[3]

At Pfalzklinikum Klingenmünster, the Head Physician and Vice Medical Director, Dr Sylvia Claus, is in charge of the project together with the senior physician, Dr Esther Klingelhöfer, and Jeannette Berger, Head of the Nursing Department for Out-Patient and Outreach Services.

When the ward comes to the patient

It is Monday morning and Linda Seez is standing in the "control centre" in front of a colourful organisation board: the operational plan for the employees of the ward-equivalent treatment team at Pfalzklinikum Klingenmünster is prepared analogously. There is a good reason for this because every day a team member visits the five WeT patients at home for treatment – professional team, the organisation is a logistic masterpiece solved best with pen and magnets. This weekly schedule sets the structure; spontaneous adjustments and new admissions, however, call for the team members to be flexible.

Today, the tour starts with a female patient in Bad Bergzabern, which is only a stone's throw away. The woman is glad about the visit and presents to me a picture she works on every day, representing the small steps she is taking in her therapy. Linda Seez spares one hour for her patient: she sorts out the mood and motivation, discusses the structure of the day and calmly prepares the next tasks on the way to independence. "The WeT team's visits give structure to my day", the patient declares, and in hospital I would not feel better."

Exactly what lacked in the landscape of psychiatry

This thought is shared by most WeT patients as Jeannette Berger, Head of the Department of Outreach and Out-Patient Services, reports: "Ward-equivalent treatment is exactly what lacked in the landscape of psychiatry. Here, we reach people who do not want to go to a clinic." Driving from Bad Bergzabern to Godramstein to the next patient, we talk about the particular characteristics of ward-equivalent

treatment. The treatment is strongly individualised and through intense daily contact with the patients treated in their familiar environment, other persons living in the same household can be closely involved. That way, difficulties in daily life become obvious and can be dealt with together.

"However, you have to be aware of the fact that you are a guest at the patient's home", Linda Seez underlines. As guests, we are sitting in the cosy dining-room of today's second patient. Only the clock is ticking as the conversation does not get going immediately. Empathetically Linda Seez directs the conversation towards the patient's biographical background. The respective work exhausts the woman fast, which is why the appointed time is adjusted to the needs and shortened. Indeed, at the beginning of each treatment, a plan is set up together with the patient allotting the specific professional groups needed, but the WeT team also reacts flexibly to various treatment needs. If necessary, the psychotherapist, for example, visits a patient more often, while the occupational therapist has a closer contact with other patients.

Flexible working and constructive error culture

Spontaneous changes demand much flexibility from the team, Jeannette Berger confirms: "This work is only possible because of a tolerant, creative and innovative team." She frankly confesses: "We are a learning system, nothing is fixed, many things are questioned and we learn from errors. This is only possible with a highly motivated team and the courage of the chief physician, Dr Claus."

"WeT belongs to the Clinic for Psychiatry, Psychosomatics and Psychotherapy at the Klingenmünster site. The close interaction of wards and ward-equivalent treatment is not only of fundamental importance for its success but also structurally arranged", as Jeannette Berger explains: "Lilian Fischlhammer and Lisa Schotter, for example, two pioneers of ward-equivalent treatment at the Klingenmünster site, also work partially on the ward. It is essential that they bring along their knowledge from the ward."

> "Ward-equivalent treatment has been possible at Pfalzklinikum since January 2018, after the cost unit and the German Hospital Society agreed on an action framework for home care which should reach patients who, for various reasons, cannot or do not want to be treated in a clinic."

"You have to like flexibility, you work very autonomously and not everybody enjoys going to the patients' home environment", Nina Heid, a master student of psychiatric nursery outlines. It is also a question of whether dangerous situations may arise for the visiting WeT team members. Of course, they thought about this, Linda Seez says, but the team is specially trained in de-escalation for out-patient work.

For the remaining day, no visits are planned. Documentation that is much more extensive than that of the ward has to be completed, and the next days have to be planned and telephone calls must be made. "Today was an extremely quiet day", Linda Seez remarks. This is also due to the fact that ward-equivalent treatment with currently five patients is still in its initial stages. Basically the "mobile ward" is scalable – with the appropriate staff and the required IT-infrastructure in the form of a virtual ward more patients can be cared for. At the Pfalzklinikum Klingenmünster site, the first steps are made, and others will follow to successfully establish this future-oriented concept as an integral part of complex psychiatric-psychotherapeutic treatment.

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Finding balance, health and happiness in the workplace

Alex Elmywood, The Growth Company, provides advice on how to obtain balance, health and happiness in the workplace

It was Aristotle that said, "Eudaimonia (happiness) is the meaning and the purpose of life, the whole aim and end of human existence" – so if we are to spend approximately 85,000 hours over our lifetime at work, surely it needs to be a place we find joy and happiness.

But – let's face it, for most of us, work can have its challenges; whether that's in the form of people and relationships, responsibilities and workload, office cultures and politics, the ever-growing impact of technology; the list is endless!

Our wellbeing – what we see as our health and happiness – is a major factor in how well we can cope with these challenges and manage our balance.

Organisations do have a role in supporting and guiding wellness in the workplace to enable the productivity and performance of staff. Well-intentioned programmes are welcomed by many as a break to the norm or indeed seen as a tremendous employee benefit, however, what we are seeing too often is that these programmes are failing to change attitudes and behaviours – and as such are having little impact on the long-term health and happiness of employees.

So whilst organisations have a part to play, it can't be a substitute to personal responsibility. Putting aside children and vulnerable adults, no-one should define what health and happiness looks like, feels like, and sounds like other than the individual themselves. We are all unique, and as such, we need to accept that we all have different needs and opinions on what will make us a healthy and happy person – and in turn what makes us happy and productive at work.

And so, it is down to each of us as individuals to define our balance. Our health. Our happiness. And to take the lead in making those changes in our life.

So how do you find your balance? Consider the following question: At this moment in time, how content am I with my life as a whole?

This is such a big question and one which – for many – is not easily answered. To help with this, we have identified six areas of wellbeing which we believe, when joined together, form a complete picture of our wellbeing:

Physical wellbeing – reflecting on general overall health and the elements that influence your health: how satisfied are you with such as exercise levels, nutritious diet, healthy sleep and of course your lifestyle choices?

Emotional wellbeing – when you consider your emotional and mental health, how satisfied are you with your confidence-levels, how well you manage your emotions and your degree of positivity? Are stress-levels manageable and how confident are you in your ability to cope with life's ups and downs?

Intellectual wellbeing – when you consider your personal growth, how content are you with the degree to which you engage in creative and stim-

ulating mental activities to expand your knowledge and skills?

Social wellbeing – reflecting on the people your life (i.e. family, friends, professional relationships, the community you live in etc.), how content are you with the level of positive connection and interaction? How content are you with the level of support you receive from others?

Spiritual wellbeing – reflecting on our own personal values and beliefs to help bring meaning and purpose in our life: how empowered and able are you in living your values and beliefs and in turn do you believe you have personal harmony and balance in your life?

Occupational wellbeing – finally, the one that we all strive to achieve – a healthy work-life balance. When you consider the balance of workplace stress and the degree of satisfaction and reward that you get from your occupation (including the financial aspect), how content are you?

Once you have reflected on these questions, you then have the opportunity to make some conscious choices in order to find your balance.

"Between stimulus and response, there is a space. In that space is our power to choose our response. In our response lies our growth and our freedom" Vicktor E. Frankl.

In his book 'The 7 Habits of Highly Effective People', Stephen Covey encourages us to consider the things in our lives that we are concerned about, the things that we can influence, and most importantly, the things that we can control. Covey argues the case that we are more successful, effective and resilient if we are to focus on those things that we can control.

To find your balance – consider the final points:

From your reflections on the six areas of wellbeing;

a. What are your ambitions or goals for each of those elements?

b. What are the things that you can personally control – and have the power to change? As such, what are the steps that you can take to strengthen your health and happiness?

c. What are the things that you can personally influence – and as such – what are the things that you need to do to influence others to make improvements to your health and happiness?

For the things that you can't influence or control, self-care is incredibly important from both a physiological and psychological perspective.

Eight tips on self-care:

- Do something that makes you smile for at least an hour each day.
- Be mindful of how lifestyle choices influence your mood and energy levels.
- Spend time with people that make you laugh, cry, think and feel.
- Strive to make every day a school day.
- Find your purpose – and live by the values that make you, you.
- Find one thing a day which you are grateful for.
- Give, give, give – in whatever form makes you happy.
- And finally, be active in your body, mind and soul.

"Life is a sum of all your choices. So, what are you doing today?" *Albert Camus.*

Our Leading Well programme, delivered in partnership with Manchester Stress Institute, is designed to develop the confidence and capability of leadership teams in supporting and guiding employees in wellbeing issues – but also encouraging leaders to lead by example and explore for themselves what health and happiness looks like for them... making the step changes in finding their balance.

"I have absolutely LOVED this course. I can honestly say I have never been so engaged on a work-related course. I have learnt many simple life changes that will greatly impact my workplace and emotional wellbeing. Thank you! *(Lisa Hough, Head of Support Services, Fourteen IP).*

"Excellent course. Exceptionally motivating. A must for any Leader/HR Manager" *(L Berry, L&D Manager, OneFile Ltd).*

Visit our website for more details on how to start Leading Well: www.leading-well.uk .

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Europe: The potential of big data in mental health

The role of big data in health from the perspective of the European Commission is detailed here, as well as its potential for the future for mental health in Europe

By way of an introduction, the responsibilities of European Commissioner for Health & Food Safety, Vytenis Andriukaitis, European Commissioner for Health & Food Safety include building up knowledge on the performance of national health systems in Europe to shape national and European Union policies. Another is to rise to the challenge of increased calls on national health services during a period when public finances are under intense pressure.[1]

The potential of big data in healthcare

A recent prominent theme coming from Commissioner Andriukaitis is big data which is well worth a look at in some detail. In his view, big data, "has the potential to unlock important new prevention, diagnostic and therapeutic avenues". While innovation is now linked even more with the use of big data, challenges in this area remain, as Commissioner Andriukaitis explains.

"Big data does come with its own challenges – especially fragmentation. The Commission's 2018 Communication on digital health and care recognised these obstacles.

"It focuses on fostering EU coordination in this area, so that the quality and security of big data, as well as access to it, can be improved. How will this benefit citizens? eHealth solutions have the potential to better understand health conditions and to strengthen health capacities.

"mHealth tools can contribute to promoting good health; preventing diseases; and enabling early detection of health problems."[2]

In another recent speech, Commissioner Andriukaitis underlines the increasing acceptance of big data, a fascinating point he goes on to explain in his own words.

"Whether it be pools of sequenced genomes, or real-world environmental and lifestyle data, it is clear that access to larger samples will facilitate more effective, deeper, more targeted research.

"The need to share relevant data more broadly led to the launch of the European Open Science Cloud. This pilot project is funded by Horizon 2020 and is a big data demonstrator scheme. It includes pan-cancer analyses to identify common mutation patterns for better care."

In the same speech, Commissioner Andriukaitis notes that in November 2017, the European Commission published a call on the use of big data and artificial intelligence (AI) in order to establish better cancer care. Also, earlier in 2017, a call on risk-based screening was published by the European Commission.[3]

Big data in mental health: Endless opportunities?

We know that mental health is just one part of Commissioner Andriukaitis's remit. Certainly, in the 2018 Health at a Glance: Europe joint report of the European Commission and the Organisation for Economic Cooperation and Development (OECD) underlined the need for improvements in mental health and preventing mental illness.

It's quite interesting then to link mental health to big data, indeed, in the view of MQ: Transforming mental health, the potential for harnessing big data in mental health has not yet been met. In a blog on their website, we learn that breakthroughs for treating and understanding conditions such as cancer have been transformed by harnessing the power of big data. They explain more about this interesting development in their own words.

Image: © European Union, 2019 / Jennifer Jacquemart

Vytenis Andriukaitis, European Commissioner for Health & Food Safety. Source: EC - Audiovisual Service

"Treatments are most effective when they are delivered to the right people, at the right time, in the right way. Currently, we don't know what mental health treatments will work for whom, and this wastes valuable time, money – and most devastatingly, lives.

"Big data could be the key to changing this, creating personalised care for people facing a mental illness.

"Researchers are increasingly recognising its potential for improving conditions like bipolar disorder, schizophrenia and depression – you only have to look at MQ's recent data science awardees[4] to see the kind of impact it could have."

We then discover that mental illnesses are not easy to understand, categorise and communicate. Certainly, those living with a mental health condition often have to wait months or even years before obtaining a diagnosis that is right for them and as such, they do not receive the treatment they need. Let's see some of MQ: Transforming mental health's thoughts now about the potential of big data in the area of mental health, including in depression.

"Big data could change this, by using large sets of data we can identify patterns that are otherwise hidden and hard to detect – machine learning can identify biological causes, different medical signs and symptoms and link them more accurately to a diagnosis.

"Adam Chekroud and colleagues have also looked into the effectiveness of antidepressants in a 2016 study focusing specifically on one called citalopram. They identified 25 variables that could be used to predict treatment outcome and developed a tool that successfully forecasts whether or not someone would respond to the drug. Whilst it worked for citalopram, it didn't work for other drugs – a lesson in itself."

While studies concerning the relationship between MRI scans and how well an antidepressant works for someone have taken place, there is clearly much potential in the future when it comes to big data in mental health. One challenge is that most studies have been difficult to scale and another, is funding. Let's end the article with some additional thoughts from the charity, MQ: Transforming mental health.

"If utilised properly, big data could enable us to identify risk factors for mental illness, get people the right treatment for them, track how well people improve and even investigate how we could prevent mental health conditions from developing.

"Big data shouldn't be a futuristic add-on to the treatment of mental illnesses – but an intrinsic part of how we understand it. With the right approach, the opportunities are endless." Certainly, it looks like big data is set to play an important role in national health systems in the future."[5]

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Mental health big data research at the University of Glasgow, Scotland

Dr Jo Inchley, Dr Judith Brown and Prof Daniel Smith tell us all about the valuable mental health big data research taking place at the University of Glasgow, Scotland

Several areas of medicine are currently benefiting from the application of innovative data science and health informatics approaches, including mental health. The Medical Research Council (MRC) in the UK have the ambition to establish a UK-wide Mental Health Data Platform to drive research, innovation and clinical translation for mental illnesses. As a first step, in 2018 they awarded nine UK research centres initial funding to set up Mental Health Data Pathfinder Projects.

The University of Glasgow's Mental Health Data Pathfinder Award will build on our excellent record for interdisciplinary health informatics research in mental health and will be delivered in partnership with the NHS in Scotland, the voluntary sector and with both local and national government. The project has two primary areas of activity: the development of a Scotland-wide schools health improvement research network (called SHINE); and enhancing existing clinical and eHealth cohorts to drive discovery science for mental health.

The Schools Health and Wellbeing Improvement Research Network (SHINE)

Promoting the mental health and wellbeing of children and young people is a top priority. Pupil health and academic attainment are intertwined as healthier pupils have higher attainment. However, a lack of evidence-based, up-to-date, local data has been identified as one of the barriers to improvements in health and wellbeing. SHINE is a pilot study to establish a national infrastructure for school-based health improvement research in Scotland with the aim of building stronger data partnerships between schools, policymakers and academic researchers.

SHINE follows the successful Schools Health Research Network (SHRN), established in Wales in 2014. SHRN began with a small number of secondary schools participating in the Health Behaviour in School-aged Children (HBSC) study, but by 2018 all Welsh secondary schools had joined the Network. Fundamental to its success has been the production of individual school-level health and wellbeing data reports which enable monitoring of health and wellbeing within the school community, targeting of interventions and an evidence base for health improvement planning.

In Scotland, the SHINE network aims to support schools in addressing their health and wellbeing needs, with a focus on mental health, by using a data-driven, systems-level approach to health improvement. Underpinning SHINE is the Scottish HBSC survey, led by Dr Jo Inchley who is also the International Coordinator of the HBSC study, currently involving 49 countries. HBSC collects internationally comparable data every four years on 11-, 13- and 15-year-old boys' and girls' health and well-being, health behaviours and their social context. Data from the HBSC survey is now being fed back to participating SHINE schools via an individual school health and wellbeing data report and will be used to inform health improvement planning and facilitate actions which promote positive health and educational outcomes.

Self-report mental health data have several key strengths, particularly within the context of population-level health promotion and disease prevention. They can be collected at low cost, and are relatively non-invasive and hence can achieve high response rates and greater representativeness. While a wide range of self-report mental health measures currently exists, there is a need for further validation among the adolescent population and for increased harmonisation across surveys. SHINE will review existing self-report mental health measures and undertake validation work to produce a suite of recommended indicators which are valid for use in the UK and international surveys. SHINE will also establish mechanisms for linkage of adolescent mental health data to a range of existing educational and health data to enhance understanding of the causes and consequences of mental ill-health.

Building capacity for big data research in mental health

The NHS in Scotland is unique in having a dedicated service for health informatics, the NHS Information Services Division (ISD). We have a range of projects currently in progress with ISD, one of which was focused on using national-level linked health data to assess changes in patterns of prescribing for bipolar disorder. This work was published recently in the British Journal of Psychiatry. In brief, we found that a quarter of patients with bipolar disorder were being prescribed antidepressant medication on its own, a practice that is at best unhelpful (antidepressants are ineffective for bipolar depression) and, at worst, potentially harmful (antidepressants may cause more frequent episodes of mania). Furthermore, only 1 in 20 patients were taking lithium monotherapy. Lithium is the gold standard treatment for bipolar disorder and is recommended as first-line treatment by clinical guidelines in the UK and in many other countries around the world. To find so few patients on lithium monotherapy is a major concern and suggests that many patients in Scotland with bipolar disorder may be missing out on the best available treatment options.

"...this is a very exciting time for mental health big data research. Health informatics and data science approaches have the potential to radically change the way that we approach the assessment, diagnosis and treatment of very large numbers of people with psychiatric disorders."

This work has been covered widely in the media and we hope it will act as a stimulus for psychiatrists in Scotland to review their prescribing preferences for bipolar disorder. Another area of activity within the Glasgow Mental Health Data Platform Award is the development of large NHS clinical cohorts as future resources for data science research. For example, the Glasgow Psychosis Clinical Information System is a clinical database tracking over 10,000 patients with schizophrenia and bipolar disorder. We have started innovative work to link these patients to routinely-collected data (such as brain MRI scans and blood monitoring) to provide a much more comprehensive set of phenotype and outcome data for research. Additionally, we are collecting consent from these patients so that we can store a routine sample of blood for future pharmacogenomics and stratified medicine research projects.

Overall, this is a very exciting time for mental health big data research. Health informatics and data science approaches have the potential to radically change the way that we approach the assessment, diagnosis and treatment of very large numbers of people with psychiatric disorders. As our SHINE project highlights, this work also has enormous potential for public health approaches to improving mental health at a population level. We are very grateful for the support provided to us by the MRC in the UK for this work.

SHINE
Schools Health and Wellbeing Improvement Research Network

MHDSS
Mental Health Data Science Scotland

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U.S. research on deafness and communication disorders

The National Institute on Deafness and Other Communication Disorders charts the work of their organisation over the last 30 years that concerns research around the communication sciences, including deafness

Over thirty years ago, in 1988, President Ronald Reagan signed P.L. 100-553 into law, establishing the National Institute on Deafness and Other Communication Disorders (NIDCD) as a new institute within the National Institutes of Health (NIH).

Until that time, research on communication sciences had been supported by the NIH through the National Institute of Neurological and Communicative Disorders and Stroke (now the National Institute of Neurological Disorders and Stroke). Individuals with hearing loss, researchers, clinicians, and professional societies worked together to advocate Congress to authorise a new institute at NIH.

For just over 30 years, the NIDCD has brought national attention to disorders involving hearing, balance, taste, smell, voice, speech, and language. NIDCD contributes to advances in biomedical and behavioural research that improve the lives of the millions of people with these disorders.

Hearing and balance

Hearing loss and balance dysfunction can occur at any age and can affect communication, safety, and quality of life. The NIDCD's robust program of basic and clinical research on hearing and balance includes genetics, genomics, and proteomics. This research focuses, in part, on the identification of genes involved in hearing loss, which can lead to earlier diagnosis and treatment, and to new therapies.

The NIDCD also supports innovative clinical and translational research to lay the foundation for making hearing health care more accessible and affordable. Even though nearly 30 million adults in the United States could benefit from using hearing aids, only one in four has used them. Current research includes identifying barriers to hearing health care and assessing novel service delivery and screening models.

Researchers are also applying cochlear implant technology to develop other neural prostheses. These devices will, for example, provide a sense of hearing for people whose auditory nerve is removed or damaged; normalise balance by electrically stimulating the vestibular nerve, and; help patients with severe speech and physical impairments express themselves using speech synthesized from brain-computer interfaces.

2018 also coincided with the 10th anniversary of NIDCD's It's a Noisy Planet, Protect Their Hearing.® health education campaign, aimed at increasing awareness of noise-induced hearing loss (NIHL) and how to prevent it. NIHL can happen to people at any age, so the campaign teaches kids and their parents and educators three key messages – turn down the volume, move away from the noise, and wear hearing protectors, such as earplugs and earmuffs.

Balance disorders can be quite disabling, impairing mobility and often leading to falls. NIDCD-supported scientists are examining how the brain interprets information from the ear's vestibular organ. NIDCD clinical researchers are also developing rehabilitation procedures and prosthetic devices to improve the quality of life for individuals with balance disorders.

Taste and smell – the chemical senses

NIDCD-supported research helps us understand how our senses of taste and smell relate to our health and well-being and allow us to interact with our environ-

Image: © Geraldine Dietz Fox, personal communication

Geraldine Dietz Fox, a patient advocate, testifies in support of the NIDCD in the institute's early years. Ms Fox was instrumental in the establishment of the institute

ment. NIDCD-funded scientists study many aspects of taste and smell, from how we first detect odours and tastes through sensory cells in the nose and taste buds in the tongue and mouth to how the brain regions involved in the central processing of incoming taste and smell information function. Scientists are also working to better understand how taste and smell sensory cells are regenerated or replaced across the lifespan by underlying stem cells. These studies may someday help scientists develop ways to restore the loss of taste and smell due to chemotherapy, ageing, injury, or disease.

The NIDCD encourages clinical research to improve the diagnosis, prevention, and treatment of taste and smell disorders in all age groups. More clinical and epidemiological studies will help us better understand how factors such as nutrition, early dietary experiences, individual genetic variation, ageing, infection, and disease affect chemosensory sensitivities and taste and smell disorders.

Voice, speech, and language

NIDCD research is leading to improved identification and treatment of voice, speech, and language disorders such as spasmodic dysphonia, stuttering, and specific language impairment (SLI). In addition, scientists continue to identify genes responsible for persistent stuttering, which may be inherited from family members.

Other ongoing research is focused on ways to improve communication in children with autism spectrum disorder (ASD), including the 25 to 30% of children with ASD who remain functionally non-verbal beyond age five.

NIDCD-supported research also addresses voice, speech, and language impairments linked to injury, stroke, and neurodegenerative disorders. These communication problems – such as aphasia, dysarthria, and apraxia – often lead to increased isolation and poor quality of life.

Future directions

As we head toward new frontiers in scientific discovery and precision medicine, the NIDCD is well-positioned to support innovative studies to produce more sensitive, effective, and individually tailored interventions. NIDCD-supported researchers are dedicated to expanding our understanding of the normal processes of hearing, balance, taste, smell, voice, speech, and language and improving rehabilitation strategies for children and adults who face the challenges of communication disorders.

About the National Institute on Deafness and Other Communication Disorders (NIDCD)

NIDCD supports and conducts research and research training on the normal and disordered processes of hearing, balance, taste, smell, voice, speech, and language and provides health information, based upon scientific discovery, to the public.

About the National Institutes of Health (NIH)

NIH, the U.S.'s medical research agency, includes 27 institutes and centres and is a component of the U.S. Department of Health and Human Services. NIH is the primary federal agency conducting and supporting basic, clinical, and translational medical research, and is investigating the causes, treatments, and cures for both common and rare diseases. ■

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Tinnitus: Developing effective treatments or even a cure

Dr Will Sedley provides his opinions on how to objectively ' measure' tinnitus – the first crucial step in developing effective treatments or even a cure – as an example of the kind of project that Action on Hearing Loss is funding

I studied medicine at the University of Nottingham and, after graduating in 2007, took up a series of positions in Newcastle and nearby hospitals. I'm fascinated by how the brain works, and why we see, hear and feel the things we do. When I came across tinnitus, I realised that this captured every fascinating aspect of perception – and, most importantly, presented a massive unsolved problem in modern medicine.

I completed my PhD into brain mechanisms for tinnitus in 2015. I currently work as a specialist registrar in neurology, and as a postdoctoral research scientist, in Newcastle University's Institute of Neuroscience.

The search for treatment

At the time of my PhD, there were two competing schools of thought about tinnitus. All we really knew for certain was that it's usually caused, in some way, by hearing loss.

One view was that the hearing loss causes the brain to 'turn up the volume' to compensate and that this inadvertently turns up the volume on spontaneous, random brain cell firing. In other words, the tinnitus sound that people hear.

The other view likened tinnitus to 'phantom limb' pain – the lack of hearing input in the higher frequency ranges means that the brain has to fill in the missing input from somewhere. Our brains are constantly weighing up what our senses are telling us against our predictions of what we expect to hear.

So it was thought that these predictive mechanisms were going into overdrive and making up the missing input from the brain's memories of sound, or from sound inputs in undamaged frequency ranges.

The two accounts seemed mutually exclusive and also there were a lot of paradoxes that neither could explain. I developed a framework which incorporates aspects of both but with the fundamental difference that the brain is not using predictive mechanisms to make up the tinnitus sound.

Instead, it's usually successful in using predictions of silence to overrule the tinnitus signal – and tinnitus occurs when these mechanisms fail to fully override it. This opens up a number of testable hypotheses about how tinnitus is caused. It might even help in the search for treatment if we can find ways to modify the relevant predictive mechanisms.

> "Human studies of tinnitus are vital if we're to understand it better, and for developing effective treatments. We rely heavily on the goodwill of lots of people with tinnitus who give generously of their time."

Tackling the issue of trying to come up with a convenient, accurate and objective test for tinnitus is an example of a new project, funded by Action on Hearing Loss. The lack of such a 'biomarker' has been a massive barrier to tinnitus research up to now. The method of examining a type of electrical brain response to sounds started out as an attempt to test my theory of how predictive mechanisms may cause, or suppress, tinnitus.

Happy volunteers

A range of different sounds are played to a volunteer, and the pattern of these responses across different conditions (such as sounds that are louder than expected versus others that are quieter than expected) can reveal whether the brain's predictions of sounds are being skewed in a particular direction.

I've seen a very different pattern of results in people with tinnitus compared to people without it. The brain recordings can be used to categorise people as having tinnitus or not with fairly high accuracy. Importantly, this method is also quick, cheap, and requires no training, so it has the potential to transform the way tinnitus research is conducted internationally.

From the volunteers' point of view, it's really simple; they wear an electrode cap and headphones and we play some beeps to them, which they ignore while watching a subtitled film. The work so far is almost ready for scientific publication and now, with this new funding, the next stage will be to improve the accuracy and efficiency of the method (as well as learning more about the brain mechanisms of tinnitus). While it's not in itself a treatment, an accurate and quick test for tinnitus is essential for developing effective treatments for the condition in future. If it lives up to expectation, it will be a major step towards treatment or even a cure.

Human studies of tinnitus are vital if we're to understand it better, and for developing effective treatments. We rely heavily on the goodwill of lots of people with tinnitus who give generously of their time. Happily, almost every one of my volunteers has found the experience interesting. Often, they feel that tinnitus isn't taken all that seriously by health practitioners, so they appreciate the experience of meeting people who are deeply interested in it.

Tinnitus can seem a very unattractive condition to study, either because the symptom can sound rather boring, or because it's not really seen as a big problem compared to, say, cancer or dementia.

In reality, to truly understand tinnitus, you need to understand perception – which means getting to grips with a range of some of the most fascinating aspects of neuroscience, including the unsolved problems remaining. In terms of the importance of the condition, 1% of the UK population are suffering for years (or even decades), because of it. They may not talk about it much – or even at all – but we probably all know people who struggle with tinnitus.

Early on in my career, things were rather all-or-nothing. I would work on one research project at a time and

commit everything to it. When things went well, it was incredibly rewarding, and when experiments or whole studies failed, it would feel like the bottom had fallen out of my world.

> "Tinnitus can seem a very unattractive condition to study, either because the symptom can sound rather boring, or because it's not really seen as a big problem compared to, say, cancer or dementia."

Now I have so many things going on at once (research, clinical work, family) that there's just not enough hours in the day. But it's great because I enjoy every aspect of what I do in life.

Research is one of the most rewarding long-term 'hobbies' to have. The feeling of being able to apply your own creativity to tackle important challenges and fascinating puzzles is wonderful. The downside is that the research progresses much more slowly than I'd like.

No telling when

I don't want to fall into the trap of saying we're on the cusp of curing tinnitus or speculating about when we will cure it. I think it can, and will, be cured eventually – but there's really no telling when, or how.

Ideally, my ultimate goal would be to conclusively work out how tinnitus occurs (including, along the way, how perception in general works), and develop a cure or a safe, non-invasive and effective treatment – perhaps one that can be freely downloaded as a smartphone app. Realistically, I'd be pleased to move the field of research in any direction that eventually benefits people struggling with tinnitus. ■

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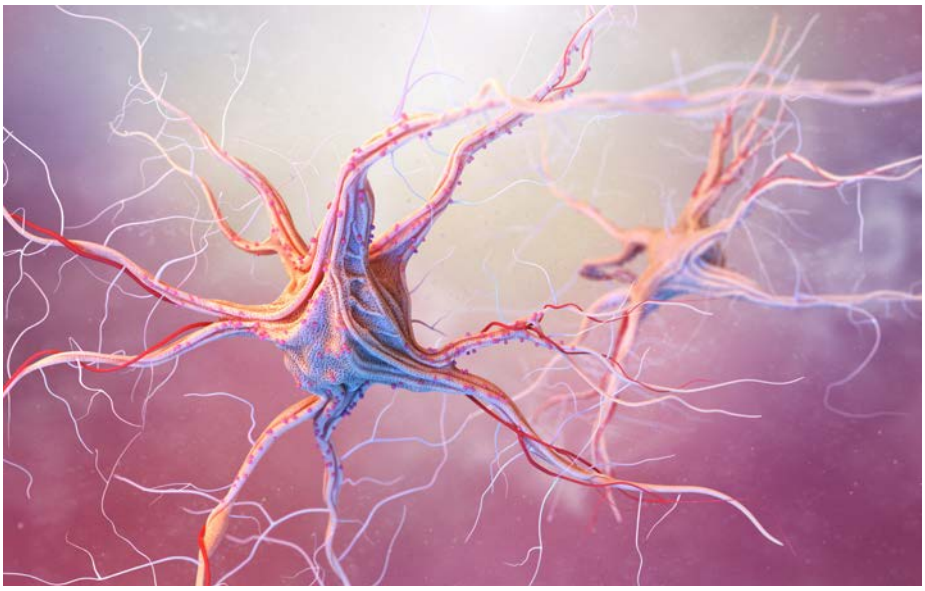
Complexity of neurotrophin signalling in the nervous system

Momoko Takahashi, a Doctoral Student at Northwestern University, explains the complex research of neurotrophin signalling in the nervous system in this report

Ever since Rita Levi-Montalcini, Stanley Cohen, and Viktor Hamburger discovered the first neurotrophin over a half-century ago,[1,2] scientists have continuously worked on characterising this class of proteins, its receptors, and its signalling pathways. What has been revealed is that the complexity of neurotrophin actions are immense; not only do neurotrophins determine the fate of brain cells, known as neurons, they also regulate proliferation, survival, differentiation, migration and neuronal death[3]. Neurotrophins behave differently depending on their location in the nervous system, developmental time period, and species of animal,[4] acting on a multitude of key biological pathways and functions.[5]

Three primary neurotrophins and their corresponding receptors are known today. They are nerve growth factor (NGF) and its receptor, tyrosine receptor kinase A (TrkA), brain-derived neurotrophic factor (BDNF) and its receptor, tyrosine receptor kinase B (TrkB), and neurotrophin-3 (NT-3) and its receptor, tyrosine receptor kinase C (TrkC).[6–12] However, due to the lack of available pharmacological tools, as well as discovery order, the literature on the actions of NT-3/TrkC signalling is less when compared to the other neurotrophins.

The literature that does exist, however, tells a complex story regarding the function of NT-3/TrkC signalling.



Research shows that TrkC induces cell death without NT-3 activation,[4,13] implicating alternate signalling pathway that involves TrkC but not NT-3. Complicating matters more is the fact that TrkC also has multiple isoforms with each behaving differently.[14] Despite these obstacles, recent research strongly suggests that NT-3/TrkC pathway deserves to be studied not only because of its biological, but also clinical significance,[15,16] especially in terms of neurological diseases and the advent of pluripotent stem cells.[17–20] In this research profile, we briefly describe areas of established research in the brain, as well as highlighting mechanisms of NT-3/TrkC signalling in the auditory system – an area of interest for our laboratory.

The hippocampus

In the hippocampus, where neuronal plasticity is heavily dependent on neurogenesis and differentiation to integrate into neural networks,[21] the NT-3/TrkC signalling pathway plays an active role in maintaining network architecture. Learning and memory are reliant on this; animals that lack NT-3/TrkC signalling have deficits in memory tasks.[22] It was recently discovered that NT-3/TrkC also facilitates synaptogenesis by interacting with a molecule known as PTPσ.[23–27] This was a novel discovery because the classical model argues that Trk receptors interact only with neurotrophins. At the cellular level, the story becomes more complex. Injecting NT-3 into hippocampus neurons permits signals to travel backwards from the axon to the cell body.[28] This phenomenon, called retrograde axonal transport, indicates a continued targeted effect in the cell body of neurons, a site where multiple survival-promoting effects are initiated. Not only does the NT-3/TrkC

pathway promote axonal transport, but it also regulates the location of the axon initial segment, altering neuronal excitability and action potential dynamics.[29]

The cerebellum and Purkinje cells

In the cerebellum, the unique and large dendritic architecture of Purkinje cells shed an interesting light onto NT-3/TrkC signalling. With the genetic deletion of TrkC, elaborate dendritic arborisation of Purkinje cells is minimal; however, the fact that dendritic structure is not entirely eliminated suggests that NT-3/TrkC signalling plays another role in dendritic maintenance. Removal of endogenous NT-3 alleviated the reduction of dendritic arborisation, indicating that the NT-3/TrkC pathway controls the neighbouring neuron's dendrite structure in order to maintain a particular density of dendritic architecture within this specific brain region.[30–32]

The auditory system

Several lines of research suggest that the auditory system is dependent on neurotrophin signalling for its proper function and the field of auditory neural science can yield a wealth of knowledge if delved further. Still, the study of NT-3/TrkC signalling in the auditory system can also be a complex endeavour, in part due to the topological gradients of TrkB and TrkC that coexist in same brain regions. For example, the chicken auditory system shows an interesting developmental pattern that is reliant on both Trk receptors.[8] However, a global genetic deletion of either protein can be fatal to the animal, and therefore, methods like the one reviewed in our previous research profile – e.g., focal gene manipulation via *in ovo* electroporation – must be used to further elucidate its functions (please see Open Access Government, January 2019 issue, pages 130-33).

In terms of auditory functions, NT-3/TrkC does several crucial things. It plays a role in regulating action potential properties of auditory neurons in the peripheral pathway;[33] our laboratory has discovered that this happens in the central system as well. Here, neurotrophin signalling regulates action potential kinetics by maintaining a balance between different types of potassium channels.[34] We suggest that this function is critical in establishing normal tonotopic gradients, a biological process required for the neural encoding of different sound frequencies. Similarly, NT-3/TrkC signalling modifies potassium conductance of inner hair cells in guinea pigs, depressing responses and permitting repetitive action potential firing.[35] It also increases calcium currents in the chicken inner ear, promoting more efficient synaptic transmission[36] and in mice, it is involved in synaptic maintenance and neuronal migration of the auditory nerve.[6]

With respect to hearing, correct levels of NT-3/TrkC signalling is required to maintain inner ear health. For example, NT-3 induces synapse regeneration in the inner ear and can repair synapses after acoustic trauma in mice.[15] Similarly, overexpressing NT-3 protects inner ear synapses by promoting its repair after noise-induced synaptopathy in guinea pigs.[37] Conversely, excessive levels of NT-3 in the inner ear can also disrupt the synaptic network of the same species and therefore, negatively affect hearing properties.[38] This suggests that the inner ear requires just the right amount of NT-3 in order for TrkC signalling to be effective in maintaining normal hearing health.

What does this all mean? Few things can be assumed from studies in both normal and abnormal NT-3/TrkC signalling. One conclusion is that due to its ubiquitous presence, a careful study of NT-3/TrkC temporal and spatial expression is necessary before embarking on clinical applications. Nevertheless, research studies in the brain and auditory system suggest that targeting the NT-3/TrkC pathway shows promise as a non-invasive and effective method to treat neurological and auditory ailments.

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Nanomaterials: Understanding and managing the risks

The European Agency for Safety and Health at Work (EU-OSHA) helps us to understand and manage the risks when it comes to nanomaterials, as we find out here

The rapid development of nanotechnologies has brought with it concerns about the potential hazards to human health. Managing the risks associated with nanomaterials in the workplace is fundamentally the same as for other dangerous substances. However, some important differences need to be taken into account. If you work with nanomaterials, be sure to keep up-to-date with developments.

What are nanomaterials?

Manufactured nanomaterials[1] are structures on a scale comparable to that of atoms and molecules, invisible to the naked eye. Their small size allows for the development of light-weight materials with high strength, high conductivity or high chemical reactivity. Nanotechnologies are often viewed as one of the critical breakthroughs of the 21st Century.

Nanomaterials are now used in a wide range of products and sectors. You may have come into contact with them in your daily life as they are used in food packaging, cosmetics, paints and electronics. They are also increasingly used in industries, such as aerospace, construction, medical technology and the automotive sector.

Exposure and health effects

Research into nanomaterials is still ongoing, and it is important to stress that not all have toxic effects. Their use needs to be looked at on a case-by-case basis. However, evidence is mounting that some nanomaterials are more dangerous than first thought and pose greater health risks than the same material in bulk form. Some have even been classified as potentially carcinogenic to humans.

Workplace exposure to dangerous nanomaterials[2] can occur at different stages of the supply chain, meaning that workers may not even be aware of it. The main risk comes from airborne particles, as a result of handling and processing nanomaterials. These particles can either be inhaled or can come into contact with the skin. Such risks can arise in many sectors – from healthcare to maintenance and construction, among others.

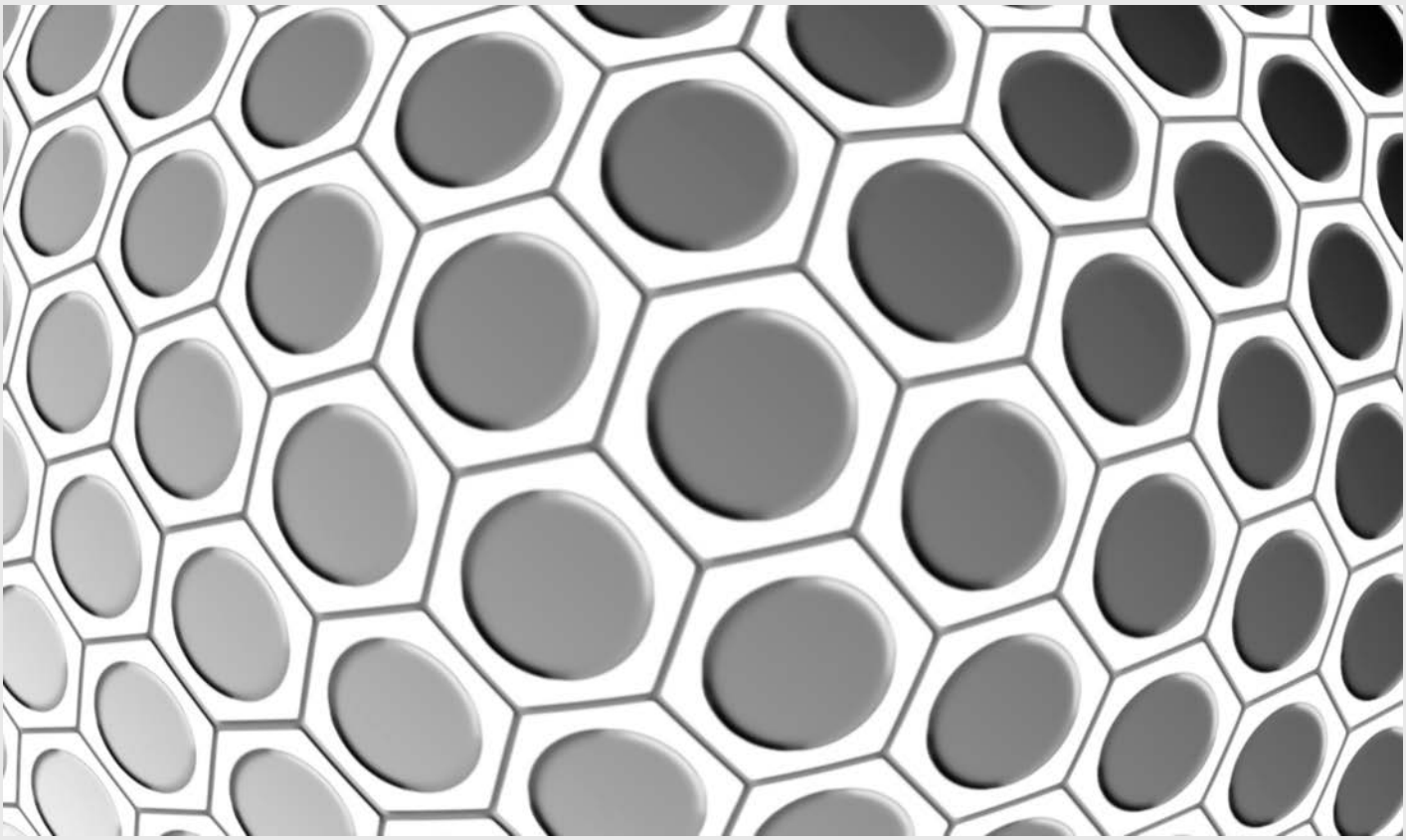
"Research into nanomaterials is still ongoing, and it is important to stress that not all have toxic effects. Their use needs to be looked at on a case-by-case basis. However, evidence is mounting that some nanomaterials are more dangerous than first thought and pose greater health risks than the same material in bulk form. Some have even been classified as potentially carcinogenic to humans."

The European Commission's Risk Assessment of Products of Nanotechnologies[3] has found that nanomaterials can affect the lungs, in particular. The cardiovascular system may also be impacted and some substances have been found to reach the liver, kidneys, heart, brain, skeleton and soft tissues.

Managing the risks in the workplace

There are currently no occupational exposure limits in place, so workplaces should adopt the precautionary principle[4] when dealing with these substances. This means reducing exposures to "As Low As Reasonably Achievable" (ALARA). Generally, employers should follow the same approach as for other dangerous substances. Risk assessments, use of the STOP principle[5] and training are recommended, as per usual. Employers should also follow the European Commission's guidance on the protection of the health and safety of workers from the potential risks related to nanomaterials at work.[6]

However, there are some difficulties that need consideration: risk assessment is more difficult as many properties of nanomaterials are unknown, and; methods and



devices for measuring exposure levels and emission sources are still being developed. This OSHwiki article[7] explains these difficulties in depth.

> "Nanomaterials are now used in a wide range of products and sectors. You may have come into contact with them in your daily life as they are used in food packaging, cosmetics, paints and electronics. They are also increasingly used in industries such as aerospace, construction, medical technology and the automotive sector."

You can find out more about nanomaterials by reading EU-OSHA's info sheet[8] which includes many links to information for employers, workers and occupational safety and health (OSH) professionals. ■

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Materials science: The role of nanostructures and nanoparticles in contemporary society

Thomas W. Hansen, Senior Scientist at DTU Nanolab, Technical University of Denmark

details an aspect of materials science that concerns the role of nanostructures and nanoparticles in contemporary society. Much of the discussion focuses on why a fundamental property of these materials is the melting point

Nanostructures in general and nanoparticles in particular play an increasing role in contemporary society – especially in catalysis where materials often consist of metal nanoparticles – supported on a substrate, this class of materials play a pivotal role.

Catalytic reactions occur at surfaces where reactants can absorb, dissociate and combine into products of higher value. The metallic nanoparticulate component of the catalyst is often a precious metal, for example, platinum group metals (palladium, platinum, ruthenium...), hence it is important to get as much surface area from as small a volume as possible. However, as the defining size of such structures decreases into the sub-10 nm regime, their properties start to diverge from their bulk counterparts.

When trying to extract specific size dependent fundamental properties from a sample, it is highly beneficial to have a large ensemble of particles with narrow size distribution. Such samples are challenging to prepare by taking the chemical route. However, a cluster source with a mass separation system allows for samples with narrow size distributions (below 0.5 nm).[1] Extracted parameters will then no longer rely on continuously keeping the same nanoparticle in the field of view and statistics are extracted more easily.

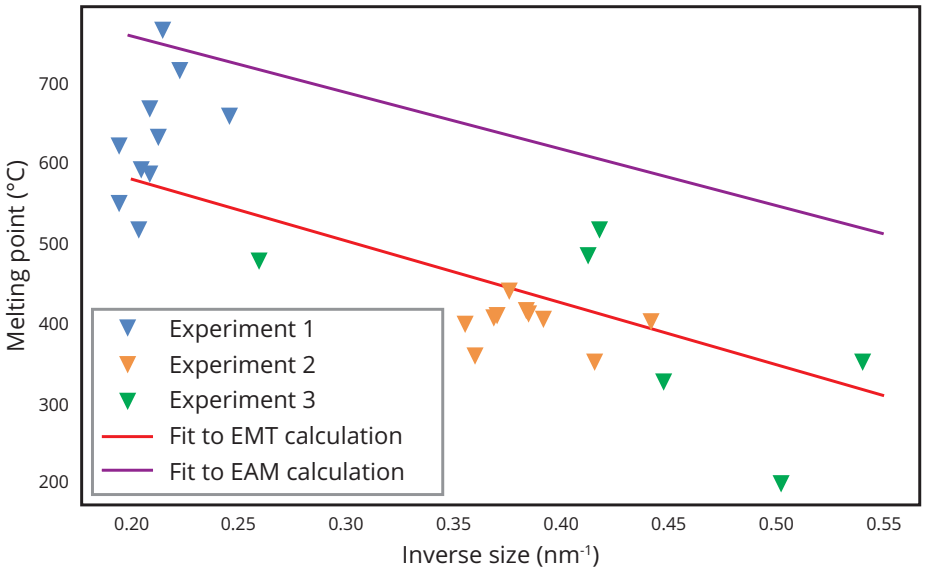

Figure 1: Observed and calculated melting point as a function of inverse particle diameter

> "Our experiments indicate that a pre-molten surface exits prior to complete melting. Such a mobile surface should be taken into account when investigating phenomena occurring at elevated temperatures."

The melting point

One such fundamental property is the melting point. The depression of the melting point was investigated in depth by Buffat and Borel in 1976 using diffraction techniques on ensembles of nanoparticles.[2] Recently we investigated the melting temperature of both ensembles with narrow size distributions as well as individual gold nanoparticles using high-resolution transmission electron microscopy in combination with molecular dynamics calculations (MD).[3] The local information provided by microscopy sheds light on not only the melting point but also the melting process itself.

Gold nanoparticles with diameters around 5 nm, 3 nm and 1.9 nm (designated as Experiment 1, 2 and 3

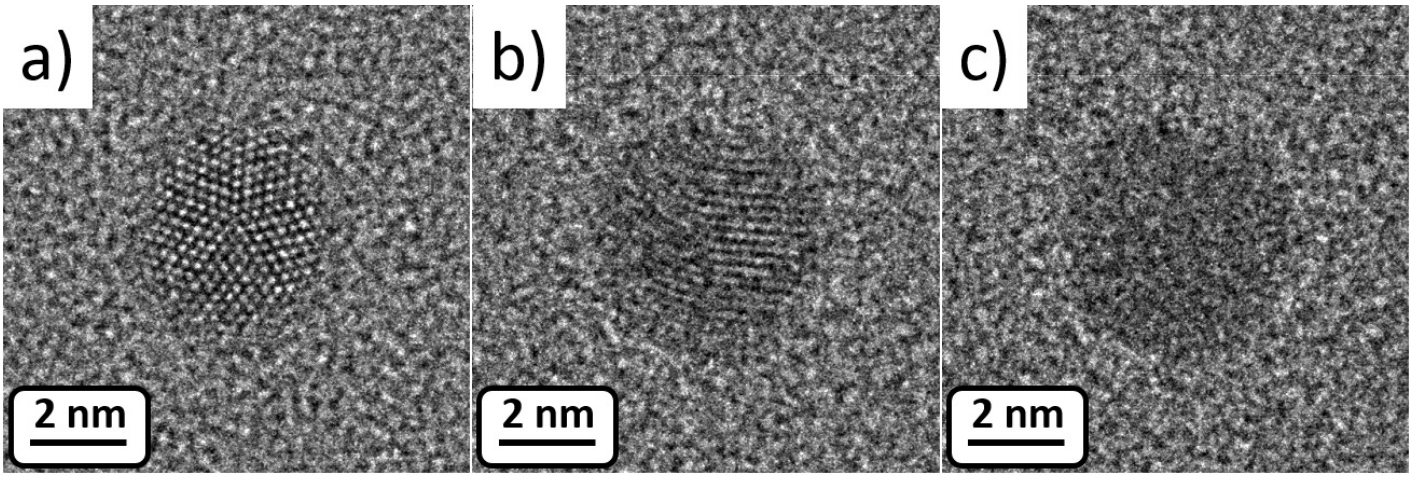

Figure 2: Snapshots from an image sequence acquired at 612°C showing the melting process of a 5 nm gold nanoparticle

respectively) produced with a cluster source was deposited on a MEMS fabricated heating chip with a silicon nitride membrane from DENSsolutions. These chips allow imaging at the deep sub-nm scale while increasing the temperature up to 1300°C. For imaging, an aberration corrected FEI Titan 80-300 transmission electron microscope was used, the microscope is equipped with a OneView camera from Gatan which provides a good combination of speed and sensitivity. In order to image the melting process, the samples were first heated to temperatures a few tens of degrees below the expected melting point in a single step. After observing a stable crystalline sample exposing lattice fringes in the TEM image, the temperature was gradually increased until the lattice fringes were no longer observed (interpreted as molten) at which point the exact particle diameter and temperature was logged.

The results showed a significant drop in melting point (Figure 1), decreasing with size despite a significant scatter in the results, particularly for the largest particles. As the temperature approaches the melting point, the particles become increasingly mobile. For the MD calculations, both Effective Medium Theory, as well as the Embedded Atom Model, were used for the interatomic potentials. Figure 1 shows the comparison between the experimentally observed melting points as well as the MD results using both approaches.

However, for applications where surface properties are important, for example, catalysis, the exact melting process is of higher importance than the state of the interior of the particle. This is the type of information that can be derived from high-resolution transmission electron micrographs. Figure 2 shows three frames from an image sequence acquire at 612°C. In frame a), the crystalline lattice is clearly resolved with the five-fold symmetry, which is typically observed for gold nanoparticles. The crystalline particle is surrounded by a halo, which we interpret as mobile atoms (i.e. molten). Frame b) still shows fringes but not as clear. In frame c) which is acquired 0.2 seconds after frame b), no fringes are observed and the particle is molten.

Conclusion

Our experiments indicate that a pre-molten surface exits prior to complete melting. Such a mobile surface should be taken into account when investigating phenomena occurring at elevated temperatures. The results indicate how technological advancements such as MEMS heaters and aberration correctors can provide new insight into materials science.

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NanoStreeM: The nano-safety roadmap for semiconductor research and development

Dimiter Prodanov from Imec and Daniela Iacopino from Tyndall reveal how NanoStreeM has set up the nano-safety roadmap when it comes to semiconductor research and development

The semiconductor industry uses a growing variety of materials, as companies seek to further improve devices' performance to meet increasing market demand in a constant process of innovation. At present, there are more than 200 chemical compounds consisting of elements, such as silicon, germanium, copper, gold, hafnium, indium and many others, which are present in most computer and mobile phone chips. Understanding the properties of these innovative materials and nanoforms, and how they behave in living systems, such as the human body, often comes years after the materials have been introduced in manufacturing. Such an inherent uncertainty brings about multiple challenges in the governance of the occupational and environmental risks. This is a common challenge for many technology-intensive sectors and it requires a systematic risk reduction approach. This understanding was the driving force behind the NanoStreeM project, which was funded by the European Union (EU) from 2016 until 2018. The objectives of the project were to:

1. Build inventories of materials, research topics and applications relevant for nanomaterial use and exposure in nano-electronics manufacturing;
2. Identify gaps in knowledge and methodologies to assess the risk of engineered or accidentally produced nanomaterials and;
3. To inform stakeholders in order to support decision making and governance of the risks related to the use of nanomaterials and nanoforms in the semiconductor fabrication process.

The NanoStreeM consortium, comprising 14 partners from six European countries, combines unique expertise throughout the research and development chain: from the academic labs via technology development through to the semiconductor application side. The companies represented in the consortium have some of the largest fabrication facilities in Europe and are represented globally. The consortium included leading centres of semiconductor research, such as Imec, CEA, Fraunhofer and the Tyndall National Institute, and several other academic institutions.

The project identified the most commonly used commercial nanomaterials in the semiconductor industry chip manufacturing sector. From the information collected, it was established that materials in nanoform were used in some well-defined production steps but were not present in finished products, such as computer chips. It was also found that under some circumstances nanomaterials were generated as process residues. Finally, collected findings showed deficiencies of communicating risk along the supply chain, in particular, related to the availability of information in the product safety data sheets. More information can be found in the project roadmap available on the project website: www.nanostreem.eu

The project concluded with a public webinar available on YouTube.

The project established that only a few risk assessment tools can be currently applied to semiconductor manufacturing and to a limited extent. Project results on a larger scale indicate that not much of the identified risks are nano-specific, therefore, the useful risk assessment methodologies should be more generic and explicitly dealing with the lack of data. This promotes the efforts for read-across and establishing criteria for grouping of materials and technological processes. This also indicates that tiered and iterative approaches are beneficial as these allow for trade-offs, which can be reviewed as more data becomes available.

At present, there are significant information gaps about the properties of

Final NanoStreeM consortium meeting in ST-Crolles, Crolles, 9 Oct 2018

nanomaterials and they preclude the typical chemical safety risk assessment methodologies to be applied. The currently available public information is focused only on a very limited set of materials, while the safety data sheets fail to convey the information necessary to conduct a risk assessment. In such conditions, it is important to train engineers and researchers to understand the properties of nanomaterials and the methods to conduct risk assessments.

Definite needs for competence development was established in terms of building awareness about the properties of nanomaterials, the dedicated nanotoxicology knowledge base and finally, about the limitations of the application of traditional occupational chemical risk assessment to nanomaterials. To meet these needs, the project delivered nanosafety training packages, as one of its major outcomes. The project partners Tyndall, CEA and Imec put together three dedicated safety training packages focusing on semiconductor industry processes and clean room environments. The topics of the training are as follows:

- A start-up training package for technical personnel handling nanomaterials having no prior experience.
- A training package for safety professionals to aid in their formative education concerning nanomaterials and how to conduct occupational risk assessments and monitoring of nanomaterials.
- "Train the trainer" guideline for training deployment.

Developed training packages will be used by the semiconductor industry and the partnering institutions after the end of the project. The packages are available upon request via the European Semiconductor Industry Association or via the project coordination office at Imec. The packages are generic enough to be used by the nanotechnology and chemical industries.

Acknowledgement

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Is democracy under fire? The European Union before the elections

Günther H.Oettinger, Commissioner for Budget & Human Resources at the European Commission analyses why democracy is under fire in the European Union in the lead up to the elections in May 2019 – but also underlines the strengths of Europe including competitiveness

In this article, I cast an eye over what 2019 holds and even further over the coming decades. I want to look at how we can overcome the challenges ahead and what role Europe should play in this.

Political risks: Brexit and trade wars

If we look at the political agenda, nearly every point is prefaced with the words 'we hope that', for example:

- We hope that there won't be a trade war between the European Union (EU) and the U.S.
- We are looking at worldwide developments in Venezuela, Brazil, Argentina and Turkey – problems such as a democratic deficit, autocratic governments, inflation and recession.

Competing or clashing value systems

In essence, what we are experiencing right now is a competition between value systems. Our value system is based on parliamentary democracy, a social market economy, the separation of powers, the rule of law, independent courts – the third branch of government – and freedom of speech, the press, religion and belief. Now we are seeing that there are other forms of order – and disorder:

- The worst forms of disorder include, terrorism, forced displacement and add to that autocracies in places such as Ankara.

We must fight for our European value system

If we want to preserve this value system for ourselves, we must actively fight for it. We need to work as a team and to raise our profile and be more convincing.

Europe's strengths:

Extending our Union for peace to the Western Balkans

Europe was, is and remains first and foremost a Union for peace. If we want to extend this peace to the Western Balkans, then we should logically envisage enlarging Europe by up to six Western Balkan countries. They are doing everything in their power to meet the requirements for joining the EU, step by step. But if we as citizens, voters and taxpayers aren't willing to welcome these countries, then they will turn away from Brussels and towards Moscow or Ankara.

Our second strength: Europe must continue to export its values

Secondly, we have exported our values. The accession of 13 new countries over the last decade was perhaps too much too soon – maybe so. But the windows offered to us by history open and close so fast. If Slovakia, Czechia, Slovenia, Hungary, Poland, Estonia, Latvia, Lithuania, Malta, Cyprus, Bulgaria, Romania, and most recently Croatia, had not become part of the European Union, some of these countries would be vulnerable from aggressive wind from Russia, just like the unfortunate Armenia, Georgia, Moldova, Belarus and Ukraine.

Our third strength: the benefits of a single market and external trade

Third, the greatest economic achievement of the European Union is the single market. With 550 million people, it is still the biggest single market in the world.

Added to this single market, is external trade. If you have a single market, you must negotiate trade agreements at the European level. At the moment, we are in

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negotiations with Japan, Singapore, New Zealand, Australia, Vietnam, Mexico, Chile and Mercosur. This is a large part of the benefit we get from Europe. Our single market brings untold benefits within the EU and our collective trade negotiations bring added value in our dealings with the outside world.

Europe – the continent of freedom and free movement

Fourth, Europe is the continent of freedom and free movement. My favourite town in Europe is Görlitz on the River Neisse. After the Second World War, the river became a cold dividing line. The western half of Görlitz belonged to the district of Dresden in the GDR and the eastern half was part of Polish Silesia. There was no contact or movement whatsoever between these two parts of the town. Today, Poland and Germany are united in the European Union.

Competitiveness: Europe must not become an open-air museum

Fifth, European competitiveness. There are a few new areas where there is clear added value from European cooperation, such as robotics, sensors, photonics, micro and nanoelectronics, high-performance computing and artificial intelligence (AI).

No company (neither Philips and Schneider Electric nor Siemens and Bosch) has enough human resources, engineers, IT specialists or money to compete alone against Google, Amazon, Facebook or Microsoft in Silicon Valley. This is why in the next long-term EU Budget 2021-2027, we foresee more money for research which will allow us, for example, to co-finance public-private partnerships in areas, such as artificial intelligence (AI).

EU elections in May 2019

This year, we have also EU elections in May and we will have to see whether the European Parliament remains sufficiently stable and pro-European. At the moment, the 'grand coalition' between the European People's Party (EPP) and centre-left political group (S&D) has a majority, but the polls suggest it will not hold. We, therefore, need a third party to join forces with it, such as ALDE, the Macronists or the Greens. We should also expect an anti-European alliance for the first time.

That is why European elections should be as important as national elections to European citizens, me and everyone, no more and no less so. For our democracy, for our values, for our achievements. ■

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Cardiovascular magnetic resonance imaging and spectroscopy

Professor Ulrich Flögel explores how magnetic resonance techniques can be used for basic research into animal care in this report

Magnetic resonance imaging (MRI) is a powerful tool that uses strong magnetic fields and radio waves to produce detailed images of the inside of the body. MRI offers many benefits over other imaging techniques – it is patient-friendly as it is non-invasive, and also gives extremely clear, detailed images of soft-tissue that other imaging techniques cannot achieve. In addition, MRI scans can be used to examine almost any part of the body, such as the brain and spinal cord, heart and blood vessels, bones, joints and internal organs. As a consequence, MRI has established as gold standard for diagnosis in several clinical settings, such as cervical spine injury, tumours, myocardial infarction and many more.

However, MRI techniques are not only crucial for human diagnostics but are also of major importance for basic research to explore pathomechanisms and potential novel therapeutic targets in animal models of human diseases. Providing superior contrast between soft-tissues and due to its multifaceted field of applications (anatomy, functional parameters, angiography, metabolism, inflammation, tissue characterization etc. see below), MRI allows an accurate and longitudinal *in vivo* analysis also of cardiovascular relevant disease models.

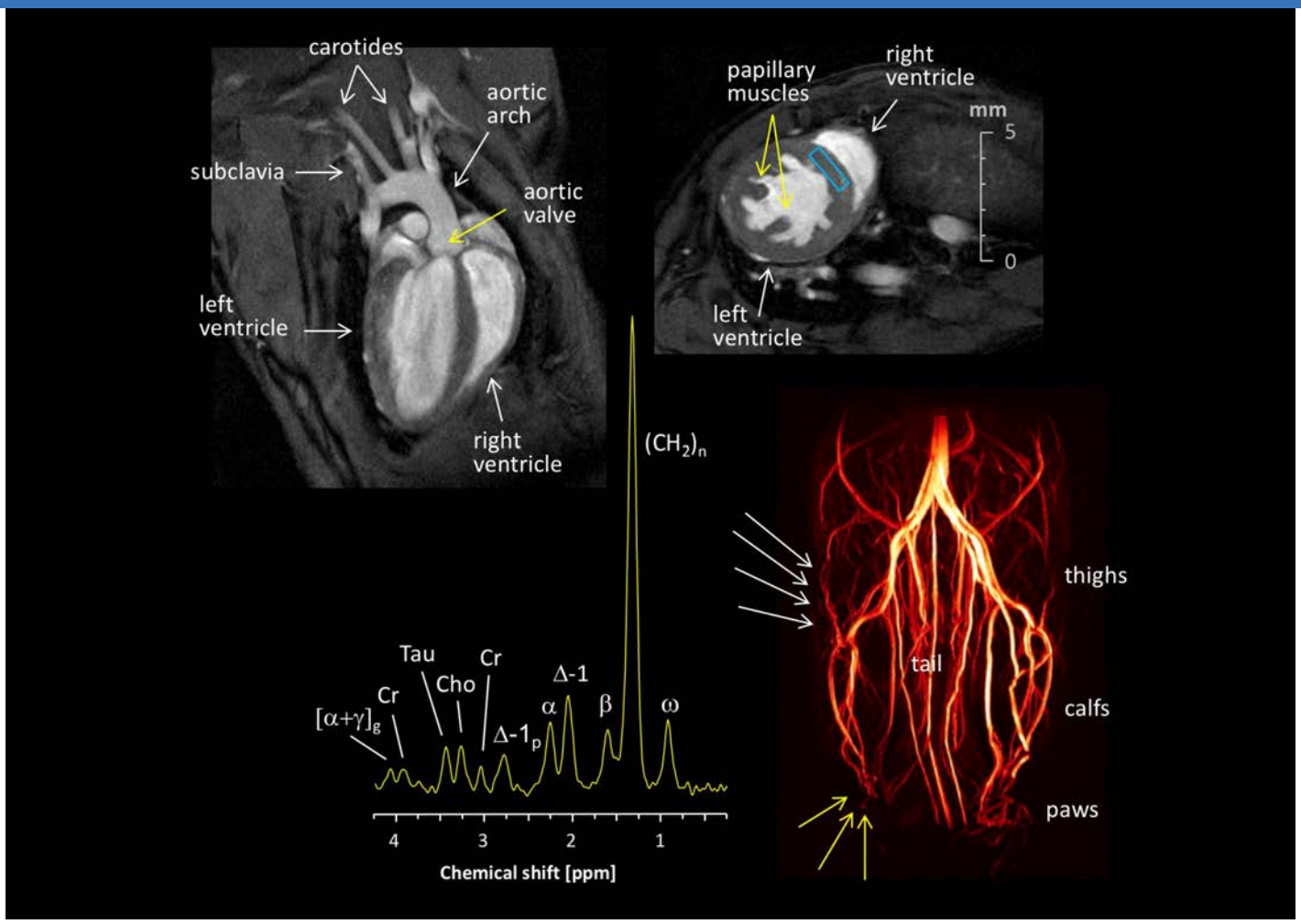
Due to its non-invasive nature it also perfectly matches current requirements of animal care, such as the 3Rs (replacement, reduction and refinement). Importantly, it also provides the possibility for locoregional analysis of immune cell infiltration, changes in myocardial texture, and local function in the myocardium in a repetitive manner, thereby reducing the number of animals and increasing the reliability of the acquired results, since over the entire period of investigation all data are obtained from the same individuals.

The most commonly used MRI scanning technique typically works by harnessing the magnetic properties of hydrogen atoms to build these images of the body. Certain atoms, including hydrogen atoms (^{1}H), can absorb and emit energy in the form of radio waves when they are in a strong magnetic field. Hydrogen atoms are present in water and fat and are vastly abundant within the body (~75% of the total mass), thus the multiplicity of MRI applications focuses on the detection of hydrogen (^{1}H) nuclei. However, other types of MRI scans can take advantage of the magnetic properties of the somewhat exotic appearing X-nuclei (such as ^{13}C, ^{19}F, ^{23}Na, and ^{31}P) to obtain information which by other means would be difficult to access.

With these methods not only anatomical images of the inside of the body can be acquired, but by special techniques also foci of inflammation or special proteins like myoglobin, small molecular compounds like adenosine triphosphate (ATP) and glucose, respectively, or even ions (like sodium, potassium or chloride) in individual organs, such as the heart, can be determined without radiation exposure. The latter applies for all MR-related methods both MRI and the so-called MR spectroscopy (MRS) but as well for MR angiography (MRA). Thus, also these measurements can be carried out noninvasively at the living animal if required in a repetitive manner.

Thereby, important issues of cardiac metabolism in the context of myocardial infarction, cardiomyopathies or heart insufficiency can be addressed, in particular, the high energy phosphates as well as oxygen supply, pH regulation and ion or body lipid homeostasis. Also, airway analysis by use of MR-active inert gases, such as ^{3}He, SF_6 of ^{129}Xe is feasible by MRI. The power of these more unusual approaches will be addressed in future issues.

The most commonly used animal model in basic research is the mouse, which can be easily genetically modified to mimic inherited human gene defects or to explore specific signalling pathways as a target for therapy. However, for murine MRI analysis dedicated hardware is required to enable high-resolution analysis of the small organs. In particular imaging of the mouse heart characterized by low



mass and very high heart rates compared to human conditions (~0.1 vs 300-gram heart weight; 600 vs 60 beats per minute) is a very challenging task. Nevertheless, by choosing appropriate acquisition parameters and coil setups, images of excellent quality can also be obtained from this species as demonstrated in the above figure.

Left top shows a healthy murine heart in long axis orientation with superb illustration of the left and right ventricle, the aortic valve as well as the aortic arch with passing of the two carotid and the left subclavian arteries, while in the right top hand corner a short axis slice of a hypertrophied murine heart is displayed with massive trabeculation and thickening of the left ventricular wall. The left bottom represents a ^{1}H MR spectrum acquired from the rectangle in the interventricular septum (right top) allowing the quantification of cardiac metabolites and lipids with discrimination of mono- and polyunsaturated fatty acids (FA), thereby addressing the impact of dynamic metabolic changes during development of heart diseases. Assignment of ^{1}H signals: $[\alpha+\gamma]_g$, bound to $\alpha+\gamma$ carbons of the glycerol backbone; Cr, creatine; Tau, taurine; Cho, choline; $\Delta\text{-}1_p$, next to polyunsaturated FA carbons; α, bound to the α-carbon of FA; Δ-1, next to monounsaturated FA carbons; β, bound to the β-carbon of FA; $(CH_2)_n$, methylene groups of FA; ω, terminal methyl group of FA. Finally, in the right bottom the vessel system of the murine hindlimbs is imaged by contrast agent free time-of-flight MR angiography revealing the evolution of collateral vessels (white arrows) to compensate for perfusion deficits in the periphery around the paws (yellow arrows).

Thus, non-invasive MR investigations of murine disease models permit a comprehensive analysis of pathomechanisms also relevant for the human setting and further allow identification of novel therapeutic targets as well as development/verification of new investigational drugs.

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Reconciliation in a higher education context: Tensions and challenges

Dawn Zinga, Associate Professor and Chair at the Department of Child and Youth Studies at Brock University explores reconciliation in a higher education context, by detailing the tensions and challenges in this area

In August 2017, I wrote about how Canadian institutes of higher education were taking up the Truth and Reconciliation Commission's calls to action. Almost a year later, higher education contexts continue to face tensions and challenges in addressing those calls to action. There has been much talk of how to address the calls and some policy changes, but it is clear that there are a lot of tensions and challenges around the implementation of any changes. Lakehead University offers an example of how those tensions and challenges can be expressed. The university's response to Recommendation 28 was to ensure that all law students were provided with opportunities to better understand Indigenous peoples and the law by weaving Indigenous content throughout the law curriculum. However, in practice, there appear to be challenges with the implementation of significant changes. Angelique EagleWoman was hired by Lakehead University as the first female Indigenous law school dean in 2016 but resigned citing systemic discrimination and racism in 2018. This unfortunate situation underscores the difference between a surface response to the calls to action and meaningful action.

> "The conundrum facing higher education is how to proceed to address the calls when institutions are having difficulty being able to recognise how the very structures of the institutions are getting in the way."

Universities and colleges are struggling to address the calls to action and to understand what reconciliation means. Indigenous scholars Marie

Battiste, Jan Hare, Jackie Ottman and Dwayne Donald spoke eloquently at the 2018 Congress of the Humanities and Social Sciences about reconciliation within a higher education context. Each of them remained committed to the conviction expressed by the Commission that education will be pivotal in putting Canada on the road to reconciliation. Battiste spoke about the importance of decolonising and how everyone has been "marinated in Eurocentrism" and that the tenets of Eurocentrism that are characterised by superiority, hegemony and a monopoly over all other knowledge systems, stand in the way of reconciliation. Battiste speaks about cognitive imperialism and how every Canadian student has been a victim and beneficiary of the same education system that has exposed them in Eurocentrism and cognitive imperialism. These act as some of the greatest barriers to reconciliation and the serve to blind people to the colonialism embedded throughout education at all levels.

Dwayne Donald agrees that it is difficult to accomplish much when the very institution that claims to want to take steps towards reconciliation gets in the way when tensions arise. He argues that part of the problem is the tendency within higher education contexts to take shortcuts by attempting to make changes without examining the embedded colonialism. When change is implemented in those contexts, tensions quickly rise and the response to those tensions is to reassert "colonial terrain".

Jackie Ottman also spoke to the hidden curriculum and unconscious codes that are triggered by attempts to meaningfully address the TRC. She stated that while the Royal Commission on Aboriginal Peoples issued its report in October 1996 and offered over 400 recommendations, the TRC's 94 calls to action has engendered a more lasting response. However, she warns that the weight of addressing those calls to action within higher education contexts could not be left to Indigenous students and scholars to do all the heavy lifting, but that non-indigenous students and scholars needed to walk alongside and share the weight and the work. Jan Hare agreed with her colleagues and calls for a continued commitment to reconciliation that is grounded in an understanding of everyone's roles and responsibilities.

> "Universities and colleges are struggling to address the calls to action and to understand what reconciliation means."

The conundrum facing higher education is how to proceed to address the calls when institutions are having difficulty being able to recognise how the very structures of the institutions are getting in the way. Most institutions are implementing policies and directives, but not doing the hard work of exploring what it will mean to actually implement those policies and directives. The end result is window dressing without any meaningful change or a resurgence of colonialism and a return to the status quo that hides behind claims of cultural inclusion or returns to pathologising Indigenous students and scholars.

Reconciliation requires an examination and understanding of what has happened and how current structures, systems and attitudes/biases that are conscious or unconscious continue to uphold colonialism and Eurocentrism. University mission statements can include commitments to Indigenisation but without a meaningful examination of what that term means and an appreciation that decolonisation is the first step and that such commitments will fail to produce any significant change, other than putting a new face on a continued inability to engage in reconciliation.

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France: Investing in education, innovation and research

Frédérique Vidal, Minister of Higher Education, Research and Innovation in The French Government explains her stance on the importance of investing in education, innovation and research

While populism rises throughout the world, governments are facing the emergency of tackling climate change and ensuring health, food and energy security. In such a time, France has a major role to play as a Nation committed to the development of knowledge and the fostering of innovative solutions. To succeed, I believe that we have to simultaneously invest massively in higher education and research, and bring together research, innovation and economic clusters. This is what the French Government is currently doing, with an ambitious national roadmap and a strong involvement in the Horizon 2020 European programme.

A long tradition of excellence in research

France has a long tradition of excellence in research and is eventually ranked 3rd for the number of Fields Medals it received and 4th for its number of Nobel Prizes. All French research organisations (CNRS, CEA, Inra, Inserm, Inria, etc.) are also in the very first places of world rankings in their own categories, and 18 French universities are among the 100 most innovative universities in Europe. To go even further, the French Government has taken strong measures to promote transfer and innovation and to ensure France's place in the European research space.

Firstly, France's budget for research has increased by 8% between 2017 and 2019. Research laboratories have seen their endowments rise while the National Research Agency (ANR) has been deeply modernised to become a more agile organisation, financing projects quicker and more efficiently. Concomitantly, €3.5 billion from the National Investment Plan (2018-2020) has been dedicated to excellence in research and €4.6 billion to innovation. On February 1st, 2019, the Prime Minister announced that France will put its research trajectory on an ambitious basis in a plurennial dedicated law starting in 2021.

Research Priority programmes for humanity

To address major challenges that humanity is facing, the Government already created Research Priority programmes provided with dedicated budgets. Their aim is to make all research labs work together to build solutions on issues such as climate change, pesticides, antimicrobial resistance or even artificial intelligence. For example, as part of the AI for Humanity strategy announced by President Macron on March 29, 2018, I launched a €1 billion artificial intelligence (AI) research programme coordinated by Inria, aimed to involve the best research labs from research organisations, universities and the private sector. Similarly, the Make Our Planet Great Again programme is coordinated by CNRS and allowed France to welcome top-level researchers from all over the world, including from the most prestigious American universities, in French labs, to work on climate change related topics. We will soon kick off a joint French-German research effort against climate change in Paris with my German Colleague Anja Karliczeck. This is one example of the several ambitious bilateral strategies for research we share with Germany.

Fostering innovative solutions and Open Science

On the innovation front, we modified a set of rules in order to make interactions between research labs and the private sector much more fluid (e.g. allowing a public researcher to spend 50% of his or her time in a private company or to keep shares of a company he or she created) and launched an Innovation Council to foster breakthrough innovation. This Council will be the national counterpart of the European Innovation Council, which is now essentially oriented towards breakthrough innovation and it will act as the disruptive innovation agency that was lacking in Europe. Among its first decisions, the French Innovation Council

Frédérique Vidal, Minister of Higher Education, Research and Innovation

launched a national plan to accelerate the creation and growth of deep tech start-ups.

I am also convinced that part of the success of this strategy relies on promoting open government measures. In the field of my ministry, I recently launched an ambitious plan for Open Science. This plan is a game-changer: it sets, among other things, the fact that research results produced with public funding have to be open.

The role of France in European programmes

This new set of tools has to be understood in the global European agenda, in which France plays a major role. Horizon 2020 and soon "Horizon Europe", for which I expect an ambitious budget, is the largest research programmes in the world. This unprecedented investment shows that the European Union (EU) is firmly committed to boosting European research in order to become the world leader. And this is essential because Europe bears a unique vision for research and progress, based on ethics and respect. Thus, I wish all French research players get involved in European programmes and contribute to promoting these values.

We all know how difficult it will be to tackle the challenges lying ahead of us but I am confident that France and the EU will be major actors for progress, by investing massively in the production and diffusion of knowledge and building a desirable future for its citizens. ■

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Aircraft transportation today and in the decade to come

Franck Plouraboué, Senior Scientist CNRS, Fluid Mechanics Institute of Toulouse,
discusses how making improvements on aircraft propulsion can solve major issues and make significant advances in the future

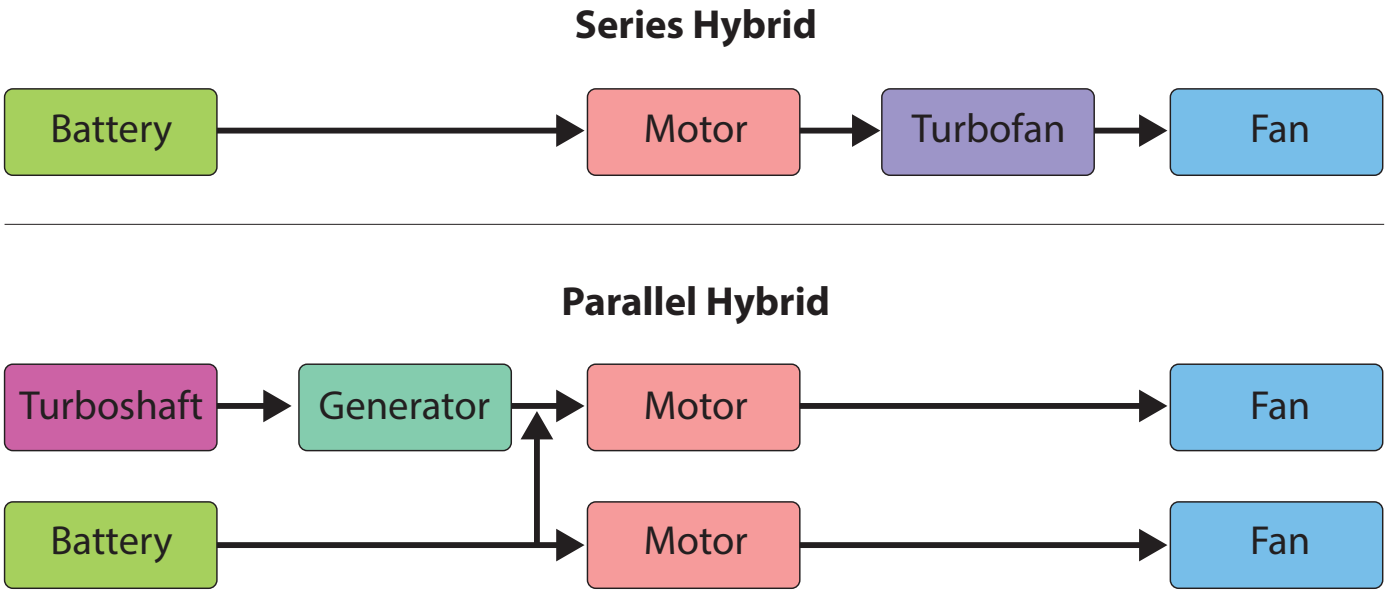
Airplane transportation has been around for a century which is a very small period compared to the time humans have inhabited the earth. Yet, the number of commercial flights exceeded four billion last year. Over the last decade the number of flights have increased by about 6% each year without any sign of decline. Compared to the world population growth rate, which is about 1.1%, the increase of air transportation is close to six times faster. Keeping with these rates, in about fifteen years, there will be as many flights per year as people on earth. The aircraft industrys contribution to CO_2 atmospheric pollution is expected to increase as aviation fuel consumption continues to grow.

Air transport accounts for about 2% of the present global carbon footprint. It will likely reach 5% in fifteen years. This percentage might become even greater as the gap narrows between the use of the electric motor and the traditional internal combustion engine to power terrestrial transport. Given these perspectives, how can existing technologies help lower the negative environmental impact of air transportation?

Aircraft propulsion achievements

One should first consider the thrust specific fuel consumption (TSFC), a figure of merit for quantifying aircraft propulsion efficiency and frugality. TSFC represents the thrust produced by the engine divided by the rate of fuel flow, i.e. the mechanical propulsion divided by its chemical cost in fossil energy. For both jet engines and turbo-propulsion systems, it has only improved by a meagre 20% over the last twenty years.

Another figure of merit is the propulsion efficiency (PE) providing the ratio between the propelling power and the rate of energy consumption. Disregarding turbo propulsion for being less efficient at high altitude than turbofans or jet engines, the propulsive efficiency is merely improved by 20% in most recent evolutions either associated with an installed gearbox to slow down fan speed or more traditional design optimisations. Both



improvements in TSFC and PE illustrate that, with a 6% increase each year over the last two decades, reaching a total of 70% build up in CO_2 emission as well as fuel consumption, a 20% gain in efficiency is just not enough. Small incremental improvements in this necessarily conservative domain of science and technology – being cautious of passenger security does not offer enough perspective to solve for the needs.

Innovative perspective for aircraft propulsion

There might be significant technological progress in the area of fuel engines propulsion associated with the economy of fossil energy usage. Innovative gas injection systems, such as plasma's igniters (using a dedicated plasma spark for better initiation and control of the internal combustion in engines), hydrogen fuel enhancement (using a mixture of hydrogen and conventional fuel inside combustion engines to improve power output and emissions), can be listed as possible tracks for progress expected in the area. Even though difficult to predict, the gain expected in propulsion efficiency in the next decade resulting from these innovative technologies will probably be incremental.

But airplane propulsion progress is not just about improving engines. The aircrafts themselves might gain efficiency from innovative strategies to improve aerodynamic performances. Lowering the hydrodynamic drag (the friction force exerted by air on the aircraft) can be obtained using various smart improvements. Improved wing design has recently been used and deployed on commercial airplanes. Boundary layers control to delay or partially remove their detachment (boundary layer of the air flow are regions where viscous effects are important, the stability of which lowers the overall drag), either using actuated mechanical systems or pulsed air-jets actuators are valuable concepts albeit only currently in the prototype stage. Even promising, performance gains from these new systems will most probably be incremental.

The need for a disruptive strategy to lower fossil energy use as well as the carbon footprint of air transport has recently turned toward electric propulsion. Of course, some caution has to be taken, electric propulsion is not 100% green – the manufacturing processes around high-density batteries are a long way off from being environmentally friendly.

Nevertheless, as far as fossil fuel and carbon footprint reduction are concerned, this is almost certainly the best choice. Many projects are now taking this route: small aircraft equipped with full electrical propulsion, or, for larger ones, co-propulsive systems. Co-propulsion is a general concept combining electric-power and fuel-based power systems. It covers hybrid-electric engines architectures (Cf Figure) or turbo-electric ones (for which turbo-shaft generated energy is transformed into electrical energy to drive – possibly multiple – distributed electric motor-driven fan(s)).

From this, one can realise that electric co-propulsion is not as disruptive as previously stated, but will, most probably, be implemented through step-by-step adoption in combination with existing aircraft systems. Of course, one key aspect for the future improvements of electric propulsion in air transport is the ability to enhance battery storage capacity, density and security. Since ground-based electrical transport is facing the same challenge, it is possible to expect synergetic efforts providing significant progress to this electric storage capacity bottleneck.

Last, but not least, albeit at a very early stage, ionic wind propulsion is an interesting new topic worth considering. Subjecting charged molecules to an electric field in air, accelerates them and produces collisions with neutral molecules so as to transfer their momentum and finally produce ionic wind. This wind can propel. Disregarded for being inefficient in the 1960s, scientists has recently discovered that this efficiency could in fact drastically be improved at commercial flight speed. Ionic wind propulsion is therefore an additional option for electric propulsion in the air, currently in its infancy, but a promising option nonetheless.

In conclusion, the constant increase in air transport raises new challenges. Here, we have covered current aircraft transport improvements showing that they can potentially help in solving some of the main issues. We also highlighted more recent progress which might permit major advances in the future.

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The European Research Area (ERA) in Austria: The mirror has two faces

Christian Naczinsky from the Austrian Ministry of Education, Science and Research explains his stance on the European Research Area (ERA) in Austria

If we look into the mirror of Austria's performance in the European Research Area (ERA), we can see success. Austria's return on investment in the European Framework Programme is positive. According to the latest available data, the Austrian research community coordinates more than 500 EU projects, punching above its weight in terms of participation and funding received from Horizon 2020.

In summer 2018, Austrian policymakers celebrated the fact that Austria had exceeded the threshold of €1 billion in EU funding from Horizon 2020. The quality of research projects with Austrian participants is among the best in Europe if measured against the success rate of evaluated projects in Horizon 2020. There is no doubt that Austrian industry benefits from a stronger link between research and innovation in Horizon 2020 since this sector represents 38% of Austria's participation in the Framework Programme.

Reforming Austria's national research system

Based on the Austrian ERA Roadmap which was adopted by the federal government in 2016, Austria set course for reforming its national research system with the aim of improving coherence between the European and the Austrian research systems. By way of example, in the Austrian ERA Roadmap, the government agreed to initiate an evaluation of the national RTI system by the OECD as an inspiration for the next national RTI strategy 2030. The OECD review started in 2017, and the final OECD evaluation report was presented and discussed at a big conference last December. This spring, an RTI government summit, chaired by the Federal Chancellor, will kick off the drafting process of the RTI strategy 2030.

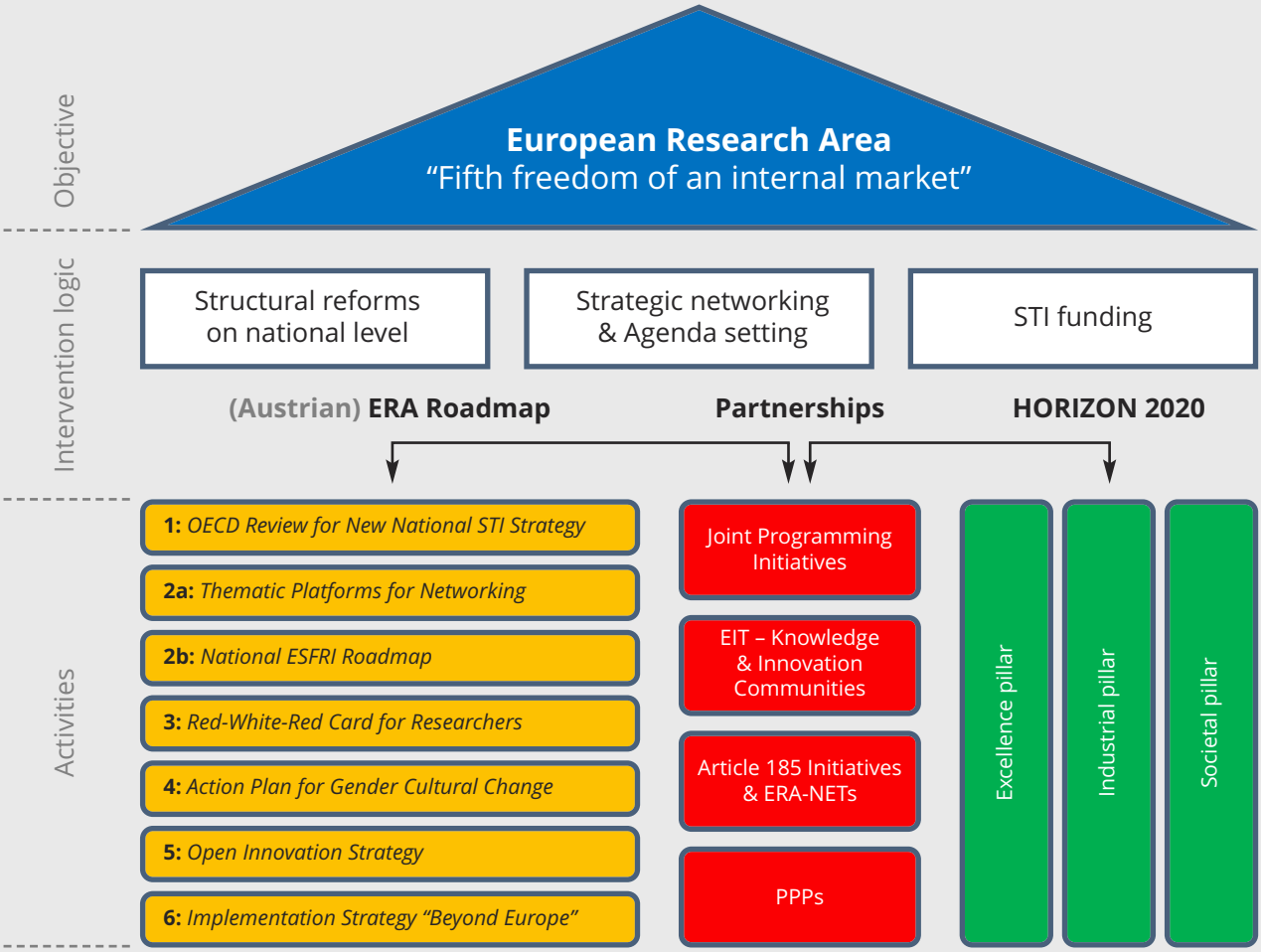
In all ERA priority fields, from joint programming to gender equality to international cooperation, Austria's ERA Roadmap provides about 50 implementation measures with a financial envelope of some €40 million. Some measures are more important because of their legal and societal impact rather than their financial relevance. For example, to improve the access of talented researchers to the Austrian labour market, the so-called "Red-White-Red Card" has been reformed. University graduates from third countries who completed their studies in Austria are now offered a period of 12 months (instead of only six before) after their graduation to look for a suitable job in Austria. This is a measure that seeks to keep the best brains from outside Austria within the Austrian labour market, given that they have become well-integrated members of Austrian society during their period of study.

Austria regularly monitors how far it has proceeded in implementing the Austrian ERA Roadmap. In late 2019, a second progress report will shed light on the current state of play of Austria's national ERA Roadmap.

In 2018, an evaluation of the implementation of Horizon 2020, EUREKA, COSME, EEN and ERA in Austria concluded that the overall Austrian architecture of interaction between structural reforms on the national level, strategic networking and agenda setting, and STI funding from Horizon 2020 provides a solid basis for Austria's success.

Austria's approach towards ERA

Austria might be tempted to become self-complacent unless it realised that Austria's success in the European Research Area mirrors achievements of the past, not of the future. The mirror of ERA in Austria has two faces, one of yesterday and one of tomorrow. It is the future that – although uncertain by nature – requires a fresh look at Austria's approach towards ERA.



The most prominent example of "tomorrow" is Horizon Europe's focus on missions. Research and innovation will be at the core of greater societal, economic or technological challenges that shall be translated into missions with clear targets, timelines, outputs and impact on sectoral policies. Missions will require strategic planning across the future clusters of Horizon Europe. Missions will be implemented in part by R&I partnerships, which in return need to be selected, implemented, monitored and phased-out in a coherent manner.

For both missions and partnerships, the Member States are facing the task of setting priorities in the light of their own research and innovation capacity, but even more in the light of their sectoral needs. Austria will only be successful in the European Research Area of tomorrow if it goes beyond the comfort zone of its "usual suspects", such as universities, research laboratories, and R&I-intensive enterprises. It needs to reach out to new players in sectors like health, food, urban development, or agriculture. It needs to establish a national process of co-creation and co-prioritisation of missions and partnerships, and it needs to use the future strategic coordinating process with the European Commission in a mutually fruitful way. Europe as a whole and the Member States individually shall benefit from research and innovation in the European Research Area post-2020.

The future of ERA

In spring 2019, Austria will create a new working group on "EU missions" in view of the next RTI strategy of the Austrian government. It takes a bow to the changing ERA landscape. This is a first step into the future of ERA. When I look into the mirror of ERA, I see plenty of opportunities for Austria. Let's embrace the ERA of tomorrow. ■

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Ralph J. Poole: Becoming a gender-queer researcher

Professor Ralph J. Poole, University of Salzburg, opens up about his career as a gender-queer researcher, here

When it comes to gender studies, I was fortunate. In the late 1980s, I started writing my MA thesis right at the point when feminist theory had hit the American Studies Institute at Munich's university full force. Women's studies were 'in the air' and I took deep breaths. My thesis was on Margaret Atwood, and I chose a feminist psychoanalytic angle to discuss eating disorders in her work. Anorexia, bulimia and the like were strongly discussed as syndromes particularly relating to the female body, and hence instead of Freud and Lacan and their focus on the father, I rather turned to theorists who emphasised the mother such as Anna Freud, Melanie Klein, Nancy Chodorow, and Jessica Benjamin, as well as the French Feminists Julia Kristeva, Hélène Cixous, and Luce Irigaray, all of which not only revised and expanded Freud's theories but put psychoanalysis and their founding fathers on the couch.

At the time, I was not even considering an academic career, but the inauguration of a graduate school at the University of Munich dedicated to the study of gender and literature, revolutionary in Germany in 1991, lured me into applying for a scholarship and starting work on a PhD thesis in gender studies. A paradigmatic shift was on its way, from women's to gender studies, and at least for me and many of my colleagues there and then the publication of Judith Butler's *Gender Trouble* felt like a lightning rod. We all were electrified by her understanding of gender as a category both performative and subversive.

Critiquing the idea of gender that relies on a universal notion of *the woman* (or of *the man*, for that matter), Butler wished to destabilise and denaturalise our habitualised belief in binary gender categories. My thesis turned into a book on *Performing Bodies: Transgressions of Gender in the Theater of the Avantgarde* (1995), and it grounds on Butler's rejection of viewing gender differences as biologically given but as being effects of contingent social practices, instead, which ultimately can be reworked and resignified. In researching gender-defying bodies on the theatrical stage of Gertrude Stein and Robert Wilson, for example, I had moved into the realm of the then new and hot academic craze: queer theory. But my shift did not come without costs.

Queer switches

Many feminist scholars have bemoaned the switch to the 'playfulness' of the highly theoretical post-structuralist streak of gender and queer studies, claiming an abandonment of the politics of feminism and thus, of the fight against systemic patriarchal oppression (an argument revivified in the recent #MeToo movement and the worldwide women's marches). My own understanding was quite different. In the 1990s, I shared with theorists such as Eve Sedgwick, Michael Warner and Lee Edelman the feeling that the recuperation of the once derogatory term "queer" signified defiance and empowerment.

> "Experiences of being actively discriminated in both my personal and academic life stand opposed to representing the patriarchal elite, and thus I find myself thrown back to a rigid gender system totally at odds with the research being done producing radical theories of the transgressiveness of gender and queerness."

Moreover, as an umbrella term it was meant to encompass various culturally marginalised sexual identities (gay, lesbian, bisexual, transsexual, butch/femme, etc.) and as a critical concept it suggested standing against heteronormative culture, especially in view of the ongoing AIDS pandemic with movements such as *Queer Nation* raising voices against the bashings of queers.

Trying to ascertain my own gender-queer space within academia, I found myself stuck in a perhaps not surprising, but clearly uncomfortable dilemma: as a gay-identified young gender studies scholar, I was competing for university positions against female colleagues. While I lost this competition for a long time, being invited for job interviews only as "the token male", even today I find myself often the only male in a group of otherwise like-minded

females. Except for my own 'queerness', which consistently allocates a marginal position to my academic standing, I am made to perceive myself as a white privileged male.

Experiences of being actively discriminated in both my personal and academic life stand opposed to representing the patriarchal elite, and thus I find myself thrown back to a rigid gender system totally at odds with the research being done producing radical theories of the transgressiveness of gender and queerness. I was the only male in the inaugurating board of the Gender Studies Association Austria (2012-14), I remain the only male researcher in our Salzburg university's Interdisciplinary Expert Council for Gender Studies, and I am the only male supervisor in our university's doctorate school "gender_transcultural". Besides such representational functions and the discriminatory set-backs, it is gender-queer research that I keep being invested in, and two current projects should exemplify my ongoing quest.

Blind spots in research I: Sexualized violence against males

One of my recent research foci emerging from gender studies workshops at Salzburg University has been to tackle the issue of sexualised violence against males as represented in film and television. With the scandals surrounding the Catholic Church but, in its wake, also other institutional settings including hazing rituals in sports, the blind spot of such abuse has finally started to be addressed. It took a long time for the public, as well as for academia to recognise that boys and men can be victims of such violence as well. For at least thirty years, feminist theory on sexualised violence has produced an immense bulk of studies. Research especially on rape, however, has often been declared a 'women's issue.'

Part of the reluctance of feminist critics to acknowledge and research sexualised violence against males is the lasting myth that 'real' men can't be raped. According to this gender bias, male rapes have often not been recorded, and it needed the change of laws in countries such as the UK and the U.S. to even acknowledge anal and oral rape as crimes. In turn, film and television productions from *Deliverance* and *Cruising* to *CSI* and *Mysterious Skin* have picked up practices of male-on-male violence, and my research shows that they have done so with at times astonishing degrees of critically challenging representations of such undocumented and illicit violence.

Blind spots in research II: Mobilising transgender

Looking at the fashion world and media celebrities, it has recently been noticeable that female transgender icons such as Laverne Cox and Caitlyn Jenner are hailed and criticised for displaying a hyperbolic performance of femininity. Conversely, transmale models face a radically different dilemma: the public's curiosity to know what their body really looks like. Critics have called this "junk politics" by basically assigning transmales a deficient genital status. Our society's neoliberal dynamics trick trans* people into confessing their transition stories – ideally with revealing images attached – only to then judge about the success or failure of adhering to optimised gender expectations. But transmale subcultures have turned to rescript and resignify such expectations by successfully posing as sports jocks (Aydian Dowling) and underwear models (Laith Ashely), visually highlighting surgical alterations, and even showing-off detachable prostheses.

Clearly, not every trans* person wants to be considered the avant-garde of gender fluidity, but some do explicitly disengage from normative body images. And this seems even more imperative in times like ours, when politicians aim to thwart trans* rights again by resorting back to defining gender as biologically established at birth. #WeWontBeErased is but one reaction to mobilise publics to take note of gender diversity, gender-queer research is another. For me, it has been a long way to professionally acknowledge belonging to the LGBTIQ* community, but becoming a gender-queer researcher continues to be rewarding in many ways.

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Research and science: Life insurance for Europe in an era of globalisation

Dr Paul Rübig MEP from the Scientific Committee of the European Parliament (STOA) states the case for research and science as forms of life insurance for Europe in an era of globalisation

One of the most important levers for making Europe competitive in globalisation is research policy. In addition to innovation, labour market flexibility, the performance of the economy and reducing bureaucracy, science and research are Europe's life insurance in the face of globalisation.

If Europe wants to have a strong voice in the world in 50 years, we have to be at the top in science and research. Within European Parliament STOA, this is the Scientific Committee of the European Parliament, deals with all questions around research, technology and innovative developments in health or digitalisation.

For me as long-term Chairman and now 1st Vice-Chairman of STOA it was always important to advocate better networking and the utilisation of research results at European level.

The silos of knowledge are already well filled and we need to do more so that research results can be better structured and used by the general public. This means that Europe has to use and connect its pipes better to transfer this knowledge in an optimal way.

However, scientific excellence does not come from political speeches, but from the right framework and the funding of the right projects.

I am pleased that it has been possible to establish consensus between EU Member States and the EU Parliament to make more EU funds available for research from 2017 to 2020, among other things.

Through reallocation and prioritisation, a total of €6 billion will be reallocated over the next two and a half years, with a particular emphasis on increasing COSME, the EU's small and medium-sized enterprise development programme, and the Erasmus exchange programme for young entrepreneurs.

The joint statement by the Council and Parliament adopted by the EU Parliament provides that, among other things, €1.2 billion will be made available for the Youth Employment Initiative and €0.9 billion for transport infrastructure, research programmes, SME grants and the Erasmus programmes become. This concerns the remaining time of the current multiannual financial framework 2014-2020.

More budget for research and innovation is an investment in the future and it is crucial that we drive the research and development of new key technologies: micro- and nanoelectronics, nanotechnology, biotechnology, new materials, photonics, artificial intelligence (AI), quantum computing and communication have great potential for the European economy and society. And we need a focus on innovation, to translate ideas in the lab faster into marketable solutions, and the new European Innovation Council is designed to help innovators, inventors, and start-ups do just that.

Europe still lags far behind rivals in the U.S. and Asia in the development and use of supercomputers.

The joint venture, which was approved by European Parliament and the Member States in 2018, will be based in Luxembourg and, on the one hand, acquire and operate supercomputers that can carry out ten quadrillion calculations per second. On the other hand, new European technology for high-performance computers is to be developed. Currently, 20 states are involved in the project.

Supercomputers create clear European added value and are a good example of where cooperation at Euro-

Dr Paul Rübig MEP

Image: © EVP_MartinLahousse

pean level pays off. This initiative provides Europe's science and industry with access to supercomputers and data infrastructure at a high level, which is critical to the development of digitisation in production, logistics, climate research, energy, cybersecurity, new forms of medicine and many other areas.

By 2023, Europe is to become one of the world's leading supercomputing powers. The joint venture has a budget of just under €1 billion. €486 million come from the EU budget, again as much as the Member States. This should ensure the operation until 2026.

Currently, six of the world's top 10 fastest supercomputers, including the fastest, are in the U.S., two with the global number two in China and one in Japan. Europe is only ranked sixth by Switzerland.

Last but not least I am convinced that research policy is also the best social policy. Research and innovation lead to better technologies, products, and services. It is a boost for the economy that creates good jobs and increases the wealth of society and releases the labour market. Innovation also generates more tax money that the state can use for its social security net to support those who need our help. ■

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The challenges of optical system design for modern optical technologies

Toralf Scharf, Senior Scientist/Faculty Member at École polytechnique fédérale de Lausanne (EPFL) enlightens us on the challenges present when it comes to optical system design for modern optical technologies

Looking at the scientific community today, one gets the impression that optical system design starts a new era driven by the latest developments in information technology. In many discussions, the impact of design concepts based on artificial intelligence (AI), learning and big data are the main subjects raised. And indeed, such concepts will revolutionise the world of optical applications. But what will be the impact of optical design? Do we still need to understand optics to engineer a complex system or is the software doing all the work for us by creating unconventional solutions that we never thought of? To understand the value of optical system design based in conventional methods, one must have a closer look at how problems are treated by utilising standard learning approaches in computer science.

A first thing to consider is the data volume, as well as the related information content. It is evident that in many situations, too much data is acquired to solve the problem and it is, therefore, very difficult to define how much information is really needed to treat a problem to satisfy the needs of the application. In optical design, the usual approach is to use selected or a spare array of rays, limited fields or specific aberration parameters and disregard other effects for the required optimisation.

When it comes to the approach of big data, this will be managed on a different level as more parameters can be introduced and sparse information processing and related optimisation algorithms might lead to faster results for a specific situation. Certainly, using more parameters will nevertheless not change the principle approach of an optical system design based on physical principles. This can only be done when learning approaches are introduced, based on feeding learning algorithms with information to learn. An essential input is the ground truth that still needs to be provided either by basic principles or measurements of the highest quality. The machine learning algorithms use ground truth that has to be highly accurate for training purposes. Without such input information, the proper objective cannot be found. Providing ground truth is one of the major tenets of keeping the conventional optical design in operation, as it allows predictable and traceable design schemes, which together are an essential demand to measure ground truth data. For optical design, there are two cases that are important: Machine learning based on commonly accepted standards (such as a point is imaged to appoint in a perfect optical system) or learning of functions based on examples, such as automated recognition of features and objects (for instance cancer cells in microscope images). While the first case touches the optical design principles itself, the second does not and only uses redundancy in data to process information for a selected application. A generalisation of such an approach that tunes systems for a certain application for general optics design will not be fruitful or possible. The more interesting case to be discussed is when one tries to introduce machine learning in optical system design based on basic principles. So far, the step to this level is not done which might have different reasons. A machine learning model has difficulties to answer questions for its robustness and content, reproducibility and integrity, as well as precision and complexity. While analytical models allow you to determine what happens outside of your ground truth data, a machine learning algorithm will not allow such conclusions easily. Once an answer to a problem is found by learning, will there be a way to understand what and how the system has done the design? When does one reach the complexity limit when the data infrastructure to treat the problem gets so heavy that an analytical design might be easier found? How can one control tolerancing? Such questions need to be carefully investigated before a relievable scheme of optical design with learning can be established.

Machine learning for selected applications in optics nevertheless develops extremely fast and will be the standard of optical sensing very soon. But this is not optical design. It is the application of machine learning algorithms to problems, which have a high redundancy of information that can be neglected for the specific objectives. This approach will change the world in the sense that very cheap devices will flood the markets and allow extensive use of optics in applications that were only accessible with expensive specialised equipment previously. Now, expensive equipment is only needed to define the ground truth, measurement and evaluation for the selected objective which can be done with a simple system.

For machine learning in optical system design, the path will be less clear. This is also determined by the problem that fabrication specifications and realisation limitations have always been and need to be part of the design process. The compatibility of analogue values with digital sampling is not always easy to manage. In analogue fabrication, a major problem is the impact of the response curve of materials that is of course not binary.

What then is expected in the future for modern techniques in optical design? Within a short timeframe, machine learning will take over the field of optical application and sensing. Partially, this has already been done as we can extract today much more information out of images and illuminated scenes than we could a few years ago. The proof is depth recognition algorithms, based on single images or face recognition devices based on point cloud projection. This trend will continue toward

Toralf Scharf

sensing in biology and medicine. However, the optical design of such a system is based on conventional techniques and does not use machine learning. The second step will be the application of machine learning in optical design. Already today, complex algorithms are used to treat problems with higher dimensionality and the tendency is clear: find optimal solutions with machine learning. Digital optics will be the door opener to this field and first examples show that tremendous increase in complexity can be handled when new tools for electromagnetic field calculation, when such an adjoint field method is applied, for instance. Examples for diffractive optics, based on metasurfaces start to appear. The optimisation, however, needs more attention and will probably mainly profit from the application of learning algorithms. For analogue optics design, the situation is different. Raytrace methods of today are already a kind of sparse data technology as they use only selected information (rays) for optical design. It will be interesting to see in which direction research and application will push and what the first example will be that might lead one outside of the conventional design space. What concerns fabrication, the technology of freeform surfaces is ready to be applied to any challenging situation.

Toralf Scharf focuses his research activities at the École polytechnique fédérale de Lausanne on interdisciplinary subjects bringing micro-system, material technology and optics together. With a background in surface physics (MSc), physical chemistry (PhD) and a profound experience in optics he is familiar with all necessary aspects of technology development and application and can communicate with different scientific communities. In over 20 years of project execution with industry and governmental organisations, he has accumulated the right experience to lead and execute the project at different levels.

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Science and innovation: Vital for the future of Europe

Carlos Moedas, Commissioner for Research, Science and Innovation believes that science and innovation are vital for the future of Europe, more of which is detailed here

Carlos Moedas, Commissioner for Research, Science and Innovation has a number of important responsibilities. One is promoting the international excellence of the research and science in the European Union (EU), as well as strengthening research capacities and innovation across all Member States. Another is ensuring that research funding programmes, in particular, Horizon 2020, contribute to the European Commission's jobs, growth and investment package.

In addition, it is worth mentioning that Commissioner Moedas is also responsible for evaluating how EU-funded research can be used in a more effective way and ensuring that proposals by the European Commission are based on scientific evidence. A way in which the many challenges faced by society can be met is to encourage private companies to apply research in this direction, and also creates more high-quality jobs.[1]

Clean energy technologies

An example of the latter point can be found when in early October 2018, when the European Commission and Breakthrough Energy signed a Memorandum of Understanding to establish Breakthrough Energy Europe (BEE). In essence, this is a joint investment fund to assist innovative European companies develop and bring to the market radically new clean energy technologies.

Commissioner Carlos Moedas comments on the benefits of the BEE: "We are delivering on our commitment to stimulate public-private cooperation in financing clean energy innovation. The €100 million fund will target EU innovators and companies with the potential to achieve significant and lasting reductions in greenhouse gas emissions."[2]

Science and innovation

In a lecture at Sciences Po on 6th December 2018, Commissioner Moedas says that science and innovation are very important subjects for politicians today. He believes that these topics are vital for the future of Europe, not only for scientists and innovators but also for the decision-makers of the future. Moedas then explains the link between a wider aim of the European Commission detailed at the beginning of this article and the policy area of science itself: "Jobs and growth are impossible without science at the centre of political priorities. They are about the direction that Europe will take in the future"

> "Right now, disruptive, market-creating innovation, has the greatest potential for growth in Europe. We should be investing in it. That's exactly what we are trying to do with the European Innovation Council. But Europe needs to do more."

Moedas then underlines that in Europe, politics and science and innovation should work in the same way, by which he means they should strengthen each other to create the best outcome. In the view of Moedas, there are three changes needed for the science and innovation landscape in the future, which are: (i) To increase collaboration; (ii) more work at the intersection of disciplines and; (iii) more disruptive innovation.

The intersection of disciplines

Let's take a look at one of those three areas, the intersection of disciplines. During the past, people were classically trained in disciplines, for example, you could be a physicist or a geologist. Moedas strongly believes the intersection of disciplines is where the magic happens. He cites the example of Tu Youyou who won the Nobel Prize for Medicine for her discovery of Artemisinin, a drug to fight malaria a few years ago. She had no medical degree, no doctorate and had never worked abroad Moedas explains before offering his further thoughts on the work of this remarkable scientist.

Carlos Moedas, Commissioner for Research, Science and Innovation

"She's possibly the furthest idea of what we imagine when we think of a Nobel Prize winning scientist.

> "Right now, disruptive, market-creating innovation, has the greatest potential for growth in Europe. We should be investing in it. That's exactly what we are trying to do with the European Innovation Council. But Europe needs to do more."

"So how did she do it? She worked at the boundaries of different disciplines. She pored over ancient Chinese texts and historical documents. And one day she found a reference to one substance, sweet wormwood, that had been used in China almost 2,000 years ago to fight malaria. That's what led to her breakthrough."

So, in the view of Moedas, working at the intersection of disciplines means for most people, taking a step outside their comfort zone. Certainly, for Tu Youyou, ancient Chinese literature led her and the world to one of the most significant breakthroughs of this century. Such an approach should be the rule, not the exception, Moedas notes.

In a High Level Conference: Sustainable and Circular Bioeconomy, the European Way, Brussels on 19 October 2018, Moedas draws our attention to the fact that the light bulb is now 139 years old and takes us back to the time when Thomas Edison and his team created the first commercial incandescent light bulb. "To build it Edison needed a team of people from all areas: a physicist, a machinist, an engineer, a carpenter, a glass blower, a blacksmith." It struck me that an intersection of disciplines was very much present in this example of an invention that has had an enormous impact on society.[3]

Disruptive innovation

Let's take a look at another one of those three areas, disruptive innovation, which relates to my earlier point about the invention of the light bulb. In his speech, Moedas notes that incremental innovation benefits Europe daily but highlights that these technologies are not delivering on their promise of gains in productivity for Europe. Moedas calls for Europe to reconnect innovation and productivity by multiplying its impact, which can be achieved by disruptive innovation. Moedas then

Continued on page 199 →

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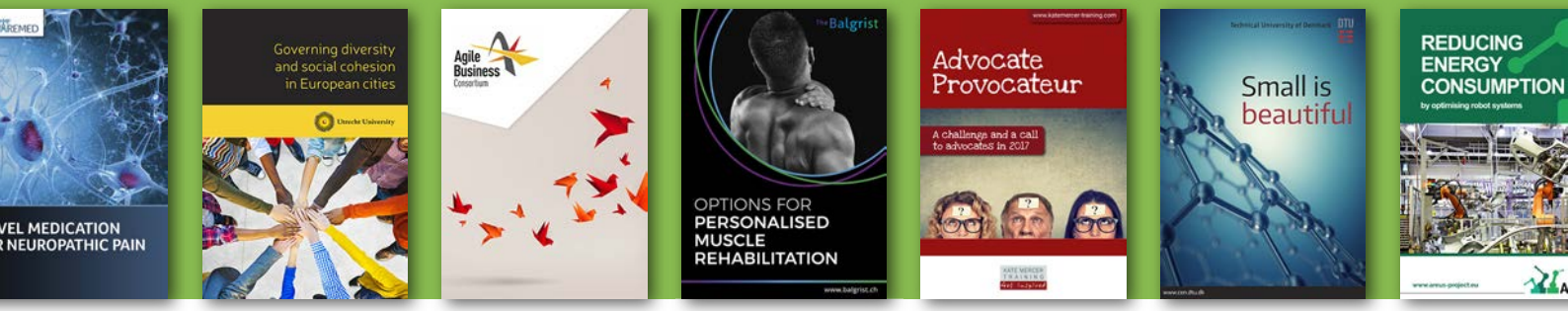

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← *Continued from page 197*

provides more detail about what he means by disruptive innovation, asking us to think about electrification, which early last century was one of the most disruptive technologies to be discovered. This was not just because it made factories much more productive but it had a knock-on effect that completely revolutionised the industry, Moedas notes.

"Think of it like this: before, manufacturers had to rely on steam engines. But with electrical motors, it meant fewer inputs for a much higher energy output. And of course this was a positive outcome.

"Before, a single massive steam engine powered a factory. With electricity, people could target power more precisely. For the first time, it was efficient to have a series of small motors, and this created the production lines. That led to the architecture of the space being changed. Wires meant that work stations could be placed anywhere.

"And the speed of the production process also completely changed. It was no longer determined by the steam engine but by the workers themselves. Factories could get their goods out to the market far quicker than their rivals. So they were more competitive. So when you take all of these changes into account, the entire ecosystem was disrupted.

"Right now, disruptive, market-creating innovation, has the greatest potential for growth in Europe. We should be investing in it. That's exactly what we are trying to do with the European Innovation Council. But Europe needs to do more."

Changing the way we educate in Europe

Moedas concludes the lecture he gave at Sciences Po on 6th December 2018, by explaining that changes in the science and innovation ecosystem of Europe can only happen if we shift our way of thinking and working. Certainly, such a shift can only be achieved if we change how we educate, something that implies a political change in society. Moedas then details precisely how Europe's future is intrinsically linked to the future of science and innovation. Having said that, the trends now being seeing now mean that a shift in how we understand education in society is very much needed. Education is an incredibly powerful tool and during the 1870s, France emerged out of war into a new world, Moedas notes.

"It was the time for a change in how each successive generation of politicians learned. Because there those at the time knew that there was a shift in society, and that shift demanded a new way of teaching French politicians and diplomats in order to secure a strong future."

Moedas says that education held the power to create a shift in society and that today, the same is needed from future political decision-makers.[4] As we have seen in this article, science and innovation are vital topics for the scientists, innovators and decision-makers of the future. Innovations such as the light bulb changed the world and future innovations could have the same impact but making sure we use the powerful tool of education is vital in such endeavours. ■

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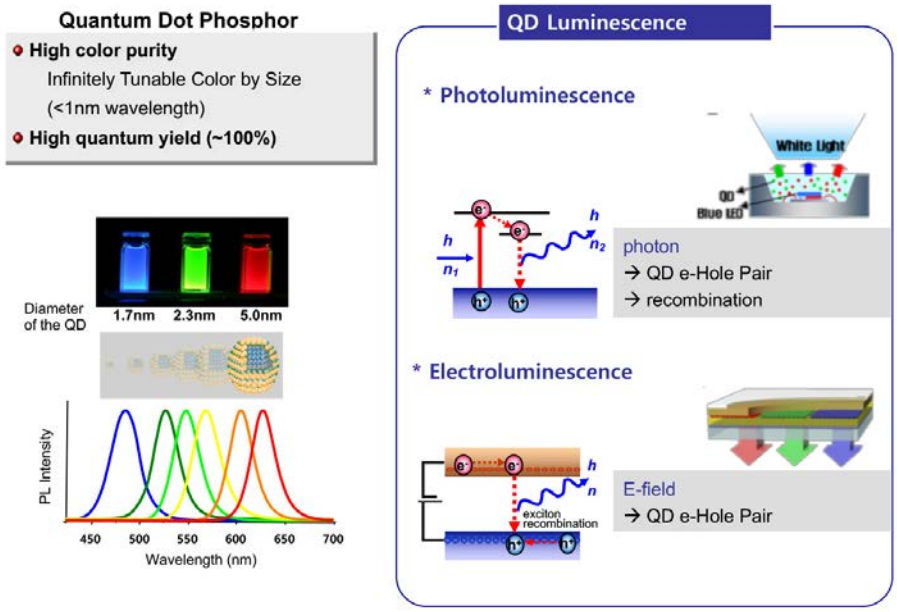
Nanotechnology: Colloidal Quantum Dots for next-generation displays and smart lighting

Luigi G. Occhipinti and Jong Min Kim from the Department of Engineering, University of Cambridge, explain an exciting aspect of nanotechnology that concerns the emergence of quantum dot-based technology for next-generation smart lighting and displays

Colloidal quantum dots (cQD) have emerged over the past decade from lab curiosities to a multi-billion-dollar component market enabled by these optoelectronic materials. It is one of the most relevant success stories of nanotechnology, where the bottom-up design of nanoscale materials influences and determines the success of macro-scale device applications across multiple sectors.



Since their discovery, Quantum Dots (QD)s have featured in a range of optoelectronic devices, including TVs and displays, light-emitting devices (LEDs), solar cells, photodiodes, thermoelectrics, photoconductors and field-effect transistors, while QD solutions have been used in a number of *in vivo* and *in vitro* sensing and labelling techniques for medical imaging.

Professor Kim's team at Samsung demonstrated the first back-lit cQD-based display device in 2006 and 2010 [Photo luminescent (PL) mode], followed by application to new displays and lighting [Electro luminescent mode (EL)] in 2009, 2011, and 2013. The cQD backlight unit for LCD displays is now in the market under the brand name of Samsung Quantum Dot displays (Samsung SUHD TV), introduced in 2015.

The global QD-based products market will be potentially valued at more than $35 billion by 2030, according to major market analysts, with the high definition TV displays dominating the end user segment for QD-based products. According to Markit, worldwide sales in TV market are dominated by quantum dot LED with 2.687 million TV sets sold in 2018, versus 2.514 million for OLED TV sets, and projected to exceed 4 million QLED units in 2019 versus 3.6 million units of OLED.

Also in the photovoltaic energy generation sector, the use of QDs to improve the conversion efficiency has generated opportunities for several pioneering research groups and companies to attract multi-million dollar investments.

Among the main academic groups developing science and technology on quantum dots, the University of Cambridge has active research programmes and engagement activities supporting future evolution of these unique nanotechnology materials and their applications.

The Cambridge University Engineering Department (CUED) is the largest university science or engineering department in the UK; in the 2014 Research Excellent Framework, 53% of research was rated 4* and another 42% rated 3*.

Science and technological innovation on colloidal quantum dots (cQD) have the potential to increase energy efficiency in visual and lighting systems while also enabling new paradigms of

Luigi G. Occhipinti

Jong Min Kim

functionality. The study of cQD is an interdisciplinary field of physics, chemistry, materials science, and engineering.

For instance, in the EPSRC-funded project SmartQD (Smart Quantum Dot Lighting, EP/P027628/1), the group led by Prof. Kim (Principal Investigator) and Dr Occhipinti (Co-Investigator), among others, is working in collaboration with their industrial and academic partners to design and develop new environmentally friendly non-toxic cQD scalable materials, and to advance their manufacturing processes and device fabrication tools toward next-generation smart lighting applications.

As for QLED technology application in displays, the superior colour purity and brightness that photoluminescent (PL) cQD offer compared to traditional phosphors and OLED, is positioned to bring disruptive innovation in the lighting market.

Additionally, cQD-based lighting benefits significantly from the intrinsic reliability of their inorganic material structure, which reduces the need for air barrier layers with low WVTR (water vapour transmission ratio).

This is associated with lower materials production costs of cQDs and their monolayer deposition methods based on the nano-transfer printing capability, towards the next generation of sustainable lighting technologies.

In SmartQD, the investigators expect that cQD LED may complement or replace current technologies for smart lighting thanks to their unique characteristics of: i) High colour purity with narrow emission (absorption) bandwidths, ii) Colour tunability/band-gap engineering through size control, iii) High photostability and lifetime.

The SmartQD team at CUED has broad experience in nanomaterials synthesis and scalable manufacturing, including cQD, organic and 2D materials, to address enhancement of state-of-the-art materials and to achieve cost reduction in manufacturing by using continuous, as opposed to batch, cQD synthesis, monolayer resin-free processing, along with device integration and packaging for general and smart lighting applications.

Design and prototype development of cost-effective cQD LED lighting devices that can be manufactured on flexible substrates and controlled through an active matrix driver to implement smart aesthetic features will be produced and showcased.

Meanwhile, the engineering research focuses on the manufacturing and processing aspects to create mono layer-controlled cQD films with entire close-packed and almost void-free structure using dry-transfer printing methods. This will enhance the efficiency and reliability of the optoelectronic film for optimal performance of EL cQD active devices.

Interface control based on a layer-by-layer transfer process will be employed in order to obtain highly uniform monolayers which can be expanded to multilayer stacked film processing including interface layers. The mass production of high-quality cQD with high photoluminescence quantum yield is critical to achieving the proposed target.

Cd-free cQD materials have been also demonstrated by major suppliers of QDs such as Nanoco (UK), Nanosys, QD Vision (US), and Merck (Germany), who are among major producers in bulk, of Cd-free cQDs for backlight application in LCD displays. Besides Samsung, other device manufacturers and system integrators such as LG, Sony, TLC, HiSense have also demonstrated cQD back-lit units for LCD displays.

The manufacturing technologies investigated at CUED in SmartQD are expected to create additional markets for cQD based companies in the materials, film component, process and equipment, and lighting device market sectors.

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Futureproof? Preparing for a data-driven future

Alison Kennedy, Director of the Science and Technology Facilities Council' s Hartree Centre, discusses the priorities organisations must address to enable UK industry to thrive and prepare for future advances in computing

It is widely recognised that advances in high-performance computing and its associated digital technologies have delivered huge economic benefits for UK businesses. Just looking at our own project portfolio at the Hartree Centre, we can offer numerous examples of industry benefitting from the competitive advantage and new insights generated by adopting advanced computing and data-driven technologies, from faster shampoo formulation and low-cost virtual wind tunnel testing to more accurate pest-risk prediction and efficient healthcare chatbots.

But to date this is the tip of the iceberg – work with early adopters that has enabled us to prove the concept. Widespread adoption is not yet the norm. In some fields, such as traditional manufacturing, public sector healthcare or food and agriculture, there are still barriers to the adoption of data-driven technologies to futureproof operations and improve product and service quality.

Maximising data potential: Fail to prepare, prepare to fail

So how can companies yet to fully embrace data-driven working practices prepare themselves? To begin with, I cannot emphasise enough how important it is for companies to consider their digital transformation strategy. The first steps are to take a good look at how they collect and store data, and take steps to improve its accuracy and infrastructure. Data quality matters. The quantity of data which companies hold can be extensive, but according to our experience in collaborative big data projects, the reliability and quality of the data is often disappointing. There is often little correlation between the data which could be usefully analysed to deliver business benefits.

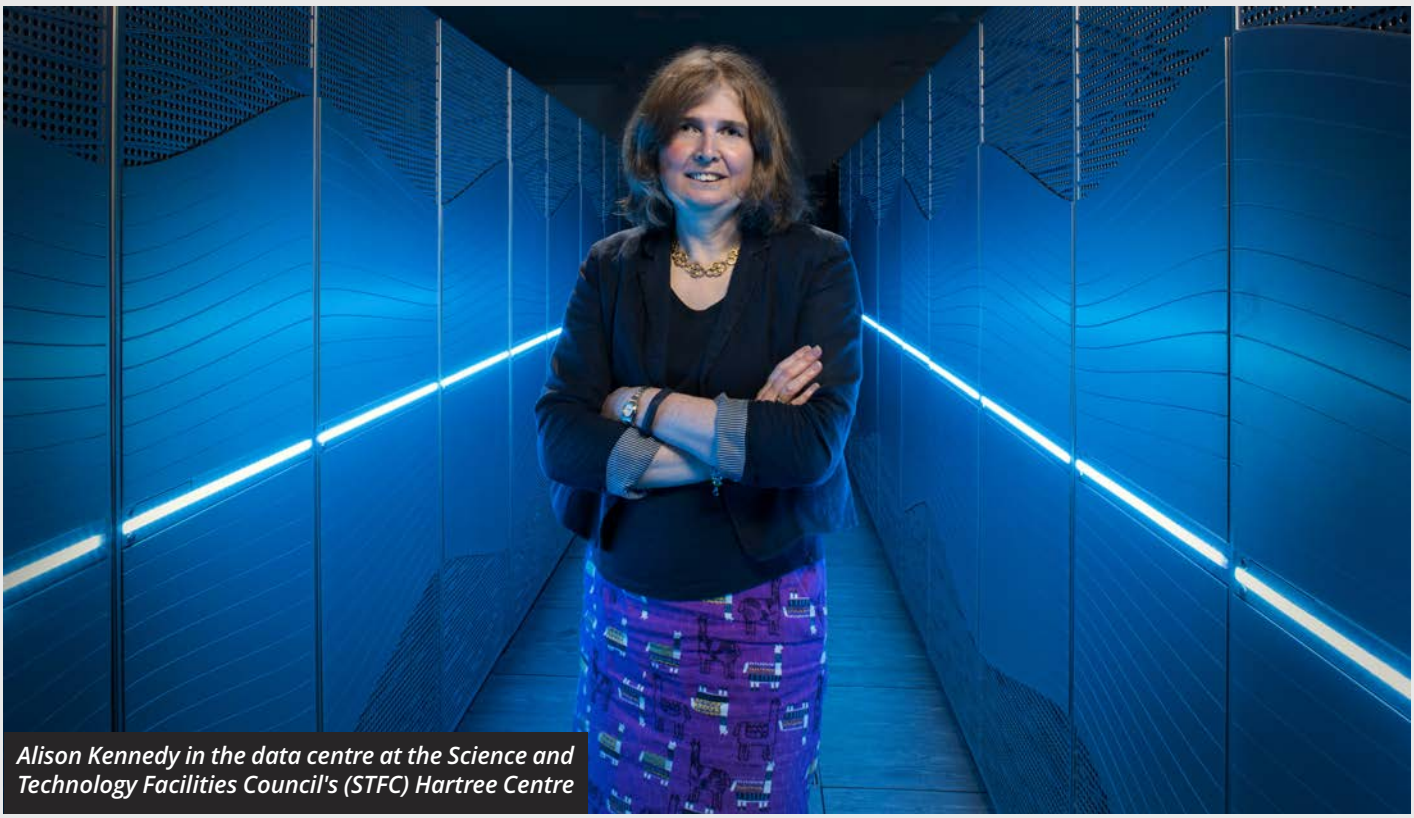
Clean, accurate data can provide unprecedented insights, but companies need to invest in their data collection, handling and quality control processes to gain the maximum value from it.

Securing digital skills are the key to success

There is also work to be done in preparing and upskilling the current workforce. In recent years we have seen the emphasis on digital skills assume greater importance within the UK Government and this has had a trickle-down effect on school curricula and higher education offerings. Coding is becoming one of the skills seen as essential for future generations, no matter their career aspirations.

At the Hartree Centre, we do our best to support and accelerate this digital upskilling process, providing high quality, experience-based training and skills opportunities in key areas of advancement and interest, from our recent "Introduction to Chatbots" workshop for beginners to more in-depth Deep Learning training for PhD-level researchers.

We are also supporting several Centres for Doctoral Training (CDTs) in collaboration with UK universities, focussed on key areas, such as distributed algorithms and data, risk and environmental analytical methods. We can, however, only support these activities where capacity and funding allows and appropriate opportunities present themselves. Training opportunities will only be taken up by organisations willing to invest in their staff and embrace change with a positive can-do attitude – but by the same token, governmental and public sector investment is also key to supporting businesses on this journey.



Alison Kennedy in the data centre at the Science and Technology Facilities Council's (STFC) Hartree Centre

Another question is how to address the "missed generation" – those too old to have been taught programming skills during their school days, but too young to be leaving the workforce any time soon. Companies are missing a trick if they do not retrain and equip mid-career employees with the new skills needed to succeed in an ever-more digital climate.

What does the future hold?

Computing is a field which accelerates and advances at an unprecedented pace. Current research is focussed on Exascale computing, to overcome the many technology challenges needed to deliver super-computers one thousand times more powerful than the ones that we have today. Such unprecedented computing power will allow us to work on previously intractable problems using a combination of simulation and modelling, high-performance data analytics, artificial intelligence (AI) and machine learning. This will enable advances in precision medicine, green energy, autonomous vehicle design and a whole host of other areas. This research is being fuelled by the exponential growth of data being generated and processed.

One of the most exciting new technologies that we are working on is quantum computing. At this early stage, no one knows what the future of quantum computing will truly look like – but at the Hartree Centre, we have taken steps, in partnership with Atos, to provide a quantum learning environment to help UK businesses de-risk proof of concept work and innovation in this area. By working with organisations like us, to develop their algorithms in a safe environment, and to understand where quantum computing could potentially deliver disruptive change to business models, meaning they can secure products and services for the future. ■

The Hartree Centre is a department within the Science and Technology Facilities Council (STFC), which is part of UK Research and Innovation. We help UK companies to generate economic impact and improve the productivity of people and processes through advanced digital technologies such as high-performance computing (HPC), big data analytics and AI.

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Co-location data centres and privacy regulations

What do you need to consider as a customer when it comes to co-location data centres and privacy regulations? Green Mountain Data Centres Ltd tell us more

As a data centre, we are used to answering a number of questions from our potential and existing customers. The questions traditionally concern power, cooling, sustainability, connectivity, and physical security measures, but lately more and more people ask us about privacy regulations as well. The introduction of the General Data Protection Regulation (GDPR) in European Union (EU) in 2018, and it's potential €20 million[1] penalties for breach, have made companies very focused on being GDPR compliant. So how does GDPR affect your company if you trust a co-location data centre to store your data?

Where does the GDPR apply?

Let's start with the basics – what is GDPR and where does it apply? In simple terms, GDPR gives people more control over their data and businesses benefit from a level playing field. The GDPR not only applies to organisations located within the EU but also to organisations located outside of the EU if they offer goods or services to or monitor the behaviour of EU data subjects.

But what about Norway, which is not a part of the EU? Having our data centres in Norway makes no difference. Norway is a member of the European Economic Area (EEA) which means we are also subject to the GDPR regulation and have also incorporated it in our own national privacy regulations. To conclude, if you store personal data on servers in data centres in Norway or other EEA member countries or the EU, you are subject to GDPR. Norway not being part of the EU should not be a factor to consider when choosing a data centre location in Europe.

Who is responsible for compliance?

In order to explain this, we have to look closer at two important terms in the regulation – the data controller and the data processor. The data controller determines the purpose of the processing of personal data, in what way it should be done and that data is processed in accordance with the requirements of the GDPR. A data processor processes personal information on behalf of the data controller. The data processor has independent responsibility for having satisfactory information security to protect the personal data. The data processor may only process personal data in accordance with what has been agreed with the data controller.

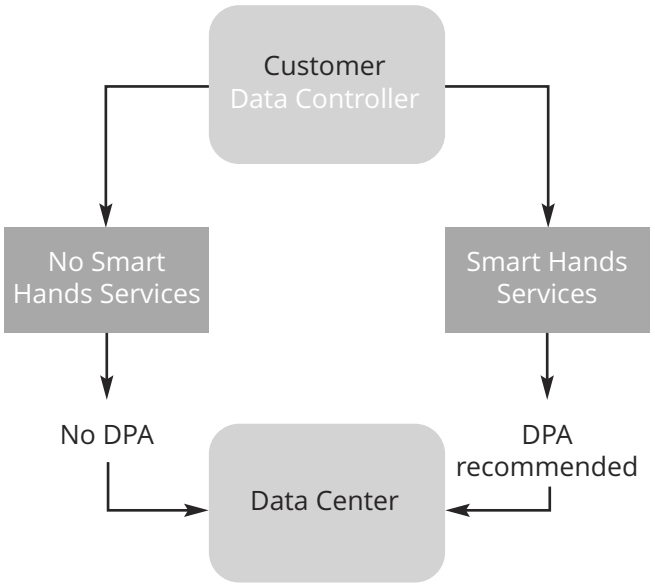
Clients at a co-location data centre can be controllers or processors or both. Some clients are data controllers who have placed their personal data about clients, employees etc. in our centres. Others are data processors, for instance, service providers or cloud companies, who process the data on behalf of multiple customers inside the data centre. The relationship between the data controller and the processor is governed by a Data Processing Agreement (DPA). The data controller is responsible for compliance and must make sure they enter into data processing agreements when necessary.

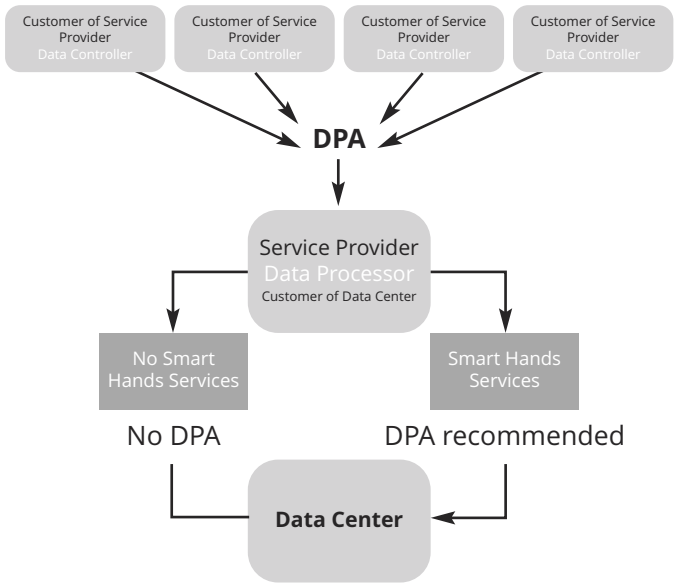
Do you need to sign a DPA with your data centre?

In general, the answer is "no", but there are exceptions. It all depends on what kind of services your data centre performs. The basic offering of a co-location data centre is the IT infrastructure – the space, power, cooling, security, and connectivity. None of which affects the processing of the personal data stored on the customer's servers. Let us look at two different scenarios:

Scenario 1: The client has its own servers and equipment, even its own personnel, and the co-location delivers the infrastructure mentioned earlier. The data centre employees do not even have access to the data rooms unless authorised by the client. In such cases, a DPA is not required, but an ordinary contract between the client and the data centre should cover the requirements relating to securing the infrastructure.

Scenario 2: On the other hand, some data centres, like Green Mountain, offers "Smart Hands" services to their clients. These services may include technical personnel getting access to the server and the possibility to log on. In theory, they would have the possibility to access and process personal data. In that context, a DPA between the parties could be considered.





A GDPR compliant data centre?

The responsibility of handling personal data in compliance with GDPR is in the hands of the data controller. They have to make the right decisions regarding the choice of service/cloud provider or data centre. Knowing that the data centre itself operates in accordance with GDPR would be a trustworthy sign when choosing a data centre partner. As an example, Green Mountain is a data controller of various personal data; we handle personal information regarding our employees, our clients, visitors, and our client's personnel who access the data centre. We use CCTV to monitor the facilities and conduct a strict ID control in order to access the data halls. Green Mountain also needs to be committed to ensuring that these subject's privacy is protected. All our procedures are designed to comply with regulations, and we have conducted a thorough Data Protection Impact Assessment (DPIA) to support it.

What about the Cloud Act? What about Brexit?

Many of Green Mountain's clients are international, and we experience that concerns relating to the U.S. Cloud Act and Brexit are recurring topics. The Cloud Act means that US authorities may require U.S. cloud service providers to disclose data, which may appear to be in direct conflict with parts of GDPR. This issue is currently being debated by the European Data Protection Board. However, this will have a greater impact on data centres owned by the cloud providers themselves. If they use a co-location facility owned by another company, it may be harder to enforce the Cloud Act in the EU and EEA.

The other topic is Brexit; do companies need to be compliant when it is unknown what will happen to GDPR in the UK after Brexit? If a company processes data about individuals in the context of selling goods or services to citizens in other EU countries, then it will need to comply with the GDPR, irrespective as to whether or not the UK retains the GDPR post-Brexit. If activities are limited to the UK, then the position is much less clear. The UK Government has indicated it will implement an equivalent or alternative legal mechanism. The expectation is that any such legislation will largely follow the GDPR, given the support previously provided to the GDPR by the ICO and UK Government as an effective privacy standard, together with the fact that the GDPR provides a clear baseline against which UK business can seek continued access to the EU digital market.

In a data-driven world, the concern for privacy is becoming increasingly important. All organisations handle personal data in some way or another and should place great emphasis on complying with regulations. Having clients that question and challenge us on these topics is a sign that companies take this seriously, in every aspect of their business.

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Industrial, trade and investment cooperation: A new era for the EU and Japan

Masanori Osumi, Japan-side General Manager and Philippe de Taxis du Poët, EU-side General Manager of the EU-Japan Centre for Industrial Cooperation, explain why a new era begins now when it comes to promoting industrial, trade and investment cooperation between the EU and Japan

The EU-Japan Centre for Industrial Cooperation[1] is a joint venture established in 1987 between the European Commission (Directorate General Internal Market, Industry, Entrepreneurship and SMEs) and the Japanese Government (Ministry of Economy, Trade and Industry) for promoting industrial, trade and investment cooperation between the EU and Japan.

With the entry into force of the EU-Japan Economic Partnership Agreement (EPA) on 1st February 2019 creating the largest open trade zone in the world which covers 600 million people, the Centre will contribute ensuring that companies in particular SMEs reap the maximum benefits from the EPA. To this end, we are mobilising several instruments, for example, the EPA helpdesk, public procurement helpdesk, and stakeholders, e.g. Enterprise Europe Network and clusters, to raise awareness, guide and stimulate SMEs.

In this context, the Centre is developing important activities regarding (i) people mobility, (ii) research and innovation, and (iii) technology transfer

- **People mobility** is one of the key elements for strengthening relations at the international level. The Centre has put in place the Vulcanus Programme, a unique internship programme involving industrial placement for European students in Japan,[2] and for Japanese university students in Europe.[3] Co-funded by the host companies and by the Centre, this one-year programme targets engineering or science students. It provides a four-month intensive language course and an eight-month internship in a host company.

- On the EU side, every year, 30–40 motivated Vulcanus participants are selected among 800 applicants to undertake industrial internships at host companies in Japan. In this vein, there is a strong signal of interest and a typical internship project includes mechanical/electrical engineering, computer science, ICT, chemistry, nanotechnology and biotechnology. Besides the technological and industrial dimension, the Vulcanus programme also helps participants gaining an in-depth understanding of culture, history and intercultural communication.

- The EU and Japan both see cooperation **in research and innovation** as necessary to promote the excellence of our research, increase the competitiveness of our industries and effectively address global societal challenges. The Centre is the National Contact Point[4] (NCP) in Japan for the EU research and innovation programme "Horizon 2020". Hence, the Centre raises awareness, disseminates information and calls for proposals, implements activities and training to support and provide guidance to potential R&D applicants in Japan. In close cooperation with the EU Delegation to Japan, NCP Japan provides information and participation support services to Japanese research institutions, companies and universities. Further expansion and development of EU-Japan relationships in science and technology are expected in the future EU research and innovation programme "Horizon Europe", including the possibility for Japan to become an "Associated Country" with this programme.

- The Centre promotes the commercialisation of technologies, and boosts innovation via the EU-Japan **Technology Transfer** Helpdesk,[5] which supports EU and Japanese companies, universities, research centres and individuals in their steps to search for and acquire available proprietary technologies, and better understand the process of tech transfer transactions. All the online services are supported by the official

website of the helpdesk, which provides general content about intellectual property rights, technology transfer, and an ever-growing database with more than 20,000 technologies potentially available for licensing deals, and more than 100 million patent documents and a wealth of information for the benefit of SMEs. Additionally, webinars, videos, podcasts, and presentations are intended to make the helpdesk's website a "must-see-and-use" for implementing open innovation practices. To favour this cross-pollination approach, research institutions can freely create an account and upload their technologies, and companies can write and publish requests for proposals to complement the existing tech offers.

"With the entry into force of the EU-Japan Economic Partnership Agreement (EPA) on 1st February 2019 creating the largest open trade zone in the world which covers 600 million people, the Centre will contribute ensuring that companies in particular SMEs reap the maximum benefits from the EPA."

The Centre also provides a six-month fellowship grant called "Minerva" for experts to work in Japan on topics of interest for researchers and businesses, including particularly creative and innovative ones, such as research into the NewSpace[6] sector in Japan and the potential for collaboration between EU and Japan New-Space start-ups. This will include a Haiku competition[7] to reach out to the public with a view of inspiring them to consider space, the theme being "Improving Life on Earth as in Space" for promoting NewSpace collaboration, by inviting artists, businesses and investors.

The EU-Japan Economic Partnership Agreement (EPA) will simplify trade and investment procedures, reduce export and investment related costs and will, therefore, enable more small firms to do business in both markets. Beyond what it includes, the EPA may also have an important triggering effect to reinforce existing and explore new areas of cooperation, such as research and innovation, space, security, investment, regions and clusters, regulation, digital economy and circular economy. It may also accelerate the current trend for joint EU-Japan business partnerships to operate together in third countries, e.g. South East Asia, Africa, Latin America, EU neighbouring countries. As stressed by the EU-Japan Business Round Table,[8] a "new era for the EU and Japan starts".

Masanori Osumi

Philippe de Taxis du Poët

In a global context with rising protectionism, where walls are being built and with geopolitical uncertainties, the EU-Japan Centre for Industrial Cooperation is also a political signal that the EU and Japan stand together for sustainable cooperation and team up to preserve the benefits of openness, ensure a level-playing field, pursue resilient economies and inclusive society. ■

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Japan: The advancement of world-class research in science

The Japan Society for the Promotion of Science works to ensure the advancement of world-class research in all fields of science both at home and in international partnerships, as this article reveals

Since 1932, the Japan Society for the Promotion of Science (JSPS) has worked to support the advancement of all fields of natural sciences, social sciences and the humanities.

In addition to directly funding scientific research, the JSPS, or Gakushin, fosters talent among young scientists, promotes science-related international exchange and supports the globalisation of Japan's universities.

While guided by the broad framework of government policies to promote science, the JSPS has since 2003, operated as an independent administrative body, allowing its programmes to be more flexible to the needs of individual researchers, universities and institutes.

As part of its aim to create diverse, world-level knowledge, the JSPS oversees the Grants-in-Aid for Scientific Research (KAKENHI) initiative, which supports research across all fields of science with an emphasis on creative and pioneering projects carried out based on researchers' free ideas.

Every year, the KEKENHI programme distributes around ¥228.4 billion, over 50% of Japan's total competitive research funding.

Projects can be proposed by individuals or groups of researchers affiliated with Japanese universities or other research institutions. More than 7,000 researchers carry out a peer review of applications, with funding awarded to those schemes judged to be of high potential and in line with cutting-edge scientific goals.

In order to ensure Japan retains its international position as a leading centre of scientific research in the future, the Ministry of Education, Culture, Sport Science & Technology (MEXT) recommended reform of the KEKENHI system to position academic research as a source of national strength.

A three-pronged reform process is underway looking at the review system in light of the rising number of applications and changing trends, as well as the research categories and frameworks to earmark funding specifically for challenging research, especially promoted research and aid for young scientists.

In addition, greater flexibility has been implemented in the use of grants with the introduction of a multi-year fund that allows researchers to carry over funds into the next fiscal year.

Following a 2012 report by Council for Science & Technology, the JSPS established a programme to contribute to advancing the humanities and social sciences in three key areas: joint research that will yield breakthroughs through close links with other fields of science; joint research aimed at making contributions to society; and international joint research. In 2017, the programme was funded with ¥208 million.

Within the programme, work is carried out in three subsets. Area Cultivation seeks research topics from different scientific fields that can spur unexpected jumps to new areas and more innovative methodologies. The second strand is responding to "Real Society", with collaboration between researchers and working-level specialists, from the planning and implementation of research to the dissemination of results. The final subset concerns global initiatives, which seeks to establish a dialogue between Japanese and overseas researchers to generate globally significant results through joint research.

In 2007, MEXT launched the World Premier International Research Centre Initiative (WPI), which sought to build a top-class research base for "super-calibre" researchers and concentrate funding for Japanese research institutes that work to achieve globally significant science.

In 2017, the ministry issued an open call for proposals for two new WPI centres and established a WPI Academy to promote the programme's work internationally.

MEXT commissioned JSPS to carry out WPI grant selection, perform evaluations and oversee project progress using procedures prescribed by the ministry. JSPS also manages the operation of the WPI Academy and supports the activities of the WPI centres with the aim of optimising the programme's output.

JSPS launched its fourth midterm plan in 2018. It is designed to respond to demands for scientific research to be highlight competitive, comprehensive, interdisciplinary and international.

Dr Yuichiro Anzai, JSPS President, says that when it comes to delivering the plan: "We will undertake to carry out our programs and operations in an ever-more efficient and effective manner toward meeting JSPS's current and new mid-term objectives".

"Concurrently, we will apply the full strength of JSPS's organization to meeting the needs of researchers and students aspiring to careers in science, while working to satisfy the public's multifaceted expectations for benefits derived from scientific advancement", he adds.

"The kind of superlative knowledge that contributes to developing a robust human society is born out of a continuum of original, cutting-edge research activities carried out by researchers ceaselessly striving to advance science across a spectrum of the humanities, social sciences and natural sciences. Such scientific thrust is the engine that drives the international competitiveness of a nation's industry and that elevates its persona within the global community. For Japan, it also plays an essential role in building a knowledge-based society.

"Scientific research lies at the wellspring of superlative knowledge creation. The fostering of talented people who can shoulder the advancement of such cutting-edge research is more important now than ever before." ■

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Chemistry and the archaeology of collagen

Takashi Nakazawa, Professor at Nara Women's University explores some fascinating aspects of chemistry and the archaeology of collagen, as well as a view point expressed on analysing ancient specimens in a collaborative way

Collagen is the most abundant protein occurring in the body of mammals. There are nearly 30 types of collagen, the majority of which are fibrous. Type I collagen has a characteristic architecture of a triple helix consisting of polypeptide chains of two α1 and one α2. This naturally occurring biopolymer is ubiquitous in bones, teeth, and skins of animals, taking advantage of its fibrous structure. The triple helix of collagen is so resistant to ageing that it can often be found in archaeological specimens as old as tens of thousands of years. Consequently, it informs us of the animal species in terms of the respective amino acid sequence, even in the absence of DNA encoding genetic information. We are using mass spectrometry to obtain information of archaeological interest.

Chemistry

As well as its triple-helical structure, collagen has a few unique features including the primary structure such that glycine (G) appears every third residue in the sequence $(G\text{-}X_1\text{-}X_2)_n$ (n > 300). Moreover, the positions X_1 and X_2 are quite frequently occupied by proline (P) or hydroxyproline (many authors abbreviate this residue as O). The post-translational modification of P to O is almost specific to collagen and catalysed by proline hydroxylase just before the formation of the triple helix. It is widely accepted that the content and position of O is closely related to the stability of the collagen triple helix[1]. Before beginning the present study of collagen in archaeological specimens, we were investigating the correlation between the role of O and the stability of the triple helix in solution using collagen model peptides[2]. Since this modification occurs enzymatically, the position of O in the amino acid sequence is not defined in the genetic code, it is very difficult to determine which P residues are modified unless protein sequencing such as Edman degradation or mass spectrometry is conducted on collagen samples.

Archaeology

Our project of protein archaeology with mass spectrometry began about 10 years ago, when we detected cow collagen in Chinese ink stick excavated from the oldest Japanese capital palace site in Nara (Heijyo-Kyo) of the mid-sixth Century AD[3]. Encouraged by such an unexpected success of finding collagen as waste disposal kept in the soil as long as 1,250 years ago, we extended the list of proteins by seeking wider area from Nara to the sites worldwide and older ages. Actually, the age of our specimens became older from the binding media of Egyptian Romano portraits (180-200 AD)[4], Egyptian wall paintings (2,400 BC) to West Asian Neolithic animal bones (5,000-8000 BC). And quite recently, we have been trying to detect collagen in Palaeolithic animal bones (30,000-35,000 BC). It is not surprising that the difficulty of analysis increases as the age of the specimens become older[5]. Nevertheless, we are excited about the challenge of solving this problem by mass spectrometry with the aid of protein chemistry[6].

> "The main target of our project of protein archaeology is collagen. This is because collagen is deeply associated with not only the evolution of animals but also the history of human culture before the invention of letters."

Note that the average lifetime of collagen to survive in archaeological specimens had been estimated to be much less than one million years[7]. It was, therefore, surprising that peptide fragments derived from collagen were found in the fossils of 8-million-year-old dinosaur bones[8]. However, another group has shown the complete match of amino acid sequences of collagen between that of modern ostrich (*Struthio camelus*) bone and those reported as of *Tyrannosaurus and Brachylophosaurus*, suggesting that there remains the possibility of cross-contamination of collagen[9]. In any case, we need to allow for the longevity of collagen, especially in the study of Palaeolithic bones for the identification of animal species.

Collaboration

Basically, we are analysing those ancient specimens in the collaborative study with archaeologists, scientists working for the conservation of cultural properties, artists, and historians, all of those who are least likely to work within our Laboratory of Biochemistry and Organic Chemistry in Nara Women's University. One of these collaborations includes a project "Culture History of Paleo Asia" organised by Professor Yoshihiro Nishiaki (the University of Tokyo), supported by a Grant-in-Aid for Scientific Research on Innovative Areas (Grant No. 1802) from the Japanese Ministry of Education, Science, Culture, and Technology. In this project, we could distinguish between a goat and sheep as the species of Neolithic bones[5]. Without these collaborations and financial aids (see "Acknowledgement"), we could not do anything so exciting as to obtain a variety of archaeological materials needed to "read" a history written in terms of the chemical structure of collagen. For this project, we welcome researchers all over the world to collaborate with.

Acknowledgement

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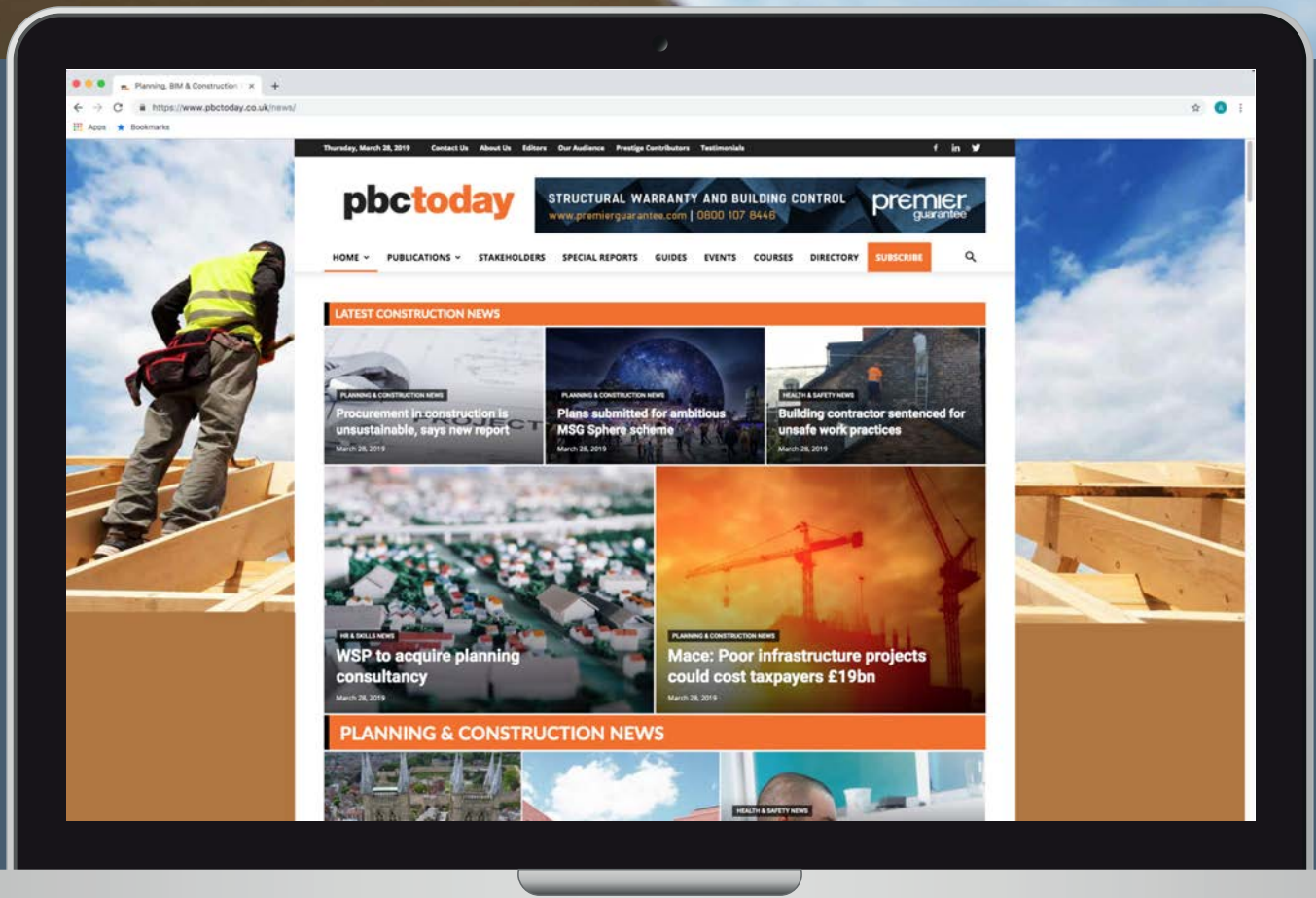

pbctoday

Taiwan: Driving forward scientific and technological innovation

In the age of the knowledge-based economy, science and technology has become a key driver of growth and national progress for Taiwan, as this article about the country's Ministry of Science & Technology (MOST) delves into

The Ministry of Science & Technology (MOST) is Taiwan's agency for driving forward scientific and technological innovation, a major pillar of the country's plans for economic growth. In the age of the knowledge-based economy, science and technology has become a key driver of growth and national progress for Taiwan.

As such, in March 2014, the National Science Council (NSC), which was originally established in February 1959, was reorganised into the Ministry of Science & Technology (MOST) with a new structure designed to strengthen the integration of academic research and industrial development.

MOST was established with three main goals: promoting nationwide scientific and technological development, supporting academic research and developing science parks.

It continues the NSC's traditional role of promoting partnerships between academia and industry and encouraging innovation, while also reinforcing the impetus for businesses to invest in research and development, fostering creativity, nurturing start-ups and supporting industrial development.

MOST formulate guidelines and policies for, as well as puts forward the overall vision and strategies of, Taiwan's national science and technology development.

The National S&T Development Plan is jointly implemented by 17 ministries, departments and agencies, the national research academy Academia Sinica, the Board of Science & Technology, the Department of Cyber Security, the National Development Fund and local government.

The plan, which covers 2017 to 2020, focuses on four goals: reviving economic dynamics through innovation; developing smart living technologies and industries; cultivating and recruiting talents with diverse career paths; and enhancing an innovation ecosystem for scientific research.

MOST also oversee national science and technology programmes. Since 1997, Taiwan's government has been promoting national-level research initiatives to address the country's social and economic needs and to enhance national competitiveness.

In 2018, the government focused on promoting the second phase of its National Energy Programme, which aims to reduce Taiwan's dependency on imported energy and to improve the international competitiveness of alternative energy industries through the development of innovative renewable and low-carbon technologies.

MOST is participating as a partner in the programme, alongside the Ministry of Economic Affairs, the Ministry of Transportation and the Atomic Energy Council.

MOST are also responsible for increasing national science and technology literacy and it actively promotes popular science. This includes funding collaborations between academia and industry to produce media content such as films, videos and animations about science and technology.

Last year, the Taiwan Railways of Popular Science train toured around the island to foster public interest in science.

In addition, the High Scope Programme helps high and

Shihmen Dam in Fuxing or Daxi District, Taoyuan, Taiwan

vocational schools to integrate the emerging science and technology of everyday life into their curriculum to fostering the development of new innovations.

Elsewhere, the Foreseeing Programme aims to translate abstract and complex science and technology into enlightening, accessible and inspiring educational resources to spark public interest in the cutting-edge. As part of this, a MOST-sponsored summer programme offers island-wide interactive science classes for students, engaging them outside the traditional classroom and showing that science is fun.

Furthermore, MOST channels corporate and social resources to fund and organise popular science activities, such as Sci-Tech Vista, an online platform for sharing popular science resources.

To promote the development of academic research, MOST has implemented a number of core facility and major instrument projects to provide first-class equipment and promote resource sharing that help researchers achieve the maximum benefit from their work.

Meanwhile, the National Applied Research Laboratories aims to further scientific research by integrating and coordinating Taiwan's national laboratories in order to translate R&D results into innovative products.

In its role as a bridge between government, academia and industry, MOST provide PIONEER grants to promote domestic collaboration between business and academia. Companies submit problems for researchers to solve.

Through the Academia-Industry Technological Alliance, research organisations are encouraged to establish service platforms centred on core technologies and SMEs are invited to participate in order to boost their competitiveness.

Finally, MOST has established three core science parks in northern, central and southern Taiwan to create a hi-tech innovation corridor to facilitate and accelerate the country's transformation into a global centre for R&D.

The three parks encourage universities and companies in their respective regions to engage in collaboration, while also establishing incubation centres to provide professional consulting and resource referral services for start-ups.

In these and many other areas, MOST is fulfilling its mission to act as a catalyst for promoting the development of science and technology in Taiwan. ■

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Robotic-assisted rehabilitation devices: A wearable hand/finger rehabilitation robot

Jen-Yuan (James) Chang, Professor at the Department of Power Mechanical Engineering, National Tsing Hua University in Taiwan, explains the essentials for robotic-assisted rehabilitation devices, including a design example of a wearable hand/finger rehabilitation robot

The development of robotic-assisted rehabilitation devices, the so-called rehabilitation robot, requires interdisciplinary synergy from both medical and engineering fields. In this article, several essential considerations in the development of a rehabilitation robot are discussed and illustrated by a wearable hand/finger rehabilitation robot developed through research funded by Ministry of Science and Technology, Taiwan. The future possibility of such rehabilitation robot will also be discussed in the context of treating the robot as a smart machine.

Rehabilitation meditated by the use of robotic devices has been an emerging and quite interesting research topic in recent years. Due to the demographic dilemma in developed countries in which an ageing population increases while the birth rate decreases, the option of adaptation of robotic devices to assist rehabilitation treatments for an ageing and impaired population does offer social and economic advantages over the traditional human-intensive option through physical therapists and occupational therapists.

Due to such advantages, in the past ten years, more and more novel rehabilitation robots attributed by traditional therapy concepts have been developed and even commercialised in products to assist lower limb, upper limbs and even hand rehabilitation. In robot-assisted rehabilitation, patients can obtain precise, repeatable, and even reliable rehabilitation treatment through motion exercises designed by doctors. However, the biggest challenge in the research and development of robotic-assisted rehabilitation devices, or commonly called the rehabilitation robots, is the integration of interdisciplinary engineering fields with considerations from clinical requirements.

Such integration is not to the degree of complexity among medical and engineering expertise but to the level in which to offer the best solution to patients with the right combination of suitable elements for effective rehabilitation. In other words, the balance among the clinical needs and the realisation of engineering approaches is, in fact, the key to the success of the development of rehabilitation robots.

In this article, essentials for the development of rehabilitation robots will be discussed in the context exampled by the wearable hand/finger rehabilitation robot as shown in Figure 1(a) which was developed by Professor Chang's research group through research projects funded by Ministry of Science and Technology in the Department of Power Mechanical Engineering

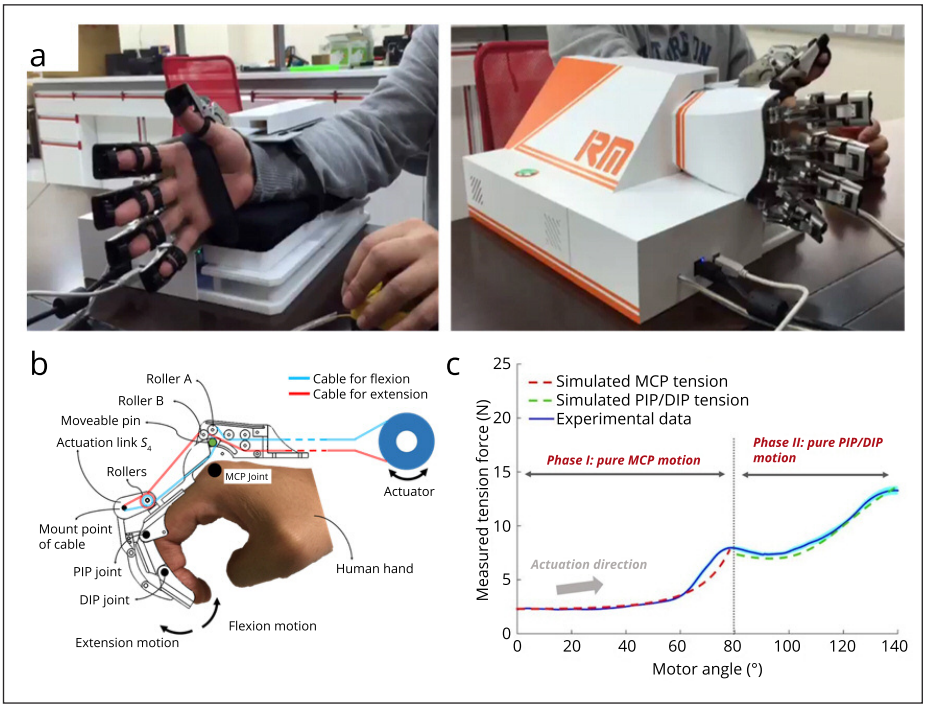

Figure 1: (a) Commercial-ready wearable hand/finger rehabilitation robot by RMTC, (b) mechanism and mechatronics designs and (c) force components of the model robot in action

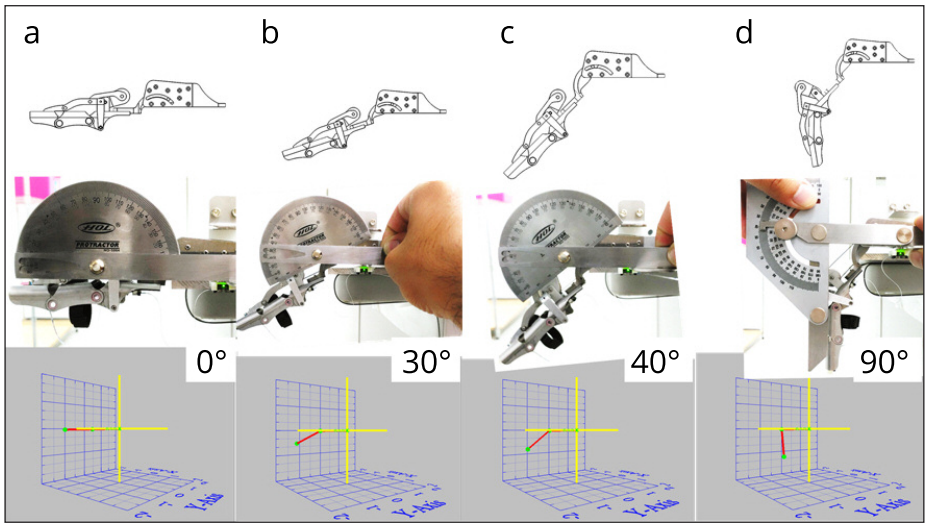

Figure 2: Finger rehabilitation robot under flexion (a) to (d) and extension (d) to (a) exercises. The bottom row shows the real-time angle measurements by IMU sensors

at National Tsing Hua University, Taiwan. Such designs were further realised in the commercial-ready product by spin-off company from the group named Rehabotics Medical Technology Cooperation (RMTC).

During robot-assisted rehabilitation, robot structures are applied upon disabled limbs with motor impairments caused by strokes, sports injuries or accidents. Driven by the robot actuators, the robot structure can then carry or move the disable limbs to perform rehabilitation exercise. As the example in Figure 1(b) shows, since the rehabilitation robot has its structure applied on a human finger, the first essential consideration is to include the human factors in the robot design. Such factors include the dimension of a human finger and thumb's proximal, middle, and distal phalanges, as well as the range of rotation for finger's metacarpo-phalangeal (MCP), proximal-interphalangeal (PIP), and distal-interphalangeal (DIP) joints. These factors will vary from race, age, gender etc. and play a significant role in the effectiveness of the robot's motion. With the human factors considered, the next essential consideration is then placed on the medical side by offering the appropriate rehabilitation exercise which will lead to the structure and mechanism designs of the rehabilitation robot. Taking the model finger robot as an example, as shown in Finger 2(a)-(d), the motions between the MCP and PIP/DIP joints are decoupled through mechanism design so that robot's movement pattern can be analogous to that observed in the human hand, as well as requested by medical doctors.

Once the robot's movement pattern is confirmed and achieved by mechanism designs, the next essential consideration is on the mechatronics integration, which includes the selection and implementation of actuators, sensors, and controller in the robot. For the model finger robot as illustrated in Figure 1(b), limited by space to accommodate for a higher degree of motion in hand/finger rehabilitation, the finger robot is not directly driven by motors but designed to be driven by cables actuated by motors which are placed away for impaired hand/fingers. The main objective of the rehabilitation robots is not only to offer repeated motion but to provide biological insight of impatiens can improve by the use of the robot.

For stroke patients, their degree of spasticity degree judged offline but can't be monitored during rehabilitation treatments. With the model robot, such online monitoring of finger joint spasticity can be achieved by the embedded force sensor data as exampled by the robot's cable force measurement as shown in Figure 1(c). Also, with the use of motion sensor, such as inertial measurement unit called IMU sensor which is embedded in the robot structure, positions and orientations of the robot movements can also be monitored real-time. Should the rehabilitation exercise be deviated from the designed path, with well-design control codes, the controller unit in the robot can alter the actuator's motion to direct the robot to move the human body back to the designed course. Since the robot possesses the capability in collecting force and kinematic information of the robot and patient, rehabilitation big data can then be established through medical trials and practices. Certainly, with such a smart machine, the rehabilitation robot, new medical knowledge in rehabilitation is thought to be generated in the near future should the data be carefully integrated and examined with artificial intelligence (AI) technologies.

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Towards mobile healthcare with medical-internet of things (IoT) devices

A move towards mobile healthcare with medical-internet of things (IoT) devices is placed under the spotlight here in an insightful piece from Prof D. Chen-Yi Lee from Department of Electronics Engineering, at the National Chiao Tung University in Taiwan

In this article, I will be looking at the impact on society when it comes to the move towards mobile healthcare with medical- internet of things (IoT)[1], technology trends, as well as an interesting example of an electrocardiogram (ECG) and my thoughts on what the future could hold in this exciting field of research.

The impact of medical devices on society

To achieve better medical services with early diagnosis and early therapy, innovative solutions for preventative medicine have been continuously investigated and promoted to both medical centres and local clinics. One of the major driving forces in exploring these solutions for mobile healthcare is to allow limited medical resources for those patients who demand in-time treatment and medical care under the coverage of national health insurance in Taiwan.

Furthermore, both medical teams and the general public need to be re-educated before these new diagnosis/therapy solutions and inherent service models can be accepted. And even some governmental regulations have to be re-adjusted or added to allow these solutions to be deployed for practical usage.

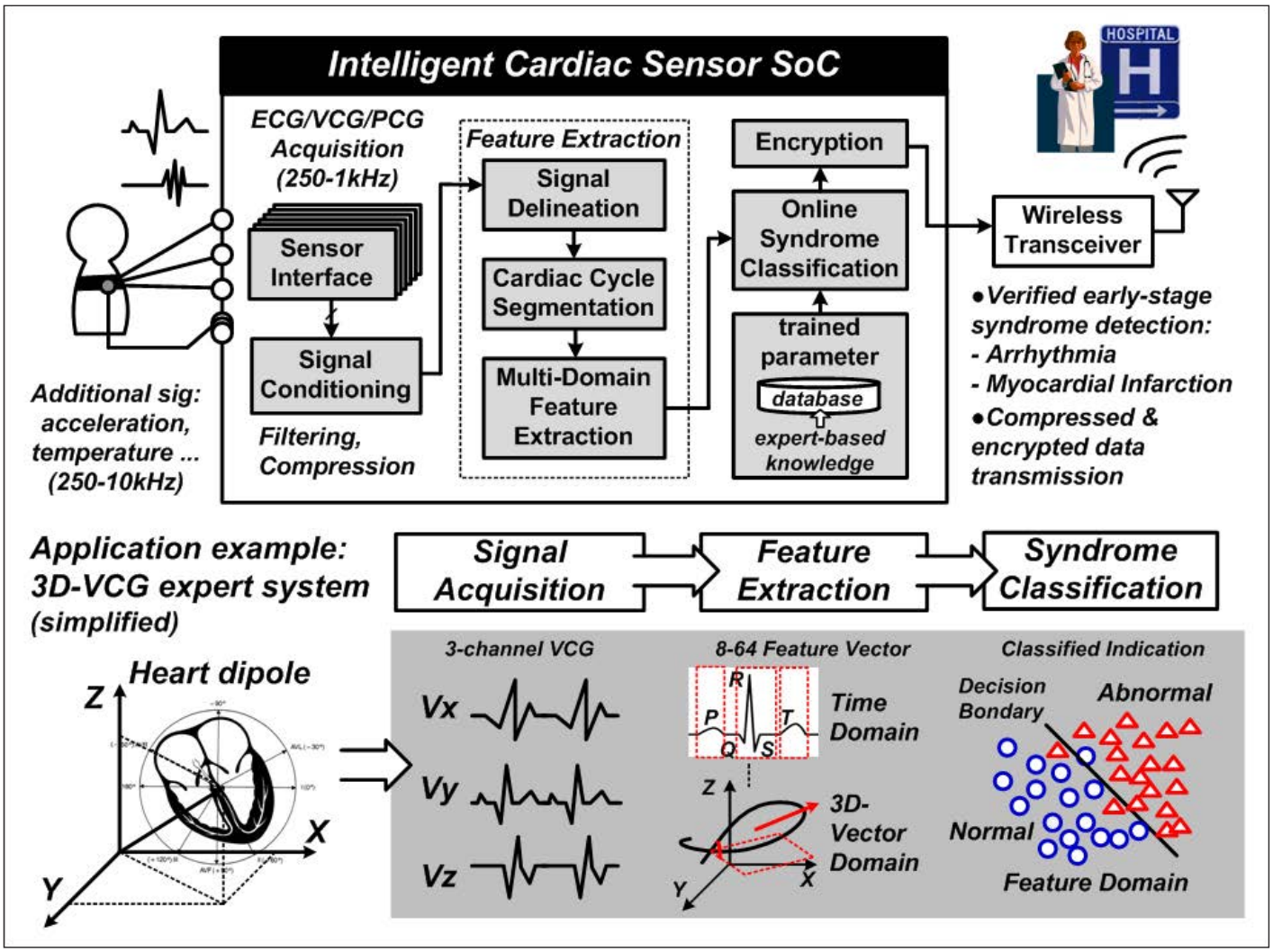
Technology trends

The advances in wireless devices and miniaturised sensors fuel the possibilities of mobile healthcare applications, where medical-internet of things (M-IoT) devices are body-worn or implanted for continuous vital signal recording. To extend the M-IoT monitoring duration, on-sensor biomedical signal processors (BSPs) can be applied to timely extract the critical information for reduced storage and transmission data. Considering the support given to versatile applications with maximised monitoring time, the BSPs should be flexible and accurate with extremely low power operation. In addition, single-type sensor or sensor-fusion solutions should be developed as well to generate valid bio-datasets for follow-up health conditions analysis. Data screening is key to enhance prediction accuracy and avoid false alarm in practical usage. Finally, data security to protect privacy leakage and personal identification to secure the quality of service should be taken into account in these M-IoT devices.

An example on an electrocardiogram (ECG)

An application scenario on an electrocardiogram (ECG) for heart disease prediction is illustrated in the following figure. To meet the requirements of mobile healthcare applications, a specific M-IoT device is demanded with enhanced energy-efficiency so that it can be operated for more than one week with one chargeable battery. In the meantime, the device should be small enough to allow user-friendly wearable usage. Thus, a specific chip needs to be designed to cover the following functions, namely signal acquisition, feature extraction, syndrome classification. In addition, data security and personal identification have to be covered as well. Wireless transmission can be leveraged by those commercial solutions, such as Wi-Fi and Bluetooth depending on how this M-IoT is deployed and used. A preliminary IRB clinical trial based on this M-IoT on the prediction of both arrhythmia and myocardial infarction with accuracy over 95% have been reported. If sensor-fusion is further exploited to cover ECG, vectorcardiogram (VCG), and phonocardiogram (PCG), it is believed that prediction accuracy can be further improved.

There are two issues to be further illustrated to avoid false alarm in practical usage. One is the input signal quality and data validation: this is a very important issue if the input signal has been affected by environmental noises, such as those from power-line, skin contact drift, motion artefact, etc. Different methods have been investigated to reduce these noise sources so that signal to noise level can be further improved. However, these noise-reduction methods may also induce human-made extra noises to signal sources, leading to worse prediction accuracy and even higher false alarm rates. As a result, new approaches to screen out valid datasets from source



signals should be further studied. The other issue is datasets collection from clinical trials. The sample volumes should be large enough to cover different test conditions in model training phase so that prediction accuracy can be accepted in practical usage. This is very important when M-IoT devices are to be deployed in different test scenarios.

However, one problem often encountered is the limited datasets collected for model training, especially in medical diagnosis based on the data-driven approach. Even test samples and procedures have been well defined and planned but it's still hard to cover all test conditions and, hence, prediction accuracy may vary a lot in practical usage. As a result, new approaches toward autonomous learning at the M-IoT device level should be further explored to enhance prediction accuracy and make it reliable for mobile healthcare applications.

A glimpse into the future

Lastly and by no means least, it is believed that with the advances taking place in M-IoT devices, including both sensing capability and autonomous learning, the penetration rate will become much fast than it is today. These new M-IoT devices, together with data-driven operation infrastructure currently under construction, will definitely provide better medical services to society. As a result, the general public will benefit more from a one-stop service platform to lead a better life while enjoying the advantages offered by those M-IoT devices, both developed and under development.

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Guard Patch: Intelligent wearable technology with Internet of Things and platforms

Professor Shuenn-Yuh Lee, National Cheng Kung University, discusses his mission to build a user-friendly development platform with smart wearable technology, in this report

I established the Communication and Biologic Integrated Circuit (CBIC) Lab in 2002. My mission is to build a user-friendly development platform with smart wearable systems, which consists of the biosignal processing integrated circuits and modules, the user-friendly websites and apps, and the artificial intelligence (AI) system on the cloud.

The goal of the Guard Patch is to develop a Low-power Long-term Wearable Body Sensor SOC for Wireless Electrocardiogram Monitor. Our team designs and implements a high resolution and low power bio-signal acquisition chip. The chip is fabricated in a TSMC 0.18 μm standard CMOS process. Based on this chip, we integrate the required circuits into a wearable system module to sense the Electrocardiography (ECG) signal from users. The communication between the sensor and the smartphone is established via Bluetooth.

The software needs to fulfil the following four principal tasks: 1) data processing, 2) analysing, 3) displaying, and 4) recording. A back-end application (APP) on Android/iOS system carries out further mathematical calculation and analysis, including demodulation and digital signal processing. With the basic monitor function (off-line bio-signal data storage), the real-time monitoring function is also developed and the real-time bio-signal can be checked on the smart device. The processed ECG signal will then be displayed on the screen. With such a wearable platform for wireless bio-signal acquisition, the user can access and monitor his own physiological condition anytime and anywhere.

For these functions mentioned above, this wireless bio-signal acquisition system will become the guard patch of the user. There are three main advantages of this system, including real-time monitoring, convenient for wear, and easy to use.

In addition, the technology of Guard Patch is promoted to other applications, including smart clothing, I-Pet clothing, TRIANSWER, intelligent medical stethoscopes, epilepsy detection and stimulation systems, portable and wireless urine detection systems and platforms, etc. The detailed has been presented in the CBIC introduction video.

24-hour arrhythmia monitoring system

Electrocardiography (ECG) is a fundamental method not only commonly used in the hospital for clinical requirement but also widely adopted in home and personal healthcare systems to obtain the electrical activity of the heart. An arrhythmia monitoring system is proposed and used in a clinical trial. The proposed system has three parts. The first is a high-resolution, low-power analogue front-end circuit for implementing bio-signal sensing circuits. The features of the circuits are low complexity, high resolution, and low power consumption.

The second part is a digital signal processor with a decimation filter and a universal asynchronous receiver/transmitter package generator. The last part is used to realise a software interface on smartphone for ECG signal recording, display, and classification. A wavelet-based classification method is also proposed to classify the rhythm. The chip used in the system is fabricated through TSMC 0.18 μm standard CMOS process. The classification algorithm is verified with data from the MIT/BIH Arrhythmia Database. The accuracy of beat detection and arrhythmia classification is 99.4% and 95.83%, respectively. Patients in Tainan hospital are enrolled in a human study to verify the performance of the proposed arrhythmia monitoring system. Results show that the system can acquire and classify ECG signals.

Smart clothing

Combining the wearable devices with the concept of the Internet of Things (IOT) to create a wearable health care system is a potential issue for an ageing society. Among the applications of the wearable health care system, smart clothing has some unique advantages. First, unlike most wearable devices such as watch and belt, clothes are necessary for every-

Shuenn-Yuh Lee, Professor

one in daily life, so the clothes-related medical wearable devices can be easily accepted by people.

Also, smart clothing has the ability to provide more variety of bio-signal monitoring than other wearable devices because they have a larger contact area to the body surface of the user. Thus, Tien Jiang Enterprise Co., Ltd. cooperates with our team in developing a system of smart clothing. The system utilises the fabric-based electrodes with a comfortable sense of touch to provide the measurement of ECG signal and respiration signal, and delivers the signal through Bluetooth to the mobile phone. At last, the physiological information such as energy expenditure and heart rate variability can be analysed.

I-Pet clothing

Through combining pet clothing and front-end sensor, the I-Pet clothing is a wireless bio-signal detecting system for acquiring ECG and respiratory signals from a pet. An algorithm is implemented to evaluate the emotion state and heart rate variability. Based on these analysis results, this system can be a reference for veterinarian and provide suggestions to pet caregivers. Moreover, the emotion index can help pet masters to understand the mental states of their pets. This work combines the concept of wearable devices and internet of things and contains the hardware implementation and software development. With a software application as a graphical user interface, users can obtain the real-time and past condition of pet. This information platform is a channel to communicate with the vet and a bridge for the pet lovers to exchange their experience.

Trianswer

Trianswer is a bio-medical evaluation module designed for wearable and IOT-based products. It not only contains several features about low-power consumption, miniaturisation and IOT-based design, but also provides the acquisition of high-quality bio-signals including Electrocardiography (ECG), Electroencephalography (EEG), Electromyography (EMG), etc. By reducing the development time and cost, developers can manufacture their wearable devices rapidly with the assistance of Trianswer.

In addition, acquiring the specific bio-signal needs its own corresponding module. Developers can combine modules assisted by Trianswer to fit their requirement. The main concept of Trianswer is to promote the development of bio-medical wearable devices.

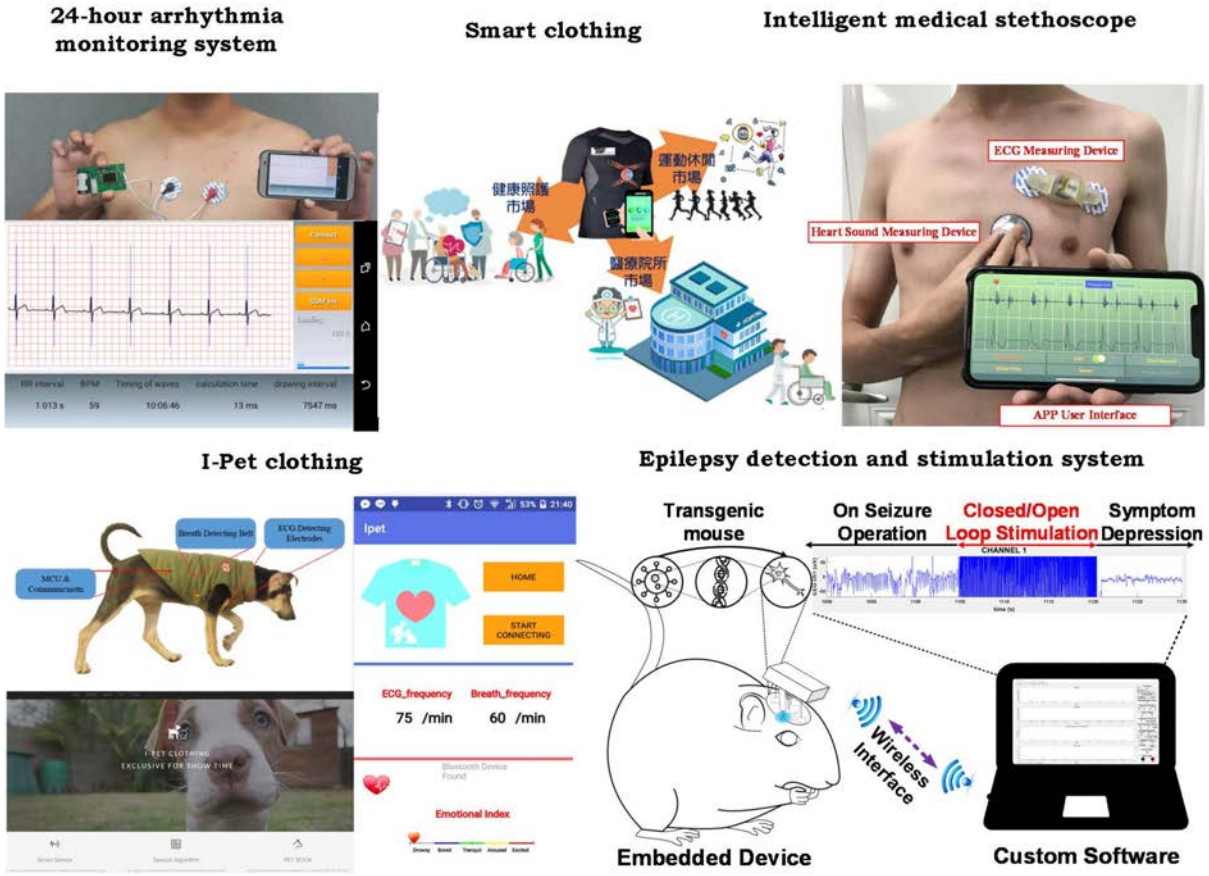
Intelligent medical stethoscope

When mentioning the cardiac auscultation in hospital, it is important but difficult to distinguish efficiently between the first heart sound (S1) and second heart sound (S2). The identification of S1 and S2 will affect the judgement of the additional heart sound and murmurs. The accuracy of auscultation relies on the experience of the doctor. In order to assist doctors in making diagnoses more rapid and accurate, our technical team develops the smart stethoscope which is capable of measuring the ECG signal and the heart sound signal at the same time. These two signals will be displayed on the smart phone and the phase of the heart sound signal can then be confirmed. To eliminate the uncertainty and reduce the demand for experience, the doctors may refer to these waveforms for diagnosing the potential heart disease by taking advantage of signal visualisation.

Epilepsy detection and stimulation system

Epilepsy is one of the most common neurological disorder. It is mainly caused by the abnormal discharge of nerve cells in the brain. The mainstream treatment for epilepsy is to take oral medication. However, conventional treatment is hard to achieve remarkable effectiveness. In recent years, many studies have focused on the development of intracranial implantable electrical stimulation.

Our team cooperates with National



Cheng Kung University (NCKU) hospital in developing the EEG sensor and electrical stimulation module. The B6 mice are selected in the animal testing at the present stage. The electrodes are implanted to collect EEG signals from mice, and the measurement module transmits the signal through Bluetooth to the computer. A custom computer software application is developed to perform a data analysis algorithm, and identify epilepsy immediately. Then, the electrical stimulation is provided to relieve the symptom. To sum up, EEG signal acquisition and epilepsy alleviation with electrical stimulation are realised in this system.

Portable and wireless urine detection system and platform

For decades, cardiovascular disease (CVD) is the top cause of death in the world and the top 3 leading causes of death in Taiwan. The statistics reveal the issue of CVD mortality awaits for a useful prevention method. Due to the high mortality of CVD, the early detection of CVD is becoming a big issue. A portable and wireless urine detection system and platform for home care and community screening is proposed. It provides a telecare platform to monitor the risks of CVD and prevent the occurrence of CVD.

The main concept is to develop a system-on-chip, a microelectrode and microchannel chip to detect the concentration of CVD-related risk factors in urine. Data will be wirelessly transmitted to a smart application platform to evaluate the user's cardiovascular status based on the outcomes in clinical research. Users will obtain the condition of CVD and the professional medical advice from the cooperative cardiovascular doctors in NCKU hospital through the platform.

Communication and Biologic Integrated Circuit Lab

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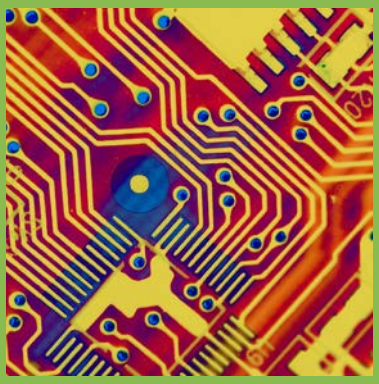





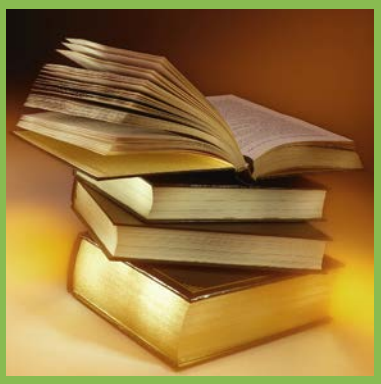

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European space policy is at a crossroads

Dominique Riquet MEP, Group of the Alliance of Liberals and Democrats for Europe explains why European space policy is at a crossroads

Perhaps you haven't noticed looking at the sky, but space has changed. Whereas space was dominated by the United States (U.S.) or the USSR during the second half of the 20th Century for military and defence purposes, since the 21st Century space is now also, and mostly considered as a fantastic reservoir of economic and environmental opportunities for multiple players. Despite the difficult premises in 1975, the European Union (EU) can now take pride in many successes achieved over the last twenty years, in a fast-changing sector that has recently become drastically more competitive.

Space is a fruitful playground: more than 10% of the EU's GDP already relies on services linked to it. We are so dependent on satellites that we would have a hard time imagining our lives without the services they provide. This is particularly clear in the field of mobility: transport alone relies largely on services linked to space for digital infrastructure, meteorological monitoring or basic orientation in modes of transportation. Whether we speak about road, maritime, rail or air transport, everything now relies – and will more and more rely – technically upon positioning services, and therefore space policy.

However, the EU did not start to develop its spatial policy due to economic benefits, but first and foremost because it is a cornerstone for its strategic autonomy. One example is that for years, countries in Europe and Europeans relied on GPS technology. GPS is owned by the United States government and operated by the U.S. Department of Defense, which has the ability to adjust it to make it less functional to a foreign power, as they did during the Iraq war. This episode was a signal for Europeans. Even if the U.S. has made clear it will not use this feature again, the consequences of triggering it would be of great significance. In terms of mobility, if one can disrupt the whole transportation system of a country, one could also provoke a shutdown of the country. This showed our vulnerability and how essential it was for Europeans to develop their own geopositioning technology, Galileo.

At the same time, countries in Europe realised that no single Member State reached the critical mass needed for a space programme by itself. It had to be a European one, and this point deserves to be highlighted: the EU space policy is in that regard a real European success story. Therefore, we can be proud the European "Galileo" is more precise than the American "GPS". It is also worth noticing that about 1,600 people work at the European Kourou base for a result today that is slightly better compared to the American base at Cape Canaveral and its 10,000 employees, which shows the high quality of the European human capital.

It is clear that the EU is aware of the potential of the space industry and economy. The investment of the European budget in space has increased significantly, with €5 billion in 2007-2014, then 13 billion in 2014-2021 and finally, €16 billion forecast for 2021-2027. The bulk of the envelope is dedicated to navigation systems Galileo (worldwide) and The European Geostationary Navigation Overlay Service (EGNOS) which is regional but even more precise – and the Earth's observation programme, Copernicus, the most developed one that exists. The newest elements of the EU space programme is space surveillance and tracking of space debris, and the next generation of secure government satellite communications, both of which are increasingly crucial in the context of space entering the security and defence sector. Moreover, the soon-to-be €13 billion European Defence Fund will also be able to fund defence-related satellites and new space technologies. Pursuing investment into operations and infrastructure

is key in order to maintain a constellation of satellites (29 satellites in orbit, 30 to be launched in the 10 to 15 years) and the increasing quality of space services.

Nevertheless, is that enough for Europe to be a space power of tomorrow? Europe's space budget is still four to six times lower than the United States', and the revolution of the NewSpace, enabled by decreasing costs, has multiplied by ten the number of space agencies and private actors in the last years (such as SpaceX and Blue Origin). By developing reusable launch systems, these new players have a significant competitive advantage, besides the massive public support they receive. In such a context, it will be very difficult for Arianespace to maintain its leading position in a near future, which should worry us because losing its market share means risking losing its capacity invest, and ultimately, to innovate.

More has to be done to secure the European position in space. Launchers, which guarantee the access to space, are a prerequisite of any space sovereignty and the EU should in that regard invest and innovate more into them. Initiatives such as Callisto or Prometheus to develop reusable launch systems have to be encouraged and endowed.

Beyond mere budget considerations, the EU could take a few steps further towards space sovereignty. In China, Russia or the U.S., local launchers exclusively provide institutional launches. Why couldn't the EU do the same? I would also support the idea of a "European Space Council" attached directly to the European Council or its President, just like the U.S. National Space Council since 1989. Another example: vehicles in the U.S. are equipped by default with the American GPS technology, but in Europe, we still play the game of fair competition and technological neutrality. Perhaps the time has come for Europeans to stop being too naïve and to compete on equal terms with their fast-growing competitors. ■

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Science in policymaking: Chemistry is everywhere

Science Communication and Policy Officer from The European Chemical Society, Alex Schiphorst offers his thoughts on the old adage that ' chemistry is everywhere' and on the important role of science in policymaking

That 'chemistry is everywhere' is an oft-repeated adage by chemists to explain the value of chemistry as a subject that just can't be ignored. But whilst true at face value – everything around us is chemistry – the statement has become somewhat clichéd and fails to catch the real significance of chemistry in everyday life. Nobel Laureate Linus Pauling, a pioneer in quantum chemistry and molecular biology stated that: "Every aspect of the world today – even politics and international relations – is affected by chemistry". From medicine to agriculture, from space exploration to deep sea diving, from cultural heritage to education, the role of chemistry is so fundamental that it is ultimately taken for granted.

The chemical sciences in Europe

At EuChemS, the European Chemical Society, we take it as our responsibility to ensure that the voice of chemistry in Europe is heard, and that scientific evidence and advice is effectively relied on to make political decisions. Representing over 40 chemistry-related organisations, and by extension more than 160,000 chemists from across Europe, EuChemS aims to communicate the central function of science in policymaking work.

Far from static, the chemical sciences are in constant flux, with breakthrough discoveries constantly reshaping our knowledge and how we view the future. New developments in nanochemistry, innovative medicines, energy sources and food safety – and the list goes on, have significant effects on the economic, political and social fabric of our world. But chemistry has also suffered from a negative image, with combative crises emerging over the uses of glyphosate or neonicotinoids.

Chemistry's image has also been dampened by a rise in populist discourse, and the increasing distrust expressed towards scientific findings and advice. The anti-vaccine argument gaining traction in Italy and Romania typifies this changing landscape. Such changes have, in turn, changed the role of chemists and scientists. There is now a genuine need to bring back that spark that makes chemistry so magical. And to do this, chemists need to proactively communicate their work to decisionmakers and the general public.

"Far from static, the chemical sciences are in constant flux, with breakthrough discoveries constantly reshaping our knowledge and how we view the future. New developments in nanochemistry, innovative medicines, energy sources and food safety – and the list goes on, have significant effects on the economic, political and social fabric of our world."

2019 – International Year of the Periodic Table

2019 was proclaimed the International Year of the Periodic Table by the United Nations and UNESCO in light of the 150-year-old discovery of the periodic system by Russian scientist Dmitri Mendeleev. And so EuChemS took this opportunity to design a new and unique periodic table. The result is an odd-looking periodic table depicting element scarcity: which details elements that may no longer be so readily available in the next 100 years, which are in short supply, which originate from conflict zones, and which are found in our smartphones. The image is far from reassuring, and the work aims to encourage citizens and policymakers alike to rethink how we use and dispose of electronics, our recycling infrastructures, our tendency to waste, as well as the ethical considerations to take into account. The periodic table was unveiled on 22 January 2019 in the European Parliament at an event chaired by MEP Catherine Stihler and MEP Clare Moody.

Over the last few months, EuChemS has actively participated in the discussion on the future EU research framework programme, Horizon Europe. In a position paper published in August 2018, EuChemS laid out a series of recommendations, including a call to increase the proposed budget to €160 billion and to boost the budgets set for the European Research Council and the Marie Skłodowska-Curie Actions. The importance of enabling the United Kingdom to continue participating in EU research framework programmes post-Brexit was also a core issue in the statement. Indeed, recent research demonstrates that international collaboration generates better and more impactful science. With both the UK and the EU being science powerhouses, neither can afford to no longer work so closely with the other.

Issues that affect the chemical sciences themselves

In addition to working on policy issues in which chemistry can play a vital role, EuChemS focuses on issues that affect the chemical sciences themselves. This includes issues linked to gender imbalances within academia and industry, ethics and scientific integrity, and the open access transition for scientific publishing. In February 2019, EuChemS responded to the call for feedback on the implementation of Plan S, the open access plan put forward by a coalition of European funders (the so-called cOAlition S) with the support of the European Commission. The issue, being at the heart of how science is done, has been a contentious topic. EuChemS has attempted to provide a balanced perspective which takes into account the concerns expressed by chemical societies and their members who may be most affected by the potentially unintended consequences of Plan S.

Chemistry: A catalyst for changing the world

From nanoparticles to building ever more efficient solar panels, from laboratories to nuclear plants, from classrooms to EU law, chemistry appears everywhere, but this does not mean it is a passive subject. Chemistry is hugely innovative and can act as a catalyst in radically changing the world around us for the better. ■

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Double vision in research? Medicinal chemistry and chemical biology

Professor Colin Sucking discusses the work undertaken at the University of Strathclyde that explores the combination of medicinal chemistry and chemical biology

It's easy to challenge academics over the relevance of their research to society and its significance for the future. My specialisations of medicinal chemistry and chemical biology, which I develop through heterocyclic chemistry, are as much open to challenge as anything else. To the general challenge can be added the question of why do you research medicinal chemistry and drug discovery in a university when there is such a large and well-funded pharmaceutical industry to do just that? Well, even senior industrialists have said to me that they honestly can't do it all, especially when their drivers are largely commercial.

So in our projects at Strathclyde, we try to tackle problems in drug discovery and chemical biology that have distinct differences from common industrial projects. And we not only try to find new, highly active compounds but also establish how they work. This is the double vision of the title, the combination of medicinal chemistry and chemical biology. The applied translational science centres on the medicinal chemistry and the basic science on chemical biology.

If, in addition, anyone should doubt that heterocyclic chemistry, or the chemistry of compounds containing rings with atoms other than carbon, is at the centre of contemporary international chemical discovery, the evidence in terms of published scientific

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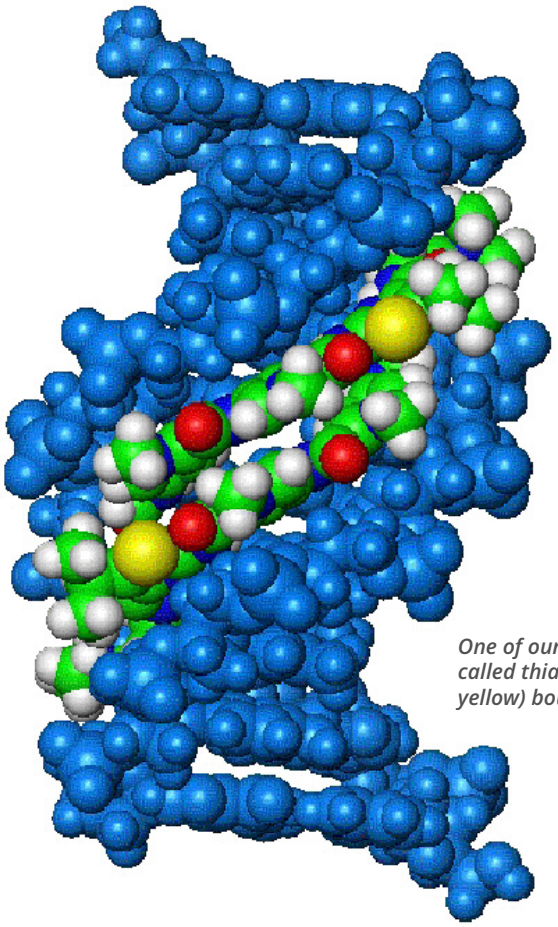
output is strong. I have just returned from a series of scientific meetings in India in which 90% or more of the contributions included heterocyclic compounds. Further, most of the scientific papers that come across my desk from major international journals for review deal with heterocyclic compounds in some way. I've written some e-books to explain to the layperson what heterocyclic chemistry is and how it works – most recently 'Why does heterocyclic chemistry matter?'.

There are fashions in science just as much as in any well-populated walk of life. Sometimes they are associated with following up genuinely new discoveries that are of long-term significance. Perhaps the discovery of the structure of DNA is the strongest example of this in the context of heterocyclic chemistry. Other times there is a neat new idea for which the significance is exaggerated by the discoverers hoping to get more recognition for it.

Although heterocyclic chemistry has been around a long time this does not mean that there is no longer any interest or value in heterocyclic chemistry, quite the contrary. It's precisely because it is mature and capable of making highly sophisticated designed chemical compounds that it retains power and importance in science. New compound classes have been discovered with value in many different applications ranging from therapeutics to television screens.

In both of these applications and everything on the spectrum of technology in between, there are new developments that depend upon heterocyclic chemistry. Here I want to point out not the physical manifestations of the chemistry in terms of compounds in bottles but a relatively new and powerful way of thinking about not only chemistry but also biology. From this approach, important new discoveries can emerge, as has been realised worldwide. It's an important aspect of how we structure and build our research programmes in health care at the University of Strathclyde.

To unpick the philosophy a little, let us take a step back in time. According to John Henry Newman's "Idea of a



One of our minor groove binders for DNA, called thiazotropsin A (green, white, red, yellow) bound to a segment of DNA (blue)

University", each subject should look after itself drawing its own boundaries and, by implication, guarding them. That 19th-century concept is quite the opposite of how we need to think today. New things and useful things happen at the interface of conventional scientific disciplines and when these disciplines mix. This is by no means a new idea either but what has changed that is relevant to heterocyclic chemistry is a relatively new sub-discipline called "chemical biology". Chemical biology has become an extremely important area in the application of heterocyclic chemistry. Essentially what it does is to use small, specially designed and synthesized heterocyclic compounds to investigate how the big molecules of biology work together. Put another way, the heterocyclic compounds probe the mechanism of action of biological systems. Because, as I've explained before, the structure of a heterocyclic compound can be exquisitely tuned to its purpose the chemical biological approach is a powerful way to investigate significant aspects of basic biology.

What I find most attractive about chemical biology from the point of view of an academic scientist interested both in basic science and practical applications is that it bridges these two endeavours. In our own work, for example, we have designed some anti-infective compounds to be fluorescent so that we can follow their passage in the target infectious agent, typically a fungus or a parasite. This gives us important information about how our compounds work.

One of these compounds is now in a phase 2a clinical trial for the treatment of Clostridium difficile associated diarrhoea.

Related compounds are being studied for veterinary applications such as Animal African Trypanosomiasis.

When I was in India, in January 2019, I concluded details of a collaborative project with the National Chemical Laboratory in Pune to seek treatments for Leishmaniasis, a parasitic disease that remains a problem in rural India. In another field, we have some very effective potential therapeutic compounds that treat inflammatory diseases but until recently, we did not understand how they worked.

Thanks to a collaboration with the U.S. Army Laboratory, AMRID, we have found out a good deal about their mechanism of action using a variety of techniques within the chemical biology domain. In both cases, if we'd simply kept our heads down as chemists we'd have made little progress. Because we've opened out into chemical biology to complement our medicinal chemistry studies, however, we have potentially a much more useful product because we know how it works. It's the double vision of therapeutic effectiveness and mechanism of action. So it's not just what you do in the laboratory, it's the way that you think about it too.

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Solving the plastic problem with biopolymers

Two scientists from Teysha Technologies discuss how organic material can now be turned into a viable plastic substitute

In this interview, we talk to two scientists from Teysha Technologies, Prof Karen L. Wooley, Chief Technology Officer and Dr Ashlee A. Jahnke, Project Research Scientist about solving the plastic problem with biopolymers, including how organic biomass can now be turned into a viable plastic substitute.

As policymakers continue to crack down on plastics, with the EU Parliament recently approving a ban on single-use plastics, businesses are increasingly under pressure to source earth-friendly bioplastics for their products.

Can you tell us about the latest developments in biopolymers?

Karen: Over the past couple of decades, we've become keenly aware of the potential negative impacts that may occur for polymer materials that persist beyond their useful lifetime. This has led us to consider the full lifecycle of plastics at the initial design stage. One way of addressing this is by building polymers from natural products so that they are capable of degradation to regenerate the natural-product building blocks.

Ashlee: This kind of technology is truly more of a platform than a single polymer system, providing inherent versatility in the properties that can be achieved. It can be thought of as a plug-and-play system where various modified natural-product monomers and various co-monomers can be used.

In addition to co-monomers, various additives can be used to modify the properties of the final polymer produced. This versatility allows for the formation of a variety of materials that can vary greatly in their thermal and mechanical properties.

How does this technology compare to existing petroleum-based polycarbonates?

Karen: A significant advantage of this kind of technology is the use of natural, sustainable feedstocks to generate polycarbonate materials with the ability to tune the physical, mechanical and chemical properties by controlling the chemistry, formulation and polymerization conditions.

Because natural building blocks offer higher chemical diversity than typical hydrocarbon sources, this method can be used to tune the degradation rates of intact material systems. Most current polycarbonates are prepared from hydrocarbon-based petrochemicals and achieve varied properties through molar mass control, crystallinity control and blending with other polymers, with fewer opportunities to fine-tune individual properties.

Moreover, the most common polycarbonate is poly(Bisphenol A carbonate), which generates bisphenol A (BPA) upon hydrolytic breakdown – for example, under the extreme conditions in a dishwasher. Since BPA has been implicated in several diseases, avoiding its use as a building block for engineering plastics is of high importance.

How can the polymers be tuned and what does this mean for things like durability and biodegradability?

Karen: The strength, toughness, durability and longevity of these polymers are dependent on the properties of the specific monomers used in polymerization and can be tuned for various applications. The material properties range from flexible to rigid, with degradation occurring over a period of weeks to years,


Prof Karen L. Wooley


Dr Ashlee A. Jahnke

and depending on the polymer composition and the environmental conditions.

Ashlee: These new kinds of polymers also have varied thermal stabilities depending on the composition and have degradation temperatures that are generally similar to but in some cases, lower than other polycarbonate and polyester materials. Another area to consider is how well biopolymers and their processing methods respond to additives, and whether they're compatible with various dyes, scents, oils, plasticizers and nanoparticles.

The main mechanism of polymer degradation is through hydrolytic degradation, allowing for a breakdown in any environment containing moisture and does not require microbial activity, anaerobic conditions or industrial composting.

To determine the best disposal methods for a complete breakdown, we're still measuring and testing full degradation profiles in various potential disposal conditions – like in waterways, landfills and composting.

What renewable sources can be used as feedstock to make these biopolymers?

Ashlee: This technology can use a wide variety of renewable, natural products for monomer feedstocks. The current focus is on the use of polyhydroxyl natural products, including those derived from starches, as well as agricultural waste products.

What kinds of material applications are these biopolymers used in?

Karen: Natural product-derived polycarbonates have applications ranging from single-use packaging and cosmetic microbeads to durable goods.

One significant feature of the current system that is unique from other bioplastics is the diversity of functional groups incorporated into the polymer. These include both carbonates and esters, which are traditionally used in degradable polymer systems, and less commonly used thioether linkages. The sulphur content in the final polymer may impart unique properties that have not yet been explored.

Further, the sugar monomers, which serve as a structural component of the polymer framework, have both alcohol and alkenyl functionalities available for modification, either pre- or post-polymerization, with various chemical groups to impart specifically desired properties to the final polymer system.

> "As policymakers continue to crack down on plastics, with the EU Parliament recently approving a ban on single-use plastics, businesses are increasingly under pressure to source earth-friendly bioplastics for their products."

About the interviewees

Professor Karen L. Wooley is the inventor and Chief Technology Officer at Teysha Technologies. She is the W. T. Doherty-Welch Chair in Chemistry and a Presidential Impact Fellow at Texas A&M University, where she holds appointments in the departments of Chemistry, Chemical Engineering, and Materials Science and Engineering.

Dr Ashlee A. Jahnke is Project Research Scientist at Teysha Technologies. She was a Colin Hahnemann Bayley Fellow at the University of Toronto, where she received a PhD in polymers and materials chemistry. Her research focuses on natural-product based degradable polymer systems, their scale-up and commercialisation. ■

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Chemistry focus: Uncertainties, a current hotspot in the risk analysis of toxicants

An aspect of chemistry, uncertainties, is a current hotspot in the risk analysis of toxicants, writes Alberto Mantovani, Research Director at Istituto Superiore di Sanità – Roma, Italy

Uncertainties can be defined as the gaps of knowledge and/or of data sets and/or of methodologies that can exert an unwanted influence on the outcome of a risk assessment. In principle, uncertainties are unavoidable; hence, a transparent description and weighing of relevant uncertainties should be a necessary component of risk assessment. It is often difficult to accurately assess the impact of each specific uncertainty, but the combined effect of identified uncertainties may – and should be- characterised.

Important examples of uncertainty analysis are provided in recent (2018) opinions by the European Food Safety Authority on widespread contaminants, with endocrine disrupting potential, such as dioxins or the perfluoroalkyl PFOS and PFOA. Differently from substances like pesticides, for which further data can be requested to applicants, for contaminants, well-investigated areas may co-exist with major data gaps. In the case of PFOS and PFOA, the data on humans allowed to define a tolerable weekly intake (TWI), further supported by the identification of toxicological mechanisms. On the other hand, the exposure assessment was weakened by insufficient data on the presence of the substances in European foods, as well as by the frequent use of analytical methods with insufficient sensitivity.

The inherent presence of uncertainties in science-based risk assessment and the need for robust and transparent approaches for dealing with uncertainties have been the core topics of the International Conference on Uncertainty in Risk Analysis (Berlin, 20-22 February 2019), jointly organised by EFSA and the German Federal Institute for Risk Assessment (BfR).

Many interventions pivoted on case studies characterised by data-rich scenarios, allowing for a refined analysis and management of uncertainties (for instance, the risk assessment of the endocrine-disrupting plasticizer bisphenol A). However, this article wishes to point out the problems arising from data-poor scenarios, which may represent the harsh reality in too many instances.

This topic was discussed in an ad hoc satellite workshop within the Conference: "Accounting for uncertainty in data-poor scenarios: Cases studies on risk analysis in food safety".

Representative instances of data-poor situations include: emergencies when risk assessors are requested to provide fast advice with limited information available (for instance, contamination of food chains by substances on which limited information is available); emerging issues stirring the need for timely decisions by risk managers (examples discussed: contamination of a staple food by poisonous weeds related to climate change, assessment of chemical mixtures, detection of rare allergens in common edible vegetables); countries where data collection still presents gaps, yet risk analysis of food safety issues is needed, beyond the simple fulfilment of legal limits (one example presented was the risk assessment of veterinary drug residues in the Republic of Georgia).

In data-poor scenarios, scientists acting as risk assessors should resist to the will (and the push by risk managers) for giving simple and straightforward answers, by ignoring uncertainties; actually, these should be identified and weighed especially when data sets are not rich. While in some data-poor scenarios (e.g., emergencies), close interaction and even overlapping between risk assessors and risk managers is unavoidable (and maybe useful), the final decision must remain firmly in the hands of risk managers. The risk assessor task is to provide an outcome that risk managers can elaborate into a straight message, i.e., the decision whether to act and how. Therefore, a critical issue is the communication of the risk assessment outcome. Especially in data-poor scenarios the final form of the risk assessor opinion should present as clearly and completely as achievable all the elements that are required to make decisions

and/or to improve the data set in order to reduce the uncertainty burden.

In data-poor scenarios, the boundaries between uncertainty and variability, which is inherent to the investigated population, may become blurred. Mixing-up the two issues may result in conceptual as well as factual hindrances for risk analysis. For instance, the population variability in the consumption of certain food items can be hidden by the lack of reliable food consumption databases. As a consequence, it will be unfeasible to make but rough estimates and assumptions on consumption of food items, without any information on the distribution of high consumers of certain foods, and differences related to age or gender.

In the meanwhile, risk assessors should not fall into a pessimistic attitude. For instance, the uncertainties related to population variability may be reduced by focusing on population subgroups which are more exposed and/or more susceptible (e.g., children). Such subgroups can be identified by "diagnostic risk assessment": we may name in this way deterministic or semi-probabilistic approaches used to screen ("diagnose") whether there is a potential problem, by using transparent elements of conservativeness.

Indeed, values, such as precaution, may be introduced in risk assessment when a time-effective response is needed to protect public health: for instance, data on a food commodity known to be highly contaminated taken as representative of the whole food category for which there are no data. In each case, the selection of conservative or precautionary assumptions must be transparent and understandable, as well as be based on the available data, however limited; ideally, these options should be discussed and agreed with the risk manager.

Expert Knowledge Elicitation (EKE) is a robust and standardised procedure implemented by EFSA, which can be of special use in data-poor scenarios to describe uncertainties and their distribution and range. EKE may also facilitate the reduction of the range of uncertainties, by promoting consensus through discussion. Obviously, EKE requires the availability of a group of experts, independent and with different backgrounds. If well-managed, EKE can be both effective and efficient.

Finally, the discussion on uncertainties must not be confined to risk assessors. Risk managers are all-important, starting from problem formulation and ending with the task of developing the assessment outcome, with its uncertainties, into options. If clear and complete, the evaluation of uncertainties should be viewed as an additional strength of a risk assessment opinion, as it increases the transparency. Thus, especially considering data-poor scenarios, it is pivotal that risk managers are trained to understand and cope with uncertainties.

ENDOCRINE DISRUPTERS

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The chemical industry and big data

Mike Snape, Associate at Oliver Wight EAME LLP shares his expertise on the role of the chemical industry when it comes to big data

Without a shadow of a doubt, big data is set to transform the way the chemical industry operates – for the better. Big data is nothing new – organisations have collected information for decades, but the crucial difference is that at last we now have the technological capability to do something useful with it. Used properly, it gives an organisation the edge over its competitors and in an increasingly more competitive and volatile environment, this can mean the difference between thriving, or surviving, (or not).

Given the scope of its various market sectors and customers, the chemical industry is not naturally suited to the 21st century, which rewards agility and flexibility. Modern markets are changing more rapidly than ever before, with chemical companies having to contend with catering to new customer segments, globalisation, fluctuating raw material costs, increasing competition and developments in technology.

What's so great about big data?

Historically, the chemical industry has been fairly predictable, with innovation and analysis of markets a biannual, or even annual event. In a 21st century framework, this is detrimental – companies which do this are missing out on valuable opportunities. By harnessing big data in the right way, organisations can reduce costs, increase margins and streamline processes, as well as allocating resources in line with the strategic goals and future objectives.

Greater demand plan accuracy is one of the many benefits, as predictive analysis is refined using big data. By using corresponding tools, such as modelling, and sophisticated IT systems to identify hidden patterns and interpret early signals, an organisation can make adjustments and realign its strategy early enough to avoid fire-fighting in the future. It promotes a proactive approach, rather than a reactive culture.

Analytics also enables companies to anticipate future customer behaviours to inform their forward business plan with true knowledge. By understanding what the customer wants and is likely to want in the future, chemical organisations can stay a step ahead in terms of meeting customer demand, with faster response times and shorter lead times. A better understanding of markets will also ensure that there is a focus on the right ones and will create shorter-term results to keep shareholders happy, whilst optimising profitable and sustainable growth in the long-term.

Practically speaking, data and analytics can have hugely beneficial effects in the chemical industry.

Production

In process-based industries, one of the proven benefits of advanced analytics is increased yield, whether through improved production or reducing waste. Similarly, superior quality is a by-product of advanced analysis, as insights emerge as to exactly which parameters influence yield variation. By carefully pinpointing which processes are underperforming and using data to assess the effect of the varying factors on production, organisations can decide on a course of action as to how to best tackle issues which are negatively affecting yield.

Preventative maintenance & asset management

There are now predictive-maintenance systems for equipment used in chemical manufacturing, such as turbines and compressors. These are fitted with sensors which collect continuous data, which is then subsequently analysed to identify patterns and prompt intervention before breakage, or to source parts in preparation for when breakage occurs to reduce the amount of time that the equipment is out of action. By avoiding unanticipated machine shut-downs,

chemical organisations can optimise performance and productivity.

> "By harnessing big data in the right way, organisations can reduce costs, increase margins and streamline processes, as well as allocating resources in line with the strategic goals and future objectives."

Supply chain

Big data also has a role in optimising a lean supply chain, especially in transportation logistics, which is crucial for the delivery of raw material for production, and for shipping out products. Advance analytics give organisations the ability to analyse weather patterns and forecasts, highlighting events that might cause a delay in the supply chain, such as tornadoes, earthquakes and other natural disasters. Based on these statistics, companies can then form contingency plans – identifying back-up suppliers, for example – to enable them to continue to meet operational targets.

Data-sharing can also encourage transparency; by linking internal and external data sources and sharing information, this can strengthen end-to-end planning along the multiple segments of the supply chain.

Pricing & purchasing

There are several factors which impact chemical pricing; market demand, raw material & energy pricing, exchange rates, competitor strategy, weather etc., making chemical pricing strategy complex. Traditionally, it's largely been based on experience, 'gut feeling' and outdated data - methods which are clearly unreliable and prone to inaccuracy. By using big data, manufacturers can leverage information from multiple sources to track prices, identify when to make key purchases and explore cost-reduction strategies. Not only does this promote increased profitability, but it can also provide competitive pricing solutions to customers. ■

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Marijuana use during pregnancy: The cannabis conundrum

Dennis R. Carty, Ph.D. and Pamela J. Lein, Ph.D., University of California, highlight the rising trend of marijuana use during pregnancy and the implications surrounding it

Many women suffer from nausea and vomiting during pregnancy to the point that these symptoms interfere with daily activities, or in extreme cases, compromise the health of the mother and unborn child. It is perhaps no surprise then that options for relieving these symptoms are a prominent topic in on-line forums for pregnant women. A notable trend in these on-line discussions is increasing advocation for the use of marijuana, also known as cannabis, to relieve pregnancy-induced nausea and vomiting. The mounting interest is driven in part by increasing legalisation and social acceptance of marijuana and approved medical use of cannabis-based products to treat nausea and pain associated with cancer, multiple sclerosis, Crohn's disease and some forms of epilepsy.

Additionally, marijuana is often promoted as a natural remedy with minimal side effects and, therefore, many women perceive it as a healthier alternative to the standard medications used to treat pregnancy-induced nausea. Indeed, 70% of women recently surveyed in the United States believe that there is "slight or no risk of harm" in cannabis use during pregnancy. The truth is that there are more questions than answers about the safety of marijuana use during pregnancy.

While humans have used marijuana (Cannabis sativa) for recreational, religious, and medicinal purposes for several millennia, basic research regarding the therapeutic efficacy and toxicity of the active constituents in cannabis, such as tetrahydrocannabinol (Δ9-THC) and cannabidiol (CBD), is remarkably limited. The basis of marijuana's biological effects was not determined until the 1990s when neuroscientists discovered two cannabinoid receptors, CB1R and CB2R, in the mammalian brain.

Subsequently, researchers found that these receptors respond to molecules naturally synthesized in the body from fatty acids, which are called endogenous cannabinoids, or endocannabinoids. The endocannabinoid system functions to regulate numerous physiological processes, including body temperature, hunger, processing of sensory information, and cognition.

Cannabis is a complex mixture of pharmacologically active compounds that includes more than 100 cannabinoids in addition to Δ9-THC and CBD, as well as other pharmacologically active molecules, such as terpenes and flavonoids. These compounds interact with the endocannabinoid system to cause the biological effects associated with cannabis.

For example, the binding of Δ9-THC to CB1R causes the "high" associated with smoking or ingesting marijuana. CB1R is widely expressed in the developing brain, and data from experimental animal models indicate that

endocannabinoid signalling plays a significant role in the normal development of the brain. Either overstimulating or blocking CB1R activity during brain development causes "miswiring" of brain circuits. This altered brain circuitry manifests as behavioural deficits in the young animal that persist into adulthood.

CB1R is expressed in the developing human brain by the first weeks of the second trimester. Δ9-THC, CBD and other cannabinoids in marijuana cross the placenta and are transferred into breast milk. Because cannabinoids have a relatively long half-life in the human body, the fetus or breastfeeding infant may be exposed to active cannabinoids for up to 5 days after maternal use of cannabis.

Such observations raise the possibility that marijuana use during pregnancy potentially alters fetal or infant brain development by interfering with the endocannabinoid signalling system in the developing brain. This possibility is supported by data emerging from several large epidemiological studies of cannabis use during pregnancy in North America and Europe.

These studies report an association between maternal cannabis use and increased impulsivity, attention deficit, hyperactivity, delinquent behaviours, and impaired memory in children, and higher rates of depression, drug abuse, memory deficits, and psychosis in adolescents and adults.

A key question is whether there is a safe level of maternal marijuana use. Answering this question requires knowing how much marijuana is consumed by women during pregnancy. However, quantifying marijuana intake is challenging because the potency of cannabis, as well as the ratio of the different active cannabinoids it contains, is extremely variable. With regard to the latter, it is also unknown as to which constituent(s) in marijuana impact the developing brain.

This is a critically important question in light of widespread on-line discussions suggesting that CBD is safer than Δ9-THC. Compared to the significant amount of research on the toxicity of Δ9-THC, which is linked to the dysphoric and other adverse effects of marijuana abuse, there has been comparatively little research on the potential toxicity of CBD.

Recent studies in zebrafish, which have an active endocannabinoid system, suggest that CBD causes abnormal development and lethality at concentrations significantly lower than Δ9-THC. While it has yet to be determined whether CBD interferes with brain development in mammals, including humans, these findings suggest the urgent need for research to characterize the developmental neurotoxicity potential of the individual active constituents in marijuana.

The developmental neurotoxicity of marijuana is also influenced by the production and method of consumption of cannabis products. For example, smoking a cannabis cigarette produces combustion byproducts, including polycyclic aromatic hydrocarbons (PAHs), which are neurotoxic to the developing brain. Vaporizing dried cannabis significantly reduces the production of combustion byproducts, but can introduce neurotoxic metal contaminants into the inhaled product and increase the amount of active cannabinoid consumed.

Concentrates such as oils, tinctures, and edibles avoid the issues associated with smoking or vaping cannabis. However, these methods of consumption do not mitigate the problem of wide variability in the purity of cannabis products.

For example, cultivation practices can introduce contaminants such as microbial impurities, mycotoxins, metals, and pesticides into the final product. Maternal consumption of cannabis products containing these contaminants can result in their transfer to the fetal brain, which is of potential concern since many of these contaminants are known to interfere with brain development.

As cannabis use becomes increasingly acceptable and widespread, increasing numbers of women are likely to use cannabis during pregnancy. While the impact of maternal cannabis use on the unborn child remains an open question, the data that are currently available warrant caution, and underscore the urgent need for additional research to inform ongoing discussions regarding the cannabis conundrum in pregnancy.

UCDAVIS VETERINARY MEDICINE

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Health research: Applying genome technologies to the study of disease

In this interview, Dr Carolyn M. Hutter, PhD, Director, Division of Genome Sciences at the National Human Genome Research Institute (NHGRI) outlines the important role of research when it comes to applying genome technologies to studying disease

On 25th April 2019, National DNA Day celebrates the 66th anniversary of the discovery of DNA's double helix and the 16th anniversary of the completion of the Human Genome Project (HGP). To mark this important anniversary, we spoke to Dr Carolyn M. Hutter, PhD, Director, Division of Genome Sciences at the National Human Genome Research Institute (NHGRI) within the National Institutes of Health (NIH), to learn more about their excellent work, including their role in applying genome technologies to the study of human health and disease. Genomics is a wide-ranging area and this interview covers some fascinating aspects of this, including understanding variation in the human genome and improving human health through genomics research.

By way of background, the NHGRI grew out of the international HGP project. Since the formation of NHGRI in 1997, the Institute has expanded in terms of what they do. Carolyn tells us that NHGRI is guided by a series of strategic plans, the most recent of which was published in 2011 and focuses on thinking about research from the bench to the bedside. She explains this point further, describing the ambitions of the Institute in her own words.

"We continually study everything from the structure of genomes all the way through to the application of genomics in clinical settings. At the moment, we are starting new strategic planning for our Genome 2020 vision. We kicked this off in February 2018 and are planning to have finished in October 2020 which marks the 30th anniversary of the start of the HGP.

"The Institute is part of the National Institutes of Health (NIH), one of the 27 Institutes and Centers within NIH, and our remit is centred around how we use genomics to understand human health. NHGRI doesn't fund all genomics but we consider ourselves to be at the forefront of the field. We recognise that other parts of the NIH are increasingly funding genomics and we collaborate with these groups and a number of international partners."

The Human Genome Project (HGP): From basic to clinical science

With the human genome sequence complete since April 2003, Carolyn then details the various ways in which scientists around the world have benefitted from this in the years since. This goes from basic through to clinical science in terms of how we think about things when it comes to genomics. She says that some argue that the HGP has not yet been completed because we do not yet have full sequencing for very complex areas of the genome. Carolyn then develops this thought further.

"The completion of the HGP really provided this initial backbone for that a much more specific sequencing and understanding of the structure on which of the human genome can be built on. It allows a blueprint upon which all of these other activities can happen. One of these is driving the technology and the innovation needed to sequence genomes, including the complex regions, faster, cheaper and more accurately. Those are the three things that we are always looking for in this area.

"You can also think about what it really means to understand the genome, including 3D or 4D structure of genomes. Another example is projects like The ENCODE Project: ENCyclopedia Of DNA Elements, which are addressing the fact that we have not fully understood what all the genes are doing, or what all the non-coding parts of the genome doing? How do we catalogue them, start to elucidate their function, and put together pieces of that whole picture?"

Understanding variation in the human genome

Carolyn says that you can then layer on top of that additional questions, such as can we understand the variation in the genome? Or what does the variation of the genome tell us about population genetics and population structure or about the relationship between the variation in the genome and disease? She then provides more detail to us about this compelling point in her own words.

"As we start to understand the variation of the genome in relation to disease, we need to move from just saying that a part of the genome is associated with the disease to understanding the causal relationships and

the mechanisms. How do we go from understanding this part of the genome is associated with the disease to translate that into ways that can benefit public health and clinical medicine?"

Improving human health through genomics research

The interview then turns to look at on interesting examples of NHGRI's work to improve the health of all humans through advances in genomics research. Carolyn stresses that their focus as an Institute is on the technologies, methods and resources to move the field of genomics forward. Although NHGRI does not have a disease focus, they do participate in exemplary disease-focused projects. As an example, they partnered with the National Cancer Institute (NCI), another branch of the NIH in the U.S., on The Cancer Genome Atlas (TCGA). Carolyn noted the impact of that project on our understanding of cancer, before moving the conversation to detail more of NHGRI's research work and the priorities for the future in this vein.

"We have a number of Genomic Medicine programmes, such as the Clinical Sequencing Evidence-Generating Research (CSER) program that maps the impact of sequencing in clinical settings. Importantly, we are also building the basic understanding of the relationship between a genome and disease which is fundamentally needed to have an impact in clinical settings.

"Questions about the future priorities for genomics research and its applications to human health and disease are a key part of our Strategic Planning efforts, as mentioned above. We are really excited to have this opportunity to reach out into the community, through workshops and social media, for example, to get feedback. We have internally organised ourselves around key areas that cover basic genomics and technology, genomics of disease, genomic medicine and health, genomics and data science, and genomics in relation to education and societal issues. In all of these areas, we look forward to getting input over the next year and a half on what people see as important questions at the forefront of genomics, and to see what ideas and key areas move to the top.

"One of these key areas we have already identified is the question of how you go from variation to function to disease, and how to study this at scale in order to gain biological insight into the nature of inherited disease, insight into functional mechanisms, and ultimately to provide a rational foundation for clinical applications. We are also seeing a real need to further identify what types of genomics are ready to go into medicine and how do we effectively implement them to get there? We are also addressing how to bring together recent advances in computational biology and big data in an integrative way that allows for innovation in genomics. Important work in all of these areas is already happening, but we need to take these to the next level and draw on the exciting scientific findings that will come out of doing that type of effort well."

Accelerating scientific and medical breakthroughs to improve human health

In closing, Carolyn shares her thoughts on how to accelerate scientific and medical breakthroughs that improve human health. She noted that as a funder, NHGRI spends a lot of time thinking about their need for a really well-balanced portfolio. As such, NHGRI needs to make sure that activity is happening at the right level in all these aforementioned areas.

"Certainly, you don't want to go too far with investments in one specific area, because you never know where you are going to have the most important breakthroughs. This is especially true for a transdisciplinary area like genomics. In addition, we are constantly balancing the need to support fundamental resources and approaches, versus really high-risk approaches where it is less clear that they are going to pay off, but when they do a giant leap is made. Another area we consider is how best to balance large-scale collaborative research and consortia, versus investigator-initiated projects.

"It's important that we have balance in terms of what we are funding and what we are doing in order to enable the scientific advances and breakthroughs." ■

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The biology of "love": Lessons from prairie voles

Sue Carter, Director of The Kinsey Institute, discusses the fascinating nature of prairie voles and explains how they can teach us about the biology of "love"

In both nature and in the laboratory small field mice, called prairie voles form life-long social bonds. Males of this species are amazing parents involved in all aspects of care of the young except nursing. Males even help to "midwife" their partner's labour and help her cut the umbilical cord at birth. Extended families form around the original pair, as prairie vole fathers and then older offspring remain in the natal nest, scrupulously avoiding incest. Males and females are about the same size and they jointly defend their family and resources. Taken together biologists have called this set of behavioural and physical traits "monogamy."

The monogamy paradox

Because prairie vole pairs were sharing a nest and raising babies together, we initially assumed that they also were sexually monogamous. But when we tried to test this assumption, voles of both sexes did not cooperate – often mating with strangers. As DNA fingerprints became available, many prairie voles again failed the genetic tests for sexual monogamy. Similar findings emerged in other apparently monogamous mammals including humans, and most species of birds. Some individuals were sexually monogamous, but when viewed at the level of a species, sexual monogamy was rare or non-existent.

Given the opportunity, both male and female prairie voles were willing to have sex outside of the pair bond. However, once mating was complete, strangers or nonfamily members were often attacked. Like a reality TV show gone wrong, we discovered that male prairie voles were raising, as their own, babies fathered by other males. We slowly began to accept the notion that social attachments are real and have causes and consequences similar to what humans call "love."

"I hope we don't lose sight of one thing. It was all started by a mouse,"
(Walt Disney)

The term monogamy is derived from the Greek for a single wedding or ritual, and does not speak to sexual choices. Considered across the lifespan, many humans have more than one sexual partner. None of this is shocking. But we now understand that the traits of social monogamy are a kind of syndrome with shared neurobiological underpinnings. Our terminology had to be adjusted to admit that what we were observing was more accurately termed "social monogamy."

Hormonal ties that bind

Prairie vole families are bound together by invisible social bonds. As we searched for a mechanism for social monogamy, we found in both male and female voles that pair bonds were cemented by powerful molecules synthesized in the brain. These hormones were released by social experiences, including sexual interactions and even the presence of a baby. In turn these brain-derived chemicals regulate social engagement, pair bond formation and parental behaviour. In addition, following mating, aggression toward strangers increased, and behaviours that looked suspiciously like "jealousy" emerged. However, as might be expected protective aggression toward intruders is based on a somewhat different cocktail of hormones than those needed to create loving relationships between pairs or directed toward a baby.

Two molecules, oxytocin and vasopressin, made primarily in the brain are at the epicentre of social monogamy. However, it has taken decades and the help of prairie voles to untangle these relationships. These deceptively simple molecules are capable of binding to each other's receptors, creating various emotional states that support many behavioural permutations. In addition, oxytocin and vasopressin and their receptors are exquisitely sensitive to experience.

In fact, prairie voles are teaching us that the genes regulating receptors for oxytocin and vasopressin can be switched off or on across the life cycle. Life's most important experiences – sexual experiences, birth, the presence or absence of sensitive parenting, exposure to hormones in early life, extreme stress and traumas – are all "epigenetic" events regulated by

molecular changes with long lasting effects on the genome. This is one of several mechanisms through which the consequences of love protect us across our lifespans, and through which the absence of love leaves us vulnerable.

Love heals and allows us to be human

Studies of prairie voles, and comparisons to nonmonogamous mammals forced us to re-imagine concepts like monogamy and love. Selective attachments, and well as parenting, are supported by a comparatively simple brain and ancient neural and endocrine pathways. Human cognition, a complex nervous system or even gonadal hormones are not essential to allow pair bonds to form or infant nurture to emerge. However, in voles – as in humans – these are influenced by social context including fear, safety, and the emotional history of the individual.

Social behaviours, such as pair bonding and parenting, are hormonally-supported and interact with emotions that facilitate good health, a sense of safety and eventually health and survival. Furthermore, nature is conservative and the same hormones are used over and over again across the life cycle and in different species of mammals, where they support variations in social behaviour and aggression across species and individuals, as well as sex differences in behaviour.

Brain regions involved in pair bond formation and parenting also are shared with other forms of rewarding experiences, and with the neural pathways involved in drug addiction. The absence or loss of love creates vulnerability to substance abuse, depression and other forms of mental and physical illness. Knowledge of these relationships helps to explain why love is rewarding, but also can be addictive, and why the loss of a partner or loved one may be experienced as physical pain or illness.

The biology of "love" is intertwined with the biology of reproduction and basic survival in a dangerous world. This is true of both voles and humans. Love and its consequences operate largely below the level of human consciousness. However, prairie voles have taught us that love is constructed from biological mechanisms that are shared with other mammals. Using insights from prairie voles, we are discovering that the same molecules that support love facilitated human evolution, now allow us to survive and thrive, help create culture, and may even help to explain how and why "love is good medicine."

Suggested reading

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The oxytocin-vasopressin pathway in the context of love and fear. 2017
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Love as medicine. 2019
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Progressing science in the U.S. – Enabling discoveries for understanding life

The work of the National Science Foundation (NSF) to advance science is charted here, with a focus on the work of their Directorate for Biological Sciences (BIO) in enabling discoveries for understanding life

The National Science Foundation (NSF) is an independent federal agency created back in 1950 by U.S. Congress, "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence". We know that NSF is crucial because they support basic research and the people that do this to create knowledge that changes the future. [1] The number of research areas supported by the NSF is staggering and includes Biological Sciences (BIO), Education and Human Resources (HER), Geosciences (GEO), Mathematics and Physical Sciences (MPS) and Social, Behavioral and Economic Sciences (SBBE).

Directorate for Biological Sciences (BIO)

Looking at just one of these areas, let's take a look now at the mission of the Directorate for Biological Sciences (BIO) and some examples of the excellent work they support. In short, their work essentially enables discoveries for understanding life itself, indeed, BIO-supported research furthers the frontiers of knowledge when it comes to biology, as well as increasing the understanding of complex systems and supplying a theoretical basis for original research in numerous other disciplines of science.

Within the remit of BIO, research studies encompass biological molecules, communities, cells, organs, organisms, populations, tissues and ecosystems up to and incorporating the global biosphere. The website of BIO provides us with an excellent overview of the major challenges of reaching a coherent understanding of life itself.

"This challenge will require that knowledge about the structure and dynamics of individual biological units, networks, sub-systems and systems be compiled and connected from the molecular to the global level and across scales of time and space. Integral to all activities across the directorate is a commitment to integrate research and education, broaden participation, and promote international partnerships." [2]

In terms of the leadership, we find out that in February this year, the NSF selects D. Joanne Tornow to serve as Head of the Directorate for BIO. Her wealth of experience at NSF includes a focus on accountability, as well as supporting cross-disciplinary, convergent research that plays on the strengths of scientists and engineers to solve problems.

"Dr Tornow is an experienced manager who brings a wealth of knowledge to BIO and the NSF leadership team", says NSF Director France Córdova. "Joanne has spent the past year leading BIO in an acting capacity and has already demonstrated that this critical component of NSF is in good hands. I look forward to seeing BIO's progress under her leadership."

We know that exciting discoveries from NSF-funding include unearthing a new branch on the tree of life with archaea, the revolutionary CRISPR genome editing tool, as well as advancing other scientific areas, and enhancing other fields and making new ones.

"I fell in love with biology in the ninth grade and have been a biologist ever since. I have a long history with the BIO directorate, a place that was my first home at NSF and one of my favourite places to work," Tornow comments. "I am honoured to lead BIO at a particularly exciting time of discovery across the spectrum of the biological sciences." [3]

There are a number of interesting examples of how this support for the biological sciences is being given in terms of projects funded. One is led by University at Buffalo physicist Andrea Markelz who reports the development of a method for rapidly measuring proteins' unique vibrations. [4] By way of background, we know that proteins vibrate with microscopic motions that help them perform essential tasks like photosynthesis and from cell repair, which is true for the cells of every living organism – humans, bees, birds, roses and even bacteria.

> "Within the remit of BIO, research studies encompass biological molecules, communities, cells, organs, organisms, populations, tissues and ecosystems up to and incorporating the global biosphere. The website of BIO provides us with an excellent overview of the major challenges of reaching a coherent understanding of life itself."

New possibilities in biological research could occur, such as studying the microscopic motions of proteins in a more efficient way. The new technique could enable scientists to quickly assess whether pharmaceuticals designed to inhibit a protein's vibrations are working. "Proteins are elegant and robust nanomachines that nature has developed", explains Markelz, PhD, at the UB College of Arts and Sciences. "We know nature uses molecular motions to optimise these machines. By learning the underlying principles of this optimisation, we can develop new biotechnology for medicine, energy harvesting and even electronics." [5]

There are so many other interesting examples of research funded this year, including a study which reveals the way in which a group of deep-sea microbes gives clues to the evolution of life on Earth, according to a paper in the ISME Journal. [6] Another example comes from Rice University and concerns protein signalling in the rapidly differentiating cells of embryos, which are believed to be more complex than previously thought. [7]

In closing, it's amazing to think that the scope of this article only covers a fraction of the NSF's wonderful work. If we think about the wider picture, we know that in fiscal year (FY) 2019, the NSF's budget totals $8.1 billion. Add to this, the fact this funding reaches all 50 states of the U.S. to almost 2,000 universities, colleges and other respectable institutions. Every year, over 50,000 competitive proposals for funding are received by the NSF. 12,000 new funding awards are made annually. Fundamental research and education across all fields of science and engineering, including the biological sciences is set to continue into the future. [8] ■

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Early detection of corneal disease with THz and millimetre wave frequency based thin film measurement techniques

THz and millimetre wave frequency techniques, combined with thin film measurement methods, provide early detection of corneal edema associated with disease in the view of Zachary Taylor, Assistant Professor at Aalto University

The adult human body is ~60% water. Tissue water content (TWC) varies from from 50%-80% depending on age, location on the body, physiologic state, and so on. Many diseases can perturb this fraction and medical research today has dedicated profound time and resources developing diagnostic systems, tools, and algorithms to detect and characterise these abnormal changes in TWC. A system familiar to many is magnetic resonance imaging (MRI), which uses precisely tuned magnetic fields and RF pulses to form volumetrically resolved maps of body water content. Brain tumour imaging, blood perfusion analysis, and spinal joint assessment are among the countless possibilities with MRI generated TWC maps. However, magnetic fields are difficult to characterize at boundaries between tissue and air, therefore, quantitative assessment of surface tissue water content is extremely difficult.

One important, water-rich, surface tissue system not currently accessible with MRI is the cornea. The cornea is the outer most layer of the human eye (Figure 1) and principally composed of collagen and water in mass fractions of ~ 21% and 79% respectively. The tough but optically transparent tissue protects the delicate structure of the eye from the outside environment and is responsible for the majority of the focusing power of the human optical system. The bottom layer of the cornea (endothelium) sits adjacent to a water volume called the aqueous humour (Figure 1). The role of the endothelium is to actively pump water from the cornea and back into the aqueous humour to maintain 79% water and, therefore, ensure optical clarity. Perturbations from the 79% water lead to significant vision degradation.

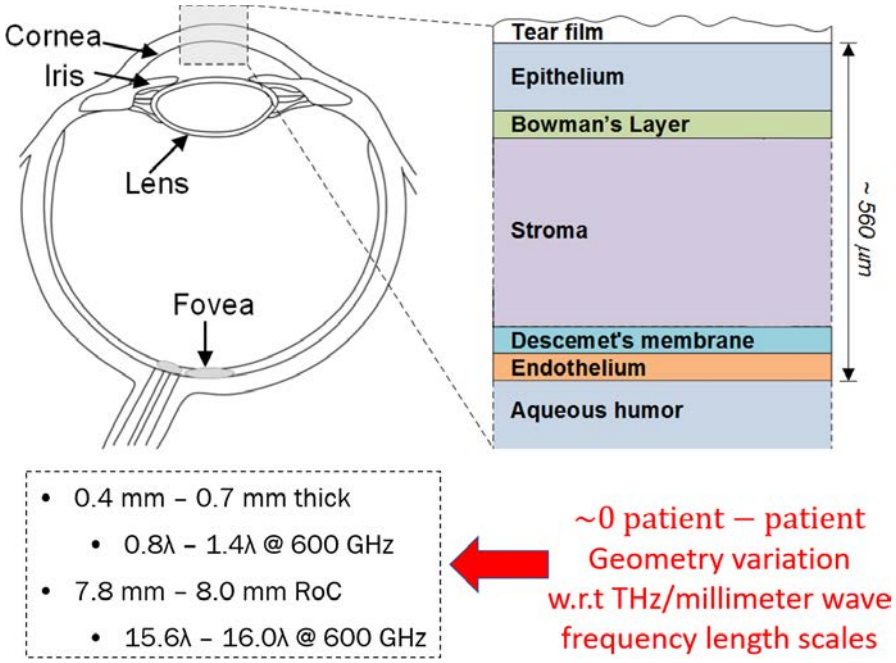

Figure 1: The patient-to-patient geometric variation of the cornea (thickness and radius of curvature) is fractions of a wavelength in the THz frequency range. The average thickness varies by 0.3 mm which is fractions of a wavelength at THz and millimetre wave/. The radius of curvature (RoC) range is even smaller at 0.2 mm.

A common disease that attacks the endothelium's pumping efficiency is Fuchs endothelial corneal dystrophy which affects ~40% of the world's population over 40 years of age. A reduction in pumping efficiency leads corneal hyperhydration and then corneal edema due to uncontrolled diffusion of water from the aqueous humor to the stroma (Figure 1). Edema is readily apparent from increased corneal thickness and significant optical opacity. This gives the cornea a "milky" or glazed over appearance. Corneal edema and, therefore, disease detection via visual assessment of opacity is straightforward but it is difficult to treat the disease at this point in

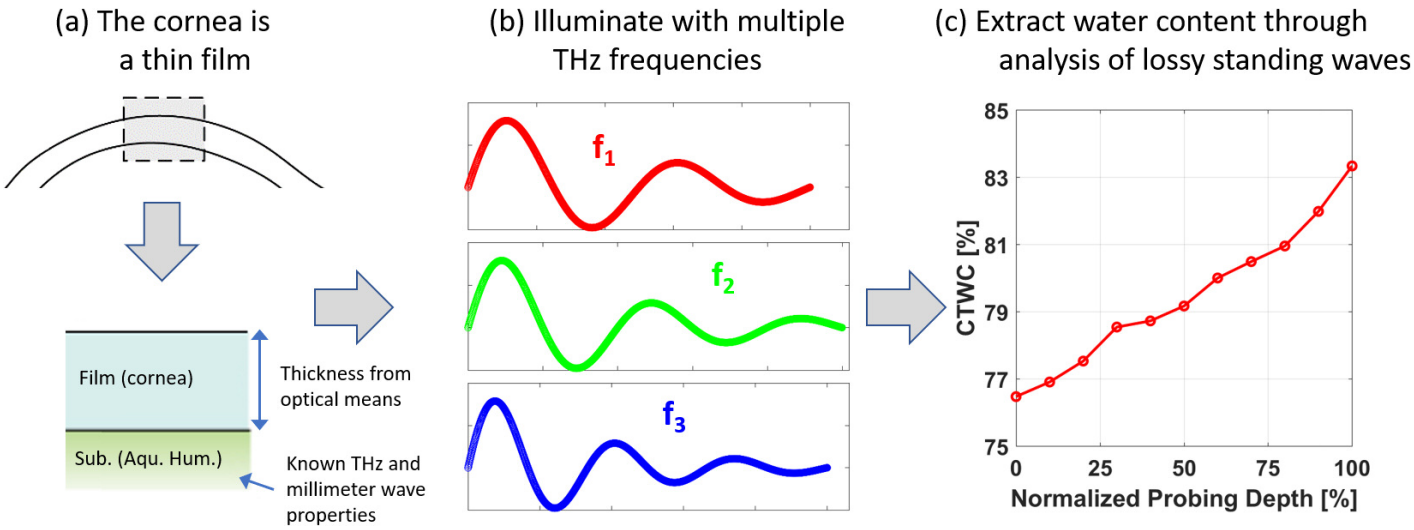

Figure 2: The lack of physiologic variation w.r.t. to THz frequency wavelengths and proximity to a deep (w.r.t λ) body of water allows one to treat that cornea as thin film sitting on top of an infinitely thick, lossy substrate. Analysis of lossy standing waves at multiple frequencies enables extraction of water content gradients in the thickness dimension.

the progression. The definitive treatment for Fuchs dystrophy is called lamellar transplant, where part or all of the diseased cornea is resected and donor or artificial cornea are grafted on. Graft rejection following transplant is not uncommon (1%-12% depending on surgical technique) and failure is typically preceded by the presence of edema in the graft. Detection of graft rejection via visual assessment of corneal edema is too late in the rejection progression to save the graft. Early and accurate detection and quantification of corneal edema, before perceptible changes in optical clarity, are not currently feasible. Development of sensitive and specific corneal edema measurement systems will considerably improve patient outcomes.

Despite efforts in research the clinical gold standard for water content is still pachymetry or a centre of the cornea thickness (CCT) measurement. This method recognises that an edematous cornea must expand (thicken) to make room for excess water and thus a history of steadily thickening cornea indicates compromised corneal health. However, the vast majority of patients do not have detailed CCT histories. Further, sincepachymetry is an indirect measure of water it cannot, in a single time point, ascertain or even infer water content. Studies performed on patients with corneal disease suggest that small, initial increases in CTWC do not produce statistically significant increases in CCT. Some high-resolution microscopy studies have identified changes in cellular morphology in Descemet's membrane (Figure 1) but these are exploratory and the clinical utility is unclear. What is needed is a direct measurement of CTWC that can be decoupled from variations in tissue geometry/morphology. THz and millimetre wave techniques may provide the key.

The inspiration for THz and millimetre wave probing of CTWC r content arose from ellipsometry; a measurement technique used to characterise thin films of materials. Ellipsometry illuminates the target with a laser that (1) has a wavelength on the order of the film thickness, and (2) the speed of light of that wavelength in the film is a very strong function of the film material and any imperfections in the film material. The illumination will bounce around inside the film and create a standing wave. Small changes in illumination parameters, such as wavelength, or angle of incidence create large, detectable changes in the standing wave. It is straightforward to numerically extract the thickness of the film and/or the material properties of the film simultaneously with a very high degree of accuracy.

The cornea is a perfect representation of a thin film (Figure 2) at THz and millimeter wave frequency length scales. It sits on top of a known material with known properties (water) and its physical thickness can be accurately measured via a number of optical techniques. Three key features render cornea a great match to THz and millimetre wave imaging. First, the thickness range, 0.4 mm-0.7 mm (Figure 1), falls right in the middle of our free space THz wavelength range: 0.1 mm-3 mm. Second, the standard deviation in radius of curvature (RoC) is fractions of a wavelength in the band of interest which enable THz and millimeter wave systems to always assume the cornea is a sphere thus allowing for straightforward optical design. Finally, the propagation speed of THz and millimetre wave radiation through physiologic material is an extremely strong function of water content and a weak function of the non-aqueous components (e.g. collagen). Therefore, quantitative mapping of corneal water content , and even water content gradients, can be through resolving the standing waves created by illuminating with an

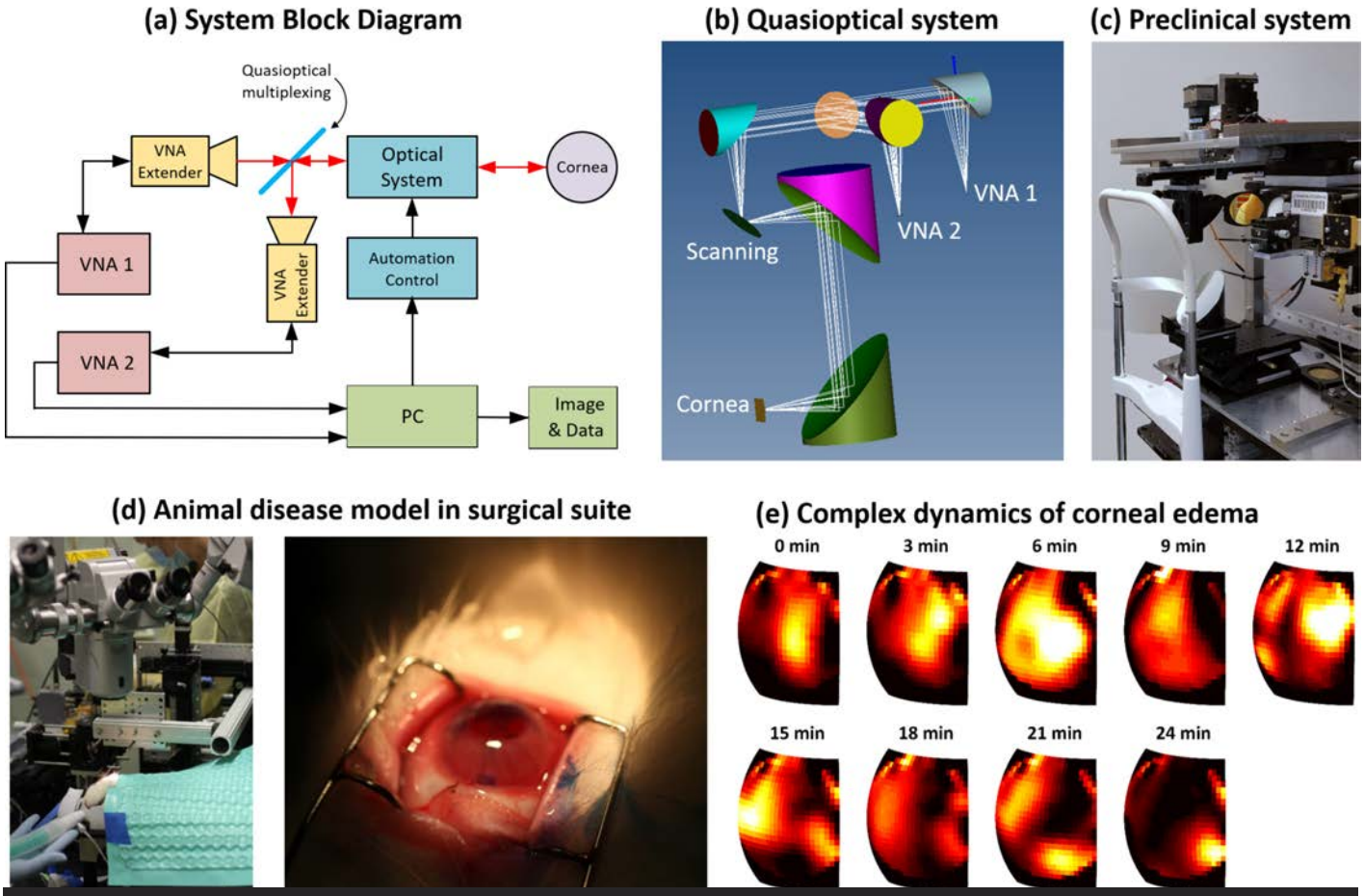

Figure 3: Ongoing corneal imaging work. (a) Block diagram of system in development. (b) Optimised THz quasioptics. (c) Preclinical test system. (d) Descemet's membrane stripping experiment. (e) THz frequency maps of corneal edema formation at numerous time points post stripping

ensemble of frequencies at in the THz and millimetre wave bands (Figure 2).

Our programme was established by an R01 grant (R01EY021590) from the National Eye Institute (NEI) for endothelial disease and graft rejection detection. We were the first to introduce the concept of lossy etalon analysis to THz millimetre wave imaging of cornea and the first to use it to decouple CCT changes from CTWC perturbations in vivo. We are currently able to resolve ~1% water by volume changes in corneal phantoms and are close to demonstrating this capability in in vivo animal models.

A current snapshot overview of the programme is shown in Figure 3. We are building multi-transceiver systems at complementary frequency bands to enhance water gradient extraction (Figure 3(a)) and have performed extensive optical simulations to optimise signal acquisition from curved surfaces (Figure 3(b)). Numerous human imaging systems prototypes have been built (Figure 3(c)) and are currently being tested tested on volunteers. We have also completed surgical trials in rabbit models (Figure 3(d)) and observed corneal edema formation (Figure 3(e)) after removal of Descemet's membrane (Figure 1).

Corneal tissue water content (CTWC) quantification offers a unique opportunity for THz and millimetre wave techniques in medicine. The relative lack or physiologic variation in corneal morphology on THz length scales and the extremely strong dependence of THz properties on water content enable successful application of thin film metrology. Successful clinical translation of this technology will require a multidisciplinary approach combining the fields of RF remote sensing, antenna design, radar engineering, optical techniques. In recognition of these challenges and the broad range of expertise required, we has moved the entire corneal tissue water content imaging programme to Aalto University in Finland.

A?

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Biology: The remarkable advances in stem cell research

Graham Rowe, Lecturer in Biological Sciences at the University of Derby turns the spotlight on an aspect of biology that concerns the remarkable advances that have been made in stem cell research

The functioning of an adult human body parallels the daily work of a university or other large organisation. Successful and efficient university functioning requires employees ('cells'), each a specialist in their role, to work with other specialists in their own areas ('tissue') and other departments ('different organs'). During their development, an individual employee is trained for many years, into an ever-increasing area of specialism, with decisions made at each step of the way, making it difficult to change direction or to turn back.

While specialists may be adaptable, this is usually only to a degree; it is unlikely that a specialist in one area, for example, marketing, will be instantly successful in cell biology research. Large-scale re-training is difficult, if not effectively impossible, especially after potentially decades of increasing specialisation in a particular role, and so it is with tissue-forming cells in the human body – or rather was, until recently.

At the point of conception, the single-celled zygote (fertilised egg), through multiple subsequent rounds of cell division and the process of embryonic development, can form any specialised cell, and group into tissues found in the adult body. After about five days of cell division, the zygote forms a hollow ball of cells (about the size of a full-stop) known as a blastocyst; embryonic stem cells on the inside are 'pluripotent' and capable, through normal development, of giving rise to all the specialised cells found in the human body. During early embryo development, cells in different regions of the blastocyst form three cellular 'germ layers' (endoderm, mesoderm and ectoderm). In each germ layer, these cellular descendants of pluripotent stem cells are already on their path to becoming a diverse array of highly specialised cells in different parts of the adult body. While all the genes in the human genome (about 22,000) are present in the nucleus of each cell, during this process of cellular 'differentiation' the protein products of certain regulatory genes (called transcription factors) can turn on, turn off, or otherwise alter the level of activity of numerous other genes (just like a single switch or dimmer can be used to control the output from multiple lights).

> "The human body has a naturally low regenerative potential, but millions of people would benefit globally if tissues and organs could be replaced on demand. Traditionally, this has been done by organ transplantation, but demand greatly outstrips supply. Bringing together advances in stem cell research with those in the field of three-dimensional (3D) printing enhances the prospect of '3D bioprinting'."

However, for most cells, once they are on their path to tissue specialisation, there is no turning back. As development progresses, cells become increasingly differentiated and specialised to the tissue environment in which they find themselves. Some adult stem cells (somatic) persist, but the cellular descendants of these part-differentiated are largely determined by their tissue environment. While the discovery of tissue-specific stem cells was an important advance, such cells are difficult to locate and hard to maintain in laboratory cultures.

Because of their enormous potential for use in regenerative medicine, such as alleviating some problems of ageing and in the treatment of chronic diseases, research and development (R&D) into stem cells is a global multibillion-dollar industry. According to one report, the field of regenerative medicine is expected to have a global market value of $53.7 billion by 2021. The 2018 governmental report from the Office for Life Sciences (the application of biology and technology to health improvement) showed that in the UK alone the sector had an approximately £70.3 billion in annual

Dolly the sheep

turnover, increasing greatly after factoring in supply chains. With one of the strongest and most productive health and life sciences industries in the world, the UK Government, through the Life Sciences Industrial Strategy paper committed nearly £500 million of investment.

For experimental research, human embryonic stem **cells can be obtained from early-stage embryos, normally those formed in the laboratory but no longer required for assisted reproduction purposes**, but this source comes with ethical and legislative issues; even words associated with the process (harvesting, cultured, laboratory, etc.) can be emotive and sound sinister to some. The requirement for a steady flow of new human embryos for research purposes has partly been addressed with an important development: the culturing of embryonic stem cells in the laboratory and their maintenance as cell-lines which retain their developmental flexibility.

Monthly advances are being made to better understand the cellular differentiation process using these laboratory cultures; the controlled differentiation of stem cells being an important requirement if they are to reach their full potential in regenerative medicine. Complementing this research, there are developments in genomics, particularly epigenomics (important for understanding gene regulation and expression) and transcriptomics (those genes actively being expressed in a particular cell or tissue, or at a particular time or set of circumstances).

In 2016, genomics-related activities in UK Life Science companies had an estimated £1 billion turnover and employed 1,800 workers. A further boost to stem cell R&D came in October 2016, with the launch of the Human Cell Atlas Project (HCAP), a global effort connecting biologists, clinicians, technologists, physicists, computational scientists, software engineers, and mathematicians.

HCAP aims to produce "a unique ID card for each cell type, a three-dimensional map of how cell types work together to form tissues, knowledge of how all body systems are connected, and insights into how changes in the map underlie health and disease". A realistic goal considering the rapid advances in single-cell genomics; genomics, epigenomics, transcriptomics – all at the level of a single cell. In December 2018, the UK's Medical Research Council announced that they would be investing £6.7 million to support the Human Cell Atlas initiative.

"In 2016, genomics-related activities in UK Life Science companies had an estimated £1 billion turnover and employed 1,800 workers. A further boost to stem cell R&D came in October 2016, with the launch of the Human Cell Atlas Project (HCAP), a global effort connecting biologists, clinicians, technologists, physicists, computational scientists, software engineers, and mathematicians."

Dolly the sheep (often incorrectly thought of as the first cloned mammal) was born in the summer of 1996 following a process of nuclear transfer; the nucleus from a mammary gland cell of an adult sheep was transferred into an enucleated unfertilized egg cell from a different sheep. The 'embryo' developed in the laboratory and, once at a blastocyst stage it was implanted into a surrogate mother sheep and allowed to develop naturally to term. The real and lasting significance of Dolly was that it was the first mammal to be cloned from a fully differentiated adult somatic cell. Since Dolly, there have been enormous advances in mammalian cloning via nuclear transfer, but for most species, the process is still very inefficient, and embryos produced via this cellular reprogramming process often show abnormal development. The real legacy of Dolly the sheep has not been primarily in advancing research into the cloning of mammals, but in highlighting the exciting prospect that differentiated cells may, in fact, be reprogrammable.

Researchers are making monthly advances in our understanding of how differentiated body cells can be reprogrammed to produce what are called 'induced pluripotent stem cells' (IPS) which subsequently, through controlled differentiation, can be grown back into any tissue. IPS are, therefore, differentiated somatic (body) cells that have been reprogrammed to behave like they were embryonic stem cells. IPS are an important research development, further reducing the demand for embryonic stem cells derived from human blastocysts and enabling scientists to better understand the normal development and cellular differentiation process. One thing's for sure, these are all necessary and important steps along the road if we are to see stem cells becoming widely used in a cost-effective way for regenerative medicine and in the improvement of human quality of life with a steadily increasing average life expectancy.

The human body has a naturally low regenerative potential, but millions of people would benefit globally if tissues and organs could be replaced on demand. Traditionally, this has been done by organ transplantation, but demand greatly outstrips supply. Bringing together advances in stem cell research with those in the field of three-dimensional (3D) printing enhances the prospect of '3D bioprinting'. Artificial organ printing, by reprogramming patient-specific cells (IPS) and bioprinting them onto natural or biocompatible scaffolds, takes the prospect for regenerative medicine to another level. While many challenges remain, advances in stem cell R&D have been so rapid over the last decade that such 'futuristic' scenarios are perhaps not as distant as they might seem. ■

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A social challenge for Europe: The fight against poverty and social exclusion

Anna Lisa Boni, Secretary General, EUROCITIES explains why the fight against poverty and social exclusion is a social challenge for Europe

One year on from the adoption of the European Pillar of Social Rights, cities are taking the lead in the fight against poverty and social exclusion across Europe.

As the level of government closest to people and the local economy, city authorities are the first to see that labour markets are changing, that we are facing an urgent housing crisis and that inequality is rapidly rising in Europe. At a time when one in four people in the European Union (EU) are at risk of poverty or social exclusion, it is now more important than ever to ensure social rights for all people and preserve social cohesion.

With this in mind, the success or failure of policies like the European Pillar of Social Rights depends on the effective involvement of local authorities. Yet, cities cannot act alone.

Inclusive cities for all

We need a fairer, more equal and inclusive Europe that puts people at its centre. The Pillar helps provide political momentum to deliver concrete actions on the ground, which is the spirit behind our new EUROCITIES initiative 'Inclusive cities for all: Social rights in my city'.

21 cities, representing more than 20 million citizens have so far pledged €4.32 billion in city measures to implement the principles of the European Pillar of Social Rights.

Nine of the 21 cities have pledged to build 75,000 new affordable housing units by 2024 with an investment of over €2.17 billion, reflecting a pressing challenge for cities in terms of rising homelessness due to a shortage of affordable housing. And we expect more cities to follow suit.

Many cities, of course, were already committed to delivering inclusive social policies to promote social rights for all people long before the arrival of the EU Social Pillar. However, in a recent report, we found that cities' efforts are not always known or recognised at national and EU levels.

It's clear that most city authorities, when faced with the urgent needs of their citizens and residents, go beyond their legal responsibilities to provide social inclusion measures in areas such as inclusive education, promoting gender equality and equal opportunities, and delivering active support for employment.

Poverty and social exclusion take the hardest toll on the most vulnerable groups in our society, including migrants and refugees, the long-term unemployed, people with disabilities, and those living in the most deprived areas of our cities.

As cities, there are many things we can do to help as many people as possible, such as taking measures to prevent school dropout, improve literacy, skills and qualification levels of adults, and facilitate the transition from education or training to employment. We can also introduce social clauses in our public procurement contracts to promote gender equality, and inclusive training, the employment of migrants, the long-term unemployed, and the under-qualified.

We work locally to coordinate broad local partnerships between public services, employers, training providers, social enterprises, civil society and NGOs to match demand and supply on the local labour market.

Every person matters

As mayors and city leaders from across Europe, we are committed to turning the Pillar principles into tangible actions on the ground, but we need better means to tackle these challenges and improve the lives of those who are most at risk of exclusion.

City authorities work locally through integrated approaches to social problems, often combining different European funds and linking social provisions with appropriate activation measures to promote social inclusion in the local community and in society at large.

We need to have more resources allocated at the local level from state budgets and better access to EU funds to build capacity for local measures and services that provide tailored support to the most vulnerable groups.

"Poverty and social exclusion take the hardest toll on the most vulnerable groups in our society, including migrants and refugees, the long-term unemployed, people with disabilities, and those living in the most deprived areas of our cities."

We are ready to work with the EU institutions as strategic partners towards these goals of building a socially sustainable future for Europe and its people. As partners in EU policymaking, we can ensure that EU level social policies respond to the real needs and current challenges of people on the ground. This includes the priorities in the future ESF+ operational programmes.

Every person matters and every citizen should feel able to participate fully in every aspect of our society. The principles of ensuring everyone has the right and access to inclusive education, training and employment, adequate housing, healthcare and long-term care, and feels welcome are worth fighting for. As cities, we are taking up this challenge. ■

EUROCITIES is the political platform for major European cities. We network the local governments of over 140 of Europe's largest cities and more than 40 partner cities that between them govern some 130 million citizens across 39 countries. www.eurocities.eu

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REGIONAL DEVELOPMENT IN SWEDEN

THE STORY OF AN INTERNATIONAL DEVELOPMENT LAB

WHEN YOU PASS THROUGH THE DOORS OF THE ALEXANDERSON INSTITUTE IN SWEDEN, IT IS LIKE SETTING FOOT IN AN ADVANCED INTERNATIONAL DEVELOPMENT LAB. IN THIS HIGHER EDUCATION INSTITUTE, NEW AND EXCITING METHODS ARE CREATED TO PROMOTE FUTURE GROWTH, AS WE NOW DISCOVER

The Alexanderson Institute is a part of Centrum För Livslång Lärande (CIl), Municipality Of Varberg, Sweden. So, what is unique about our approach at the Alexanderson Institute? In a word, it's openness. Every window is wide open. We are always looking for the best sources of experience and knowledge, while continuously developing new tools. We mix everyday ingredients of many and varying kinds, and we are happy to let others contribute to the result. We season with untested approaches and new solutions. There is a great deal of fresh thinking in everything we do at the Alexanderson Institute.

But creativity does not automatically lead to success. Instead, development is driven by experimentation, while also letting those around us contribute, become engaged and judge what we do – often receiving a surprise or two in the process.

The important thing is that the results of these efforts provide insight, vitality and value to others. We want everyone who contributes to help ensure the results are passed on. That is how organic development is created.

REVOLUTIONARY YEARS

Ten years have passed since the official opening of the Alexanderson Institute, or AI as we call it.

The concept of "Competitive Knowledge" is central to the Institute's philosophy. Our interpretation is clear: we always start from the conditions and needs of those around us before adding the value and benefit that is demanded. We have pursued this approach in real-life situations – with striking results. Right from the beginning, we had a strong position, enjoying goodwill within the EU-financed projects we participated in. And throughout these years, we have strengthened our position.

Today, we are seen as a potential partner in many of the development programmes that established organisations compete to take part in. The reason for this is largely thanks to the way we successfully deliver value for money.

It is through this funding and the tangible benefits offered by international networks that value is created for us in our region and in the regions we work with. It's about give and take – and building confidence between people.

THE THREE WISE Ms

We are constantly striving to clarify not only our role in the complex interplay of synergies around the development of the region but also how business and public organisations can expect to benefit.

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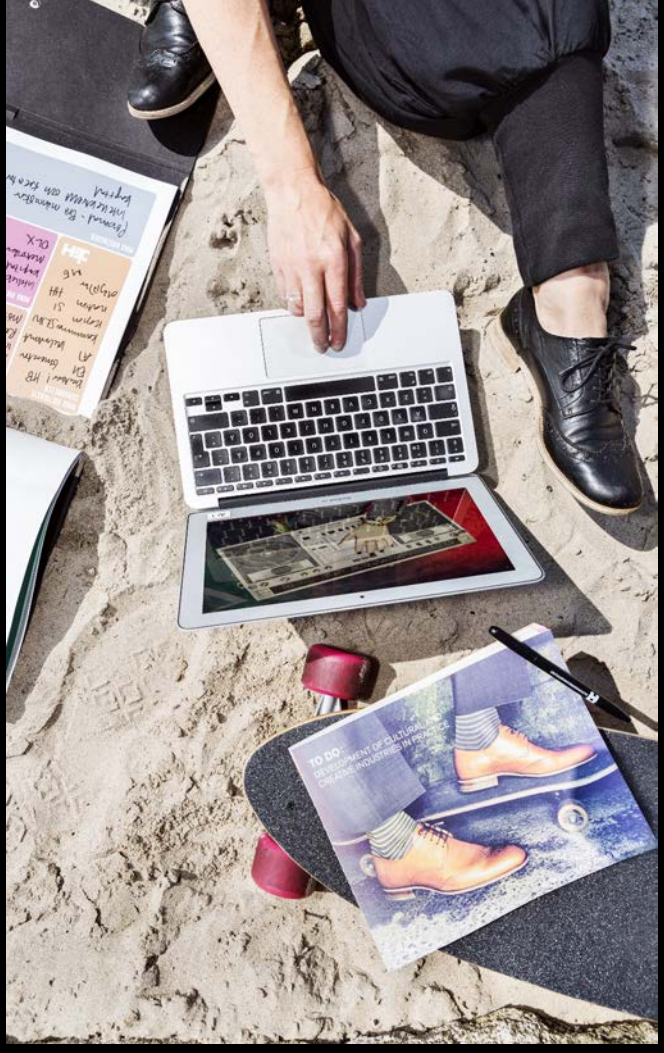

We explain this through our three Ms – mediator, meeting place and a motor for competitive knowledge. Our activities revolve around these concepts. The Alexanderson Institute facilitates the flow of knowledge, experience and competence. We offer an infrastructure for creating meetings and networks, which, in turn, generate new ideas, methods, business and returns. The motor, the third component, is a result of the other two.

A POSITION IN THE VALUE SOCIETY

The Alexanderson Institute is located in the region of Halland, Sweden. This is where we have our roots and where we wish to share our success.

Equally important for the future is being part of the same value region. Today, value solidarity is even more important than physical solidarity – thanks to the rapid growth of digital infrastructure. For the first time in history, groups of individuals, companies and organisations can establish value links in new ways.

Who is to say that a person or company, or even a municipality, derives the greatest benefit from its closest neighbours, when it is just as easy, or even easier, to maintain contact and exchange experience with kindred spirits on the other side of the world?

Thanks to its growing international networks, the Alexanderson Institute has created strong links to a value-based region. Every day, we meet people and organisations who are on the same wavelength as we are – and who want to partner with us in developing the future.

In Halland, we are the leading player in the new international value arenas. We open doors. We give all those in our networks access to these arenas. And this is just the beginning.

A GROWING KNOWLEDGE ORGANISATION

The Alexanderson Institute and Campus Varberg are developing in tandem and have built up unique network-based structures. The Alexanderson Institute is in collaboration with governmental and regional platforms, municipalities, universities and national SME's, and is involved in several key EU projects. Campus Varberg through the university programme and vocational college, in conjunction with other seats of learning, are complemented by key contacts in business and the public sector.

Cholera, water quality and public health in early Victorian cities

Romola Davenport and Richard Smith, Cambridge Group for the History of Population and Social Structure, Department of Geography, University of Cambridge explores the fascinating areas of cholera, water quality and public health in early Victorian cities

Before the twentieth century, it was almost always more dangerous to live in a city than in a rural area. A major cause of the risks associated with urban living was, and remains, gastrointestinal diseases, including cholera, dysentery, typhoid and other diarrhoeal diseases. These diseases are generally spread via ingestion of infected faeces in water and food or other sources of contamination, such as unwashed hands. Urban populations generate huge volumes of faecal waste, and this provides ample opportunities for gut pathogens to spread via contamination of wells and rivers, via flies or through inadequate domestic hygiene. The supply of clean water and the disposal of waste are, therefore, essential pre-requisites for healthy cities. Indeed readers of the British Medical Journal voted in 2007 for the 'sanitary revolution' (the introduction of clean water and water-based sewage disposal) as the 'greatest medical breakthrough in history'. It is surprising, therefore, that historians have often struggled to demonstrate the obvious benefits of clean water and sewerage provision to the populations of Victorian cities.

Nineteenth century British cities were at the forefront of developments in water supplies and sanitary engineering. The very rapid industrialisation of Britain in the late eighteenth and early nineteenth centuries was accompanied by unprecedented levels and rates of urban growth. Even London, already nearly a million in population by 1800 and the largest city in Europe, strained to cope with further growth in the early nineteenth century.

Contemporaries and historians have generally agreed, however, that it was the 'new' industrial and manufacturing towns that experienced the direst conditions and the highest mortality rates in this period as a consequence, in part, of a rapid expansion and inadequate infrastructure. They also faced a new challenge in this period, in the form of lethal epidemics of 'Asiatic' cholera that repeatedly erupted in European and American cities between the 1830s and the 1890s. We might expect, therefore, that it was these newer towns, crowded with recent immigrants and jerry-built housing, that experienced the most serious cholera epidemics.

Surprisingly, however, while London suffered major outbreaks in all of the four cholera epidemics (in 1832, 1849, 1854 and 1866), many of the 'new' manufacturing and industrial towns of the Midlands and Northern England were only lightly touched by cholera. Figure 1 plots mortality rates from cholera for English and Welsh towns in 1849, before the waterborne nature of cholera transmission had been demonstrated by John Snow.

In London, then a world leader in piped water and flush toilet technologies, cholera mortality was 5.9 deaths per thousand population. The port city of Liverpool experienced even higher mortality, of 11.3 deaths per thousand. However Manchester and many of the booming textile towns of Lancashire experienced relatively light mortality (panel B), and Birmingham escaped all four cholera epidemics virtually unscathed, despite its position as a major transport hub for canal and road transport, and its negligible provision of piped water (panel C). By contrast, the mining districts adjacent to Birmingham experienced some of the highest cholera death rates recorded.

What explains these unexpected geographical patterns of cholera mortality? Analyses of urban cholera mortality rates in 1849 demonstrate no association between the rate of growth of towns and their cholera mortality. Instead, they pick out the risk factors already identified by William Farr, the then Superintendent of Statistics: location on a major river, especially a tidal river or seaport, and mining districts. These were, in fact, the places with particular difficulties in supplying clean water to urban inhabitants as a consequence of their physical geography or peculiar development.

London was heavily reliant on its rivers, the Thames and the Lea, for water

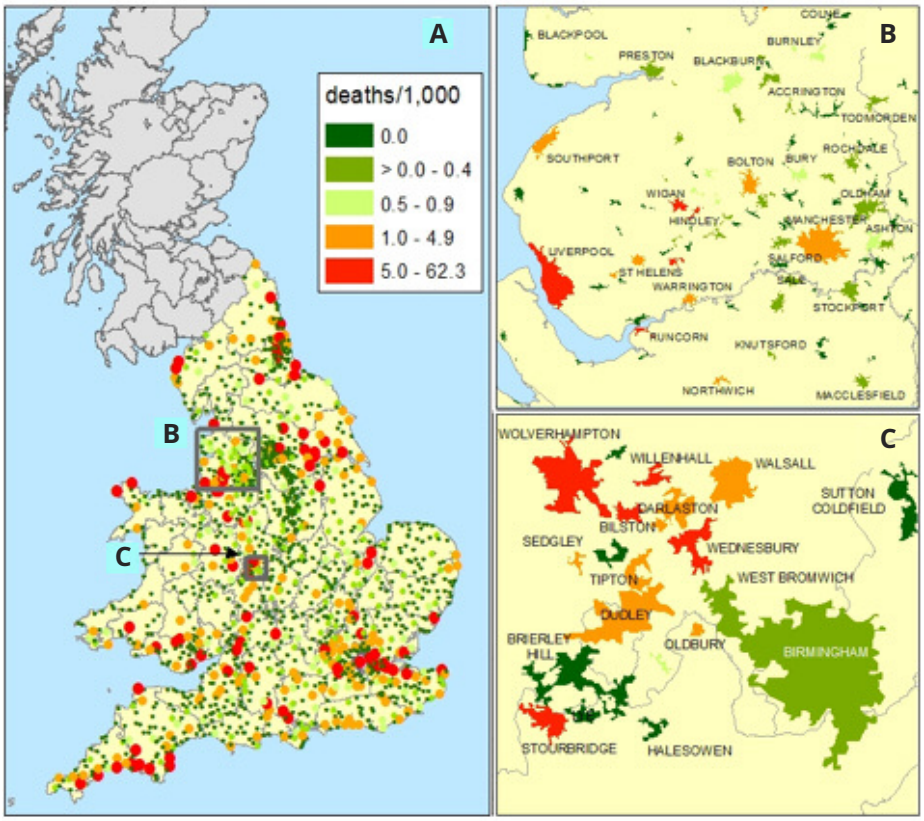

Figure 1: Cholera deaths per 1,000 population in English and Welsh towns, 1849 (Davenport, Satchell and Shaw-Taylor, History of the Family, 2018)

supply. The capital was precocious in the provision of piped water to its residents, supplying piped water to over 150,000 households, as well as street pumps, by 1828. This relatively copious provision of water-fuelled the adoption of flush toilets and this, in turn, led to the relaxing of a longstanding law against connecting household sewers to the public drains. The uncontrolled release of large quantities of sewage into London's rivers resulted in widespread pollution of the city's drinking water. When cholera was introduced by infected travellers, the contaminated river water was then piped efficiently into thousands of households. London had few alternatives to river water and, therefore, the improvement of the water supply required the construction of major sewerage and drainage works and the strict filtration of all river water (the abrogation of this rule caused the last great cholera outbreak in London, 1866).

Birmingham, by contrast, was slow to provide piped water but relied on large numbers of deep wells for most of its water supply. These wells were not easily contaminated by leakage from cesspits. Moreover, because they were numerous, contamination of a single well affected only the relatively small number of households that depended on that well, limiting the size of outbreaks. Manchester benefited similarly from the wide heterogeneity of water sources on which the population depended. Textile towns were particularly well-favoured because they were generally sited by fast-flowing and relatively clean streams on which they had originally depended for water power.

Mining towns, on the other hand, were often particularly deficient in water as a consequence of the lowering of the water table by mining operations, and the residents were often forced to depend on heavily contaminated water sources. Ironically, the backwardness of waste disposal could also be an asset for a town, since the use of cesspits and even midden heaps for waste disposal reduced the contamination of streams and rivers, compared with towns that had better sewers.

When Victorian towns did provide piped water, they often eschewed filtration in favour of unpolluted water from upland sources. By 1870, only three of England's largest twenty cities had a filtered water supply, and these were all drawn from polluted river sources. In the 1850s, Manchester invested in a massive scheme to bring pure unfiltered water 50 miles from the Lake District to supply Manchester and Salford, the first long-distance supply scheme of its kind in Britain. This and other more local schemes have been under-rated by historians of public health, perhaps they lacked the precautions adopted so precociously but necessarily in London. Nonetheless, the sourcing of clean upland water in the 1850s and 1860s appears to have been sufficient to prevent waterborne transmission of cholera, typhoid and dysentery, well before the era of really major public investments in filtration and sewerage.

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Perceptions of neighbourhood diversity: Are there generational differences?

Dr Kirsten Visser, Utrecht University, explores if there are generational differences in the perceptions of neighbourhood diversity

Since the mid-1990s, several studies have examined people's experiences with living in diverse neighbourhoods. While in the recent years some attention has been paid to young people's experiences and use of neighbourhood spaces (Harris, 2009; Hopkins, 2013), we know little about how adults and young people living in the same neighbourhood differ in perceptions and practices of diversity. The literature on attitudes towards difference shows that values and attitudes become more conservative as people age (life course effects) and that societal attitudes towards diversity in people's youth influence attitudes towards diversity later in life (generational effects) (Cornelis et al. 2009). A recent study by Visser and Tersteeg (2019), however, shows that perceptions are also shaped by the different ways in which adults and young people use neighbourhood spaces. They base these findings on in-depth interviews with adults (aged 35 to 65 years) and young people (aged 12 to19 years) in the highly diverse, low-income neighbourhood Feijenoord in Rotterdam.

Differences in perceptions of neighbourhood diversity

The study showed that both adults and young people generally appreciated diversity in the neighbourhood but that there were also important differences. Adults primarily defined diversity based on ethnicity, followed by gender, household type and age.

They generally appreciated the diversity in their neighbourhood because of the lively residential atmosphere and culturally rich variety of shops and other facilities. Many long-term residents – both with and without a migration background – however, felt less 'in place' due to the increasing flow of minority ethnic groups to the area and expressed a feeling of nostalgia for the area's more homogenous past.

Whereas most adults tended to construct social boundaries based on ethnicity, young people saw diversity as an ordinary part of their everyday lives. Different groups in the neighbourhood were often defined based on different kinds of subcultures (dancers, soccer players, basketball players), the school young people went to, or the sub-neighbourhood they were from, rather than on ethnic background. The young people were aware of the negative aspects of their neighbourhood but rarely referred to ethnic diversity in this context. They felt that discrimination and stigmatization was an important threat to cohesion within their community, while they themselves did not see ethnicity as a significant dividing factor.

Differences in encounters with diversity

Several studies show that perceptions of diversity can be influenced by encounters with difference in both public and semi-public spaces. Public space can offer a realm for one-time brief encounters with difference such as sharing space with strangers on the street, in local shops or in public transport. Semi-public spaces offer opportunities for prolonged and repetitive interaction between groups, often along shared interests. Therefore, they are considered the ideal sites for influencing perceptions of diversity. Adults and young people differ in the

way they use neighbourhood public and semi-public spaces, and as such might have different encounters with diversity.

Meeting diverse other in public spaces

Local public spaces were used in a different way by adults and young people. Adults used public spaces mostly as a passageway: social relations had rarely started off in spaces such as parks, plazas and streets. Young people, on the other hand, used a wider variety of public spaces and hung out there for longer periods of time. These spaces formed important locations to meet and get to know others. Public spaces thus formed a place for sustained contact with diverse others for young people, whereas for adults it was mainly a space for fleeting encounters. As such, diversity in neighbourhood public space is likely to contribute more to young people's perceptions of diversity compared to adults'.

Meeting diverse others in semi-public spaces

The shared use of semi-public spaces was a catalyser for the development of diverse ties for both adults and young people. Both groups discussed receiving companionship and practical support from people they met in semi-public spaces. However, also here some important differences between adults and young people can be pointed out. For adults, the semi-public spaces that were frequented were limited to community centres or sports clubs. Moreover, the potential of encounters across difference in these spaces was restricted by the fact that only a limited group of residents made use of these facilities, usually only those with a low socio-economic position. Those with a higher socio-economic position tended to spend their leisure time outside the neighbourhood. Adults, furthermore, appeared to bond most easily with people with a similar ethnocultural background. Relations formed with people of other ethnic and religious backgrounds were seldom translated into the private sphere. Networks of family and friends thus remained relatively homogeneous in terms of ethnicity and class.

For young people, a wider range of semi-public spaces such as community centres, youth and sports clubs and particularly schools acted as meeting spaces for peers of different subcultures, ages, religions, and ethnocultural backgrounds. Whereas some of the adults visited semi-public spaces outside the neighbourhood, for the majority of the young people the semi-public spaces they used were neighbourhood based. Young people spent more time in these spaces than adults, encountering diverse others daily. This made diversity more 'commonplace' and perhaps therefore positive for young people than for adults.

Conclusion: Are there generational differences?

Adults and young people living in the same neighbourhood might experience diversity in different ways: most adults constructed social boundaries based on ethnicity whereas for young people diversity formed an ordinary part of their everyday lives. Differences in the use of neighbourhood spaces and hence encounters with a difference can be an important exploratory factor. This confirms generational approaches, rather than life course approaches, on changes in attitudes towards diversity. The young people are growing up in a neighbourhood where diversity is a normal part of their lives. They have encountered differences since they were young: in public spaces, youth clubs and schools. The adults, on the other hand, generally grew up in environments that were less diverse and also the spaces they visit as an adult do not contribute to their perceptions towards diversity to the extent it is the case among young people.

This article is based on: Visser, K. and A.K. Tersteeg (2019) Young People are the Future? Comparing Adults' and Young People's Perception and Practices of Diversity in a Highly Diverse Neighbourhood, Tijdschrift voor Economische en Sociale Geografie. DOI:10.1111/tesg.12348.

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DIVERCITIES
governing urban diversity

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England's housing crisis: Is a distracted government the last to listen to obvious answers?

Chris Bailey of Action on Empty Homes asks if in England's housing crisis, is a distracted government the last to listen to obvious answers?

In England, it is often said that debate amongst national policymakers is out of touch with reality on the ground (let's leave Brexit aside for a moment on the reality question). In recent years successive governments have been lambasted by social action and charitable lobbyists over the impact of what has officially been labelled 'austerity' and unofficially is more commonly referred to, at least by demonstrators against the policy, as 'CUTS'.

It is partially to sidestep this binary debate that so many of us now talk the language of investment rather than expenditure. The Coalition for Community Investment [(1)] is thus in this space, arguing for central government to re-engage with the regeneration of areas of England variously described as 'left-behind or 'in decline' – naturally we prefer the term 'under-invested' because we know that it is investment which always makes a difference, short-term, long-term and social impact-wise.

The Coalition for Community Investment draws together organisations from across the housing world. Members include private landlords groups, such as the Residential Landlords Association; social and affordable housing providers like the National Housing Federation, Northern Housing Consortium and National Community Land Trusts Network; and campaigning organisations like Action on Empty Homes, Crisis and Shelter; as well as representative bodies, such as the Federation of Master Builders and Locality.

In looking at these 'under-invested' areas of England, some commentators also draw comparisons between industrial decline, low-value property markets and Brexit support. They use this to create a narrative of 'left behind' or alienated protest voting. But this is by no means clear-cut; not least because in the last year two-thirds of English councils experienced rising numbers of long-term empty homes. And oddly the subject of Brexit didn't come up when our research team visited areas of decline blighted by large numbers of empty homes. Paradoxically these are also areas experiencing housing need and with high levels of street homelessness (for all that many of these areas did vote decisively 'Leave', some argue as a kind of protest against marginalisation or 'austerity' itself).

Writing this on the day that a Cabinet Minister told Parliament that government policy was, in fact, responsible for a rise in the use of food banks, an admission variously described by commentators as 'bonkers' and 'cynical', it is striking to reflect that we are in the grip of a national housing crisis yet are building fewer social homes than at any time in recent history (or the last 70 years at any rate) [(2)] and have cancelled all national programmes to invest in bringing empty housing back into use.

It is not wholly unreasonable to assume that the fastest rise in numbers of long-term empty homes in England in a decade is related. Absentee investors soak up huge amounts of property in both high and low-value markets in England, yet incentives to house people in these homes are few and far between. Public policy relies on recently introduced punitive taxation but emasculates much of its impact through three factors:

1. A two year wait for empty home tax premiums to kick in after it is established that a home is empty for no good reason (owners in care, homes caught in

Chris Bailey, Community Investment Coalition Manager

probate disputes, and other reasonable explanations being sensibly excluded from enforcement; and therefore not causing the enforcement clock to start ticking)

2. A very low level of taxation on residential property due to the unwillingness of any government to grasp the nettle of revaluation of private housing stock in England, for nearly thirty years (since 1991) – years which have seen historically significant rises in value, coupled with increasing shortages of supply.

3. A wide range of potential evasion routes coupled with under-resourced enforcement. For example, housing declared to be 'second homes' can be left unoccupied with no Council Tax Premium payable. At 252,000 these currently out-number England's 216,000 long-term empty homes – yet many hard-pressed council officers suspect some will, in fact, simply be empty homes, though this is difficult to prove. Given that the identification of empty homes is the council's responsibility, the one benefit of recent rises in tax premiums may be to gradually incentivise this work and even fund it: though there is no guarantee that income will be ringfenced for such work.

A recent UCL study covered only a third of Britain but found what it called 340,000 under-used homes and proposed that simply supporting new build was unlikely to end the housing crisis. Summarising the study's findings the Daily Telegraph reported:

"Housing worth £123 billion is barely used in Britain, researchers have calculated, and have called for a 1% tax on second homes to dissuade people from keeping hold of a mothballed property.

"A new study by University College London (UCL) concluded that building new homes is not the answer to Britain's housing crisis as they are likely to be bought up as second homes or investments in the most popular areas. Researchers collected information from around one-third of local authorities in Britain covering 40% of the population." [3]

The dedicated government empty homes funding which ended in 2015 was a £200 million programme which ran from 2012 and included both funding channelled both through local authorities and directly to community-based housing providers. Overall this programme brought nearly 10,000 properties into use for around £24,000 public investment per home. [4]

With all this in mind, The Coalition on Community Investment decided to poll MPs on their attitudes to the housing crisis and the growing blight of empty homes. We also asked their opinion on a range of policy interventions, many of which have already been road-tested by successful but now cancelled government programmes. [5]

Action on Empty Homes can also call on learning from its national programme of effective demonstration projects demonstrating that with financial backing empty homes can provide valuable housing for those in housing need. These community-led projects deliver housing in even the most challenging environments. These are areas the government often calls 'low demand', despite their lengthy social housing waiting lists and large numbers of residents housed in property acknowledged to be inadequate or over-crowded; and often funded wholly or partially by state benefits.

The results of our MP polling were striking, at a time when homeless families in temporary accommodation have hit a ten-year high of over 82,000 (including 120,000 children); while rising levels of street home-

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lessness are a source of national concern.

And as with some other major current policy debates we could mention, we see a striking dichotomy between national government policy and the views of Members of Parliament across the house, regardless, in most cases, of political affiliation.

ComRes polling of MPs commissioned by Action on Empty Homes for the Coalition on Community Investment shows huge cross-party parliamentary support for action on empty homes:

- 86% of MPs polled agreeing that the government should place a higher priority on tackling empty homes.
- 72% rank action to bring England's 216,000 plus long-term empty homes back into use as one of their highest two priorities for combatting the current housing crisis.
- Over 80% also supported targeted funding for local authorities, charities and local organisations to buy, lease or refurbish empty homes.
- 68% believe landlords who own empty homes which have been vacant for more than a year should be required to bring them back into use.
- 77% support charging a council tax premium on empty homes after they have been empty for a year, rather than the current two years.

At Action on Empty Homes and the Coalition for Community Investment, we support a mixed economy approach to solving the empty homes problem. We believe in using both enhanced powers of enforcement and in funding action at local level. We call for significant targeted investment (of around £450 million) set against initial targets for delivery of 20,000 empty homes returned to use and for significant improvements in the worst-hit communities.

Action on Empty Homes also support calls for a major national programme of social housing construction but believe that returning empty homes to use is a potentially easy win for the government, not least now. As the government looks to ameliorate the impact of past decline and current uncertainty on England's most vulnerable communities. The public agrees with us. Recent polling shows levels of support for action at similar 80% plus levels to those amongst legislators.

Now we hope that the government will listen too. ■

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Securing vacant property in uncertain UK market conditions

Stuart Woolgar, CEO of Global Guardians, considers how the uncertainty caused by Brexit has impacted on the British property market and how to manage the security of vacant buildings

The uncertainty over Brexit negatively impacted on the UK property market as 2018 progressed, according to RICS (Royal Institution of Chartered Surveyors), pushing it to its weakest level in more than six years by December, with almost half of surveyors reporting that sellers and buyers were sitting tight because of political uncertainty.

Also, due to the increased economic uncertainty surrounding Britain's EU departure, which came at a time of moderating house price growth and increasing build costs, house builders were becoming increasingly risk-conscious, commented a UK residential research associate at Knight Frank late last year.

However, amidst the Brexit situation, one thing was incontrovertible. The property development market was and still is experiencing a temporary hiatus. RICS is right. House sales are flat and investors and developers are wary of the potential fall in land values and a sudden glut in commercial property for sale or to let, and the impact that will have on prices, so they are hanging back from commitment until the sector settles down. It will of course. Any review of the property market over the decades shows fluctuations with booms and recessions, but it always stabilises and recovers its equilibrium.

Vacant property and landbanked sites, already a focus of negative publicity given the housing shortage, are therefore likely to continue and increase for the foreseeable future and vacant property is everyone's worst nightmare, if you own it, manage it or live next door to it. Vandals, arsonists, thieves and fly-tippers are attracted to it, and it's a magnet for anti-social behaviour of all types from graffiti and drug dealing to illegal parties and raves. The fabric of an empty building deteriorates far more quickly than an occupied property and people generally hate living near or next to one because of all the associated problems. Finally, vacant property is difficult to comprehensively insure and owners still have a duty of care for the health and safety of trespassers, even if they are there illegally. Such is the vagary of British law.

Security is another issue that is now high on everyone's agenda but not just from the threat of terrorist bombs and guns. In uncertain times, when there is also fear of unemployment or it becomes reality, anti-social behaviour and criminality tend to increase.

Vacant property owners and managers need to focus on this serious issue, as empty buildings are a magnet for all kinds of unwanted trespassers and criminal or anti-social activity. A safe pair of hands, expert hands, is what is required to keep vacant property secure, safe and maintained... and also, productive. Something a lot of people don't even think about.

Estimates on the current number of vacant properties vary but according to The Guardian in September 2018, the number of empty residential buildings in England stood at around 200,000 whilst in October the BBC reported that more than 20,000 commercial properties in the capital have been empty for at least six months, with 11,000 of those vacant for two years or more.

Given the serious shortage of affordable housing across the country, but particularly in the larger urban conurbations, it seems obvious that so much more could be done to facilitate the use of vacant property to provide affordable homes for those on lower salaries, or people struggling to save to get on the property ladder, or those who have to live in or near our expensive city centres. People who simply want to lead a less stressful lifestyle, without so much economic pressure on their disposable incomes to pay high rent, bills, taxes, travel and general living costs such as food.

A solution to the security problems associated with vacant buildings is to install property guardians in the premises through an ethical and

responsible company such as Global Guardians, the leading organisation in the sector. They can turn the void into a productive building, preserving the property's value, as opposed to a resource drain, for as long as it's necessary. The building becomes secured, the guardian company maintains it and ensures there are adequate living and domestic facilities there for its guardians; insurance cover can benefit, and an otherwise vacant building gets turned into a low-cost accommodation opportunity so the social benefit is enormous.

Having guardians living in your vacant property is the best form of security because they provide a proactive security solution as opposed to traditional security services. In addition, our property guardians are good people, often key workers in inner-city jobs, and form close communities where they live in our clients' properties.

Along with all this, they get the satisfaction of caring for an otherwise vacant building for its owners. No matter what type of property it is, buildings are always so much better when they are occupied and looked after by people who care. The property is kept secure and maintained by us, and instead of lying vacant to deteriorate, it is put to worthwhile use.

Being a progressive and inclusive organisation, we also care for our guardians and always strive to maintain the very highest standards for them as well as our clients. However, not all guardianship companies hold the same values.

As with all business sectors, there are those organisations which strive for excellence, comply with regulations, belong to accredited professional trade bodies and care for their employees, associates and clients... saving them time and money in a responsible way, and there are those who cut corners, ignore recommended standards and are simply out to make a profit. When it comes to ethical business practice, especially in an operation where Health & Safety is paramount, as well as quality of life, property owners seeking to put guardians in their buildings should do their homework and go with members of the British Security Industry Association and who state clearly they follow the recommendations of BS 8584:2015, a standard I personally was involved with producing.

We at Global Guardians are the fastest growing company in our industry and look on ourselves as the pioneers of good practice and compliance, and are leading from the front in terms of offering our clients innovative ideas to make their vacant property productive and work for them, no matter if it is residential or commercial. We are also consulted by those in local and central government, or with an interest in the provision of affordable housing, for thought leadership and professional opinion, based on many years of experience in this evolving sector.

Our organisation offers a cost-effective vacant property security solution which protects commercial or residential buildings. Our solution keeps both clients and guardians updated via our innovative MyGlobe web portal which provides real-time reports on everything connected with the property. No worries, no stress, simply peace of mind which allows our clients to get on with other aspects of their business and life, knowing their empty buildings are being taken care of by experts.

For more information on how we could help you with your vacant property, get in touch with us today.

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The reason for the success of the European Strategy for Plastics

Vice President, European Commissioner for Jobs, Growth, Investment and Competitiveness, Jyrki Katainen hails the success of the European Strategy for Plastics thanks to the transparency and full involvement of all stakeholders

The European Strategy for Plastics aims at making the European Plastics industry the smartest, most innovative, and most sustainable in the world. The Strategy aims to create a new plastic economy. It is set to deliver a key contribution to the transition towards a circular economy and to the modernisation of our industry. It addresses the whole value-chain, creates synergies between economic and environmental goals and aims to bring everyone onboard.

The success of the Strategy adopted in January 2018 is profoundly related to its wide acceptance and endorsement by all stakeholders, from NGOs to actors from the plastics value chain. Before proposing a vision for the future of the plastics sector, the European Commission organised multiple meetings, workshops and seminars. Stakeholders presented their concerns and proposed solutions to make this sector more circular and more sustainable.

Curbing marine litter is one of the key pillars and drivers of the strategy. There is wide consensus that the EU needs to tackle the menace that is choking our oceans and poses a risk to human health. Marine litter is not only an environmental and health issue – acknowledged by European citizens, due to its very visible negative impacts. It is also an economic issue. The economic activities directly affected by marine plastic debris and microplastics include shipping, fishing, aquaculture, tourism, recreation and oil and gas offshore platforms. For the EU, the costs to the tourism and recreation sector (extrapolated from beach-cleaning costs) were estimated at up to €630 million per year. The costs to the fishing industry are up to €57 million. Economic damage from litter on marine industry users was estimated to be $1.26 billion per annum to marine industries in the Asia Pacific region. UN Environment estimates the damage to marine environments globally to be at least $8 billion per annum.

Fighting marine litter also creates economic opportunities. Innovation in product design to avoid plastic litter and microplastics, investment in marine litter prevention, such as waste and wastewater treatment or port reception facilities, enhance industry competitiveness and can create jobs requiring technical and scientific skills.

Single-use plastics were identified as a major source of litter associated with the 'on-the-go culture' that promotes disposal instead of more sustainable options such as prevention and reuse. The Commission swiftly presented a legislative proposal in May 2018 to address single-use plastic products and the European co-legislators, the European Parliament and the Council, succeeded in reaching an agreement in December 2018. The outcome is ambitious and addresses the major concerns of European citizens.

The proposed Directive on Single-Use Plastics and Fishing gear is based on facts. Our legislation on the protection of the marine and coastal environment requires that quantities, composition and impacts of litter and microlitter should be monitored and assessed. These activities provided the evidence basis for our Directive on Single Use Plastics by identifying the most littered items on the EU coastline.

That is why the Plastics Strategy and the Directive on Single-Use Plastics are among the most popular actions taken by the Commission.

Voluntary industry initiatives

As part of its strategy on plastics, the Commission

launched a voluntary pledging campaign. A preliminary analysis indicates that at least 10 million tonnes of recycled plastics could be supplied by 2025 if the pledges are fully delivered. However, based on the pledges from the demand side, only 6.5 million tonnes would be expected, demonstrating that more action will be needed to achieve the objective of a well-functioning EU market of recycled plastics.

To accelerate Europe's transition towards a circular plastics economy, the Commission launched the Circular Plastics Alliance, whose aim is to improve the economics and quality of plastics recycling in Europe. The Alliance will, in particular, provide opportunities to strengthen the match between supply and demand for recycled plastics, which is identified as a key obstacle to a well-functioning EU market of recycled plastics. It wants to contribute to the objective of achieving at least 10 million tonnes of recycled plastics finding their way into new products on the EU market by 2025 as set in the European Strategy for Plastics.

The Circular Plastics Alliance is an Alliance for the industry and by the industry. It brings together industry representatives from all stages of the plastic lifecycle, from production to recycling. The Alliance will strengthen the EU's industrial capability to transform the plastics economy, transitioning from a linear to a circular economy model. In practice, this cooperation of actors within the plastics value chain means, for example, that a recycler will need to maximise the quality and purity of recycled polymers as much as possible, in order to satisfy the demand for a recycled, high-quality and affordable raw material. On the demand side, product designers will have to take into account sorting and recyclability as key features for their products, in order to enable waste managers and recyclers to maximise the quantity and the quality of their output, and so on.

We are also interested in voluntary actions aimed at reducing marine litter, one of the examples can be the Operation Clean Sweep. This initiative could be a good start for a credible programme leading to less plastic pellet leakages throughout the supply chain. We believe that it could be complemented by credible and transparent monitoring demonstrating quantitative reduction of pellets emissions. One of the preferred options reflected in our Strategy is to strengthen this initiative through an obligatory certification scheme throughout the plastic supply chain, which could be a blueprint for a sustainable solution globally.

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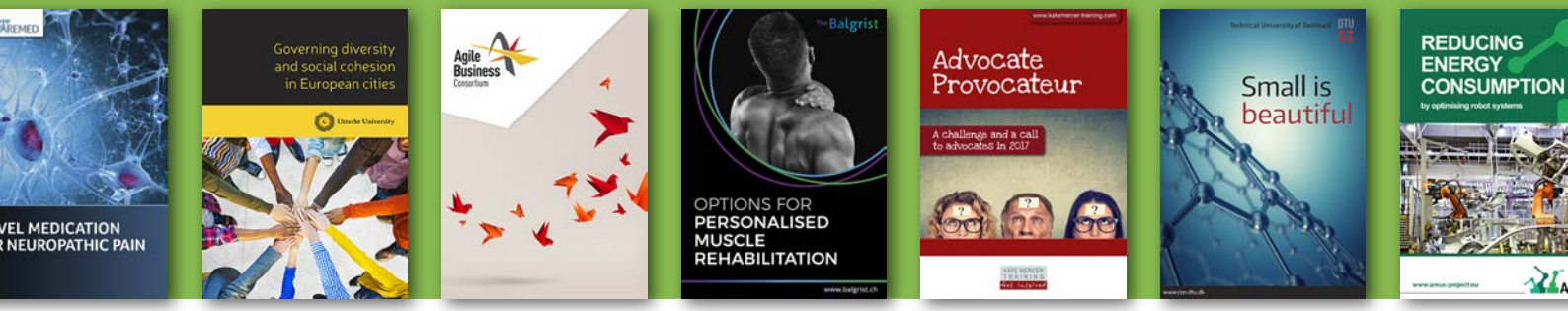

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Jyrki Katainen, Vice President, European Commissioner for Jobs, Growth, Investment and Competitiveness

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Plastic is a key material for a low carbon and circular economy. However, it needs to be properly managed at every stage of the value chain. Only by bringing the value chain together will we create a win-win situation for environmental protection and industrial competitiveness.

Microplastics

The Plastics Strategy outlines a comprehensive approach addressing not only macroplastics such as single-use products, but also all microplastics: intentionally added microplastics in products, and microplastics that are generated unintentionally during the life cycle of products. Our European Chemicals Agency (ECHA) located in Helsinki has recently assessed the health and environmental risks posed by intentionally added microplastics and has concluded that an EU-wide restriction would be justified. If adopted, the restriction could result in a reduction in emissions of microplastics of about 400 thousand tonnes over 20 years. The persistence and the potential for adverse effects or bioaccumulation of microplastics is a cause for concern. Once released, they persist in the environment for thousands of years and are practically impossible to remove. Currently, it is not possible to determine the impact of such long-term exposure on the environment.

Global action

We are very keen on discussing plastics with our global partners. In all the meetings I hold with third countries on this topic, the EU is praised for its Plastics Strategy and the Directive on Single Use Plastics, which are considered as useful policy examples by other countries to tackle plastic pollution. We are very happy to share our practices and engage in looking for sound solutions (for example: commonly agreed standards). One of the practical examples of this engagement can be High-Level Economic Dialogues we have with China, Japan or Turkey, where the issue of circular economy – in plastics in particular – features prominently.

Plastic pollution is a global problem, which can only be tackled through joint international action. The EU Strategy for Plastics with its flagship initiatives against single-use plastics, microplastics from all sources and its strong international dimension puts Europe de facto at the forefront of the international scene to promote the UN Environmental Assembly's objective of long-term elimination of the discharge of litter and microplastics.

We find it important to build on existing activities and frameworks at the local, national, regional and global level, in particular, the Action Plans under Regional Seas Conventions, the Basel Convention, UN agencies, the G7 and G20, and to ensure that they fully contribute to tackling marine litter within their respective mandates. ■

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Image: © European Union, 2018

Karmenu Vella, European Commissioner for the Environment, Maritime Affairs and Fisheries

The priorities for the environment, maritime affairs and fisheries in Europe

Some of the priorities for the environment, maritime affairs and fisheries in Europe are charted here when it comes to the all-important European Commission policy around these crucial themes

One of the responsibilities of European Commissioner for the Environment, Maritime Affairs and Fisheries, Karmenu Vella, is protecting the environment while maintaining the competitiveness of Europe. We'll be looking at an example of this in this article that concerns air quality, as well as aspects of European Commission policy around maritime affairs and fisheries.

The environment: Legislation on air quality

The European Commission recently highlighted that today, we are sadly witnessing people in Europe struggling with health issues as a result of poor air quality. Commissioner Vella made a statement about this in January 2019, some of which you can read below.

"We should all be concerned with the quality of the air that Europeans breathe. The protection of our citizens' health is therefore very important for us...when it comes to the European legislation on air quality. The European limit values, approved by the governments of all Member States and the European Parliament, are based on solid scientific evidence provided by the World Health Organisation (WHO), which is the world's leading authority on health matters.

"This evidence is backed up by countless scientific papers, which – if I may add – have been peer-reviewed."

Commissioner Vella concludes that additional action is, therefore, required urgently to speed up measures that will improve air quality so that the health of European citizens is protected. [1] We'll return to the theme of protecting the environment at the end of the article.

Maritime affairs: Renewable energy

One key aspect of the policy remit of Commissioner Vella is marine renewable energy, something that he keenly discusses during a speech at the Energy Council in December 2018. The picture he paints here is that today, Europe is the world's leader in marine energy. He illustrates this belief with some interesting facts and figures.

"We host 50% of the world's tidal energy developers, 60% of wave energy developers, 70% of ocean energy capacity, and 75% of floating offshore wind projects.

"And yes, the industry is small. But it doesn't have to stay that way. By 2050, marine renewable energy could provide 10% of Europe's electricity. For wave and tidal energy technologies alone, the industry expects up to 400,000 new jobs by 2050. And not just in coastal areas. This is a truly pan-European industry with supply chains that reach far into the heart of Europe."

In his speech, Commissioner Vella reveals his support for today's entrepreneurs, as a former businessman himself. He calls for the deployment of these technologies to start in the early 2020s, which will enable the industry to have sufficient time to learn and further reduce costs in Europe. [2]

Maritime affairs: The role of research and innovation

Speaking at the Blue Invest in the Mediterranean 2019 in Malta, in January this year, Commissioner Vella reveals that the European Commission has invested no less than €800 million in maritime research and innovation over the last three years.

> "When we have a situation where one year you can bring your fish home in a plastic bag, and the next year you are bringing that bag home in a fish, we have to work hard and work fast. We have taken a big stride towards reducing the amount of single-use plastic items in our economy, our ocean and ultimately our bodies."

"We will continue to invest. We plan to spend more than €200 million of our new European Maritime and Fisheries Fund on blue economy projects – more than ever before", Commissioner Vella remarks. He underlines that the part the Commission plays isn't just about funding but it concerns creating the conditions for businesses to succeed.

While entrepreneurs often raise the issues of a lack of access to finance, Vella reveals that the Commission is working with the European Investment Bank to

establish a European Investment Platform for the Blue Economy. "Operated by investment experts, this platform would combine funds from public and private sources into a single financing instrument. It would also offer a full range of investment-readiness services", Commissioner Vella explains. [3]

Fisheries

Another key aspect of Commissioner Vella's remit concerns fisheries, something that he discusses during a speech following the Fisheries Council on 19th December 2018. Here, his outlook for European fishermen and for fish alike is a good one, indeed fishing opportunities for European fishermen worth more than €5 billion were agreed upon. This move benefits more than 50,000 fishermen and the catches agreed in December 2018 will continue to make the European fishing industry highly profitable in the future, Commissioner Vella says.

"We were able to agree on increased quotas…fully in line with scientific advice, on a number of very important stocks, such as northern hake, northern haddock, horse mackerel, seabass and some stocks of Norway lobster."

Commissioner Vella then notes that the Member States showed solidarity towards each other, where zero or low quotas along with the landing obligation would have forced an individual Member State to stop very early or to not even start fishing for particular stocks. Commissioner Vella elaborates on the role of the Member States when it comes to quotas.

"Here, Member States used existing mechanisms to address such situations, but also agreed on a new tool, based on the Commission's proposal. The system of limited by-catch quotas together with the creation of a common pool based on contributions from a number of Member States will address possible choke situations. The solution agreed includes incentives for fishermen to be more selective and commitments by Member States to take appropriate control measures. I would like to thank all Member States who have invested a lot in preparing this package."

Having said this, Commissioner Vella believes that additional efforts are needed to further improve selectivity and to control the landing obligation. He then shares his thoughts on this matter.

"We also took some difficult decisions on stocks which are not in a good shape. In particular, I would like to commend the responsible decision to follow the Commission's proposal and to reduce catches for Herring in the Celtic Sea by 53%, reduce catches for Nephrops in the waters around Ireland by 32% and to reduce catches for sole in the Eastern channel by 26% – all three in line with the MSY advice."

Commissioner Vella adds that further progress has been made on protecting the eel stock, which is still in a critical condition. Following the important decisions taken earlier in 2018 for the Mediterranean, the European Commission has created a level playing field across the EU by establishing a consecutive three months closure period for all fisheries of European eel at all life stages. "This closure will apply to all marine waters and to brackish waters. These are crucial measures to ensure the recovery of the stock", Commissioner Vella points out.

"The Council also adopted the Commission's proposal for fishing opportunities on sprat and turbot in the Black Sea for 2019. The turbot multi-annual plan adopted last year by the GFCM was the first ever plan for the Black Sea. I am confident that the situation of turbot will improve and that IUU fishing will be reduced substantially."

Commissioner Vella states that decisions adopted in late 2018 allow for further progress in ensuring sustainable fisheries in the European Union. He highlights that there is certainly a challenge ahead in 2019 for efforts to be stepped up to reach the agreed targets. (4)

Protecting the environment

Let's bring this article to a conclusion by briefly looking at the news in December 2018 that concerns an aspect of protecting the environment. The Commission welcomes an ambitious agreement on new rules to reduce marine litter which targets the 10 plastic products most often found on the beaches of Europe plus abandoned fishing gear.

The new rules are part of a broader effort to turn Europe into a more sustainable, circular economy, something that is reflected in the Circular Economy Action Plan adopted in late 2015. The emphasis is on Europe's businesses and consumers to produce and use sustainable alternatives that avoid marine litter and oceans pollution, therefore, tackling an issue that has global implications.

Commissioner Vella provides his comments on this, which I think are reflective of his wider aims to protect the environment in a number of ways, whether that is on the land or in the ocean itself.

"When we have a situation where one year you can bring your fish home in a plastic bag, and the next year you are bringing that bag home in a fish, we have to work hard and work fast. We have taken a big stride towards reducing the amount of single-use plastic items in our economy, our ocean and ultimately our bodies." (5)

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OCEANERA-NET COFUND: Supporting collaborative innovation in ocean energy

Karen Fraser Specialist, Energy Scottish Enterprise charts the project OCEANERA-NET COFUND, which is supporting collaborative innovation in ocean energy

Europe is leading the world in the development and implementation of ocean energy technologies. The Ocean Energy European Research Area Network (OCEANERA-NET COFUND) project aims to make sure Europe stays in the lead by supporting collaborative innovation and knowledge transfer. €7.8 million of funding has been approved for nine demonstration projects under the COFUND Joint Call 2017. This includes €2.6 million from the EU through Horizon 2020, co-funding with national and regional funds, supporting €14.5 million worth of research expenditure. A second call was launched in January 2019, with a budget of €6.8 million.

The projects funded cover essential technologies for delivering the industry by tidal, wave and ocean thermal means, such as moorings/anchoring systems, connectivity, energy storage systems, hybrid steel and concrete foundations, tidal blade pitch controllers and composite materials. The co-funding model, together with direct engagement with national and regional stakeholders, complements other Horizon 2020 activity and has been particularly successful in generating "bottom-up", industry-led innovation and engaging smaller companies. 28 companies, of which 24 are small and medium-sized enterprises (SMEs) are partnering in the demonstration projects described.

This five-year project has been led by Scottish Enterprise with partners across Europe – Basque Energy Agency, Region Bretagne, Sustainable Energy Authority of Ireland, Region Pays de la Loire, FCT (Portugal), CDTI (Spain) and the Swedish Energy Agency. For the second call, Flanders Innovation and Entrepreneurship (Hermes Fond) joined the partnership.

RESOURCECODE, led by the European Marine Energy Centre, brings together leading researchers in oceanography, world-class test facilities and industry to develop open access, high resolution, North West Europe wave energy resource dataset, software toolbox and online portal. This will provide designers with the information and tools needed to push forward new marine renewable energy projects, improving cost, quality and time to market.

TOPFLOTE – Scottish tidal turbine developer Orbital Marine Power, with global drivetrain solutions provider SKF, will deliver a controller for floating tidal turbine blades allowing the blades' pitch angle to be readily varied in real time to manage dynamic loadings and optimise power performance, tested on the Orbital O2 2MW commercial demonstrator turbine. Pitch controllers have enabled dramatic increases in turbine and blade scale in wind energy, resulting in energy cost reductions. TOPFLOTE seeks to unlock similar improvements for floating tidal technology, facilitating up to a 50% increase in yield for Orbital's machines.

SEABLADE – manufacture, evaluation and analysis of blades for a 2MW floating tidal energy converter – is led by Irish company Eire Composites. The project will accelerate the development of a commercial-ready, cost-effective tidal blade product, testing at NUI Galway and on the Orbital O2 2MW turbine, aiming to gather test data to validate a 20-year design life for the blades. This will result in more reliable blades that will lead to reduced maintenance and increased productivity, and lower LCOE.

CF2T – led by Brittany-based tidal company Sabella, this project will design and test an innovative hybrid foundation, combining steel and concrete, designed to decrease CAPEX and installation costs and improve the reliability of the foundation structure, reducing the overall LCOE of a tidal project. This will be deployed alongside a classical steel foundation as part of the pre-commercial project Eussabella, which aims to install two Sabella D12 tidal turbines in the Fromveur Passage, allowing comparison of structure reliability.

INNOTEX – Innovative Thermal Exchangers, led by French company

TOFLOTE and SEABLADE technologies will be tested alongside the Orbital O2 2MW commercial demonstrator turbine

Naval Energies, focuses on ocean thermal energy conversion. It will test a falling film NH3 evaporator on a 300kW model built by INTEGASA. An analysis suggests that the evaporator can operate with a small difference in temperature and optimise the available thermal gradient, which will increase thermal evaporation performance and optimise the overall energy performance of the OTEC plant.

SPhorcis is led by Spanish company Smalle Technologies. SPhorcis is a cost-effective, innovative solution that gives wave energy harvesting a new focus: off-grid low power production (10-100 w), with potential worldwide markets. It consists of a mechanical system within a sealed box which can be directly connected to batteries so that energy demand for marine off-shore equipment can be met on the spot. SPhorcis will be tested during 2019-2020 in Galway Bay, through a collaboration with SmartBay Ireland.

UMACK – Universal Mooring, Anchor & Connectivity Kit. Led by Swedish wave energy developer CorPower Ocean, this is a joint industry effort bringing together wave and tidal developers, offshore-engineering companies and researchers. It will address affordability, survivability and reliability through demonstration of a generic anchor-foundation-mooring-connectivity system, applicable to a wide range of wave and tidal energy converters, with potential for use in floating offshore wind.

WEP+ – Wave Energy Production – is led by Neureus Technologies from Spain and will be demonstrated in Gran Canaria. WEP+ aims to contribute to the penetration of wave energy in the electricity network in accordance with network regulations. Energetic storage systems will be implemented as a tool to smooth power oscillation peaks. Work will also be carried out to optimise costs, reduce LCOE and contribute to the technological development of the wave energy technology.

OCEAN ENERGY
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Environmental citizenship research and the European Network for Environmental Citizenship

Andreas Ch. Hadjichambis, Pedro Reis, Demetra Hadjichambi tell us about the research emphasis of the European Network on Environmental Citizenship

By way of an introduction to environmental citizenship, it is a very important concept for the protection of the environment and the success of any environmental policies being pursued. This relatively new term comes mainly from the political science arena but has soon entered with claims in other different fields, such as the economy, social sciences and, more recently, education. Therefore, research on environmental citizenship finds applications in all these areas of science and society. Environmental citizenship is related to the pro-environmental behaviour of citizens, which should include both individual and collective actions. Until now, there have been many different attempts to define environmental citizenship, resulting in the creation of several definitions focusing and emphasising different dimensions and priorities of environmental citizenship.

For the first time at European level, with collective efforts of more than 120 experts from 37 countries, an agreement was reached regarding the definitions of environmental citizen, environmental citizenship and education for environmental citizenship. This great effort has been achieved within the framework of the European Network for Environmental Citizenship, which is a European network coordinated by the Cyprus Center for Environmental Research and Education (CYCERE), involving more than 85 universities, research centres and organisations.

So, when we refer to environmental citizenship, we mean the responsible pro-environmental behaviour of citizens who act and participate in society as agents of change in the private and public sphere, on a local, national and global scale, through individual and collective actions, in the direction of solving contemporary environmental problems, preventing the creation of new ones, achieving sustainability as well as developing a healthy relationship with nature.

"Environmental citizenship" includes the exercise of environmental rights and duties, as well as the identification of the underlying structural causes of environmental degradation and problems, the development of the willingness and the competencies for critical and active engagement and civic participation to address those structural causes, acting individually and collectively within democratic means, and taking into account inter- and intra-generational justice (ENEC 2018).

Environmental citizenship research

Research on environmental citizenship is a multidimensional field with applications in many research areas. From the field of the economy, an example of research is related to how enterprises can improve their public image, marketing and develop within the framework of social responsibility. From the field of education, examples of research dimensions are the possible pedagogical approaches that can lead to the development of an environmental citizen capable of actively participating in society and contributing to solving contemporary environmental problems. From the field of social sciences research, could be a focus on beliefs, attitudes and practices of social environmental citizenship movements.

The European Network for Environmental Citizenship

The European Network for Environmental Citizenship is a Cost Action (CA16229), funded by the Cost Association under Horizon 2020, and aims to strengthen networking and promote the coordination of different research attempts taking place at different European levels. The purpose is to maximise research impact through the development of common definitions and research tools, as well as joint publications. ENEC also seeks to promote European partnerships and train young researchers to achieve a critical mass of researchers capable of enhancing European research efforts in environment citizenship field. It is

important to mention that the Network has a global dimension, including researchers from countries outside Europe – U.S., Australia and Israel.

GAIA Repository Database for Environmental Citizenship

A very important infrastructure has been developed within this European network, which we believe will facilitate networking and communication efforts: the GAIA Repository Database on the Environmental Citizenship of ENEC. This database allows everybody to register and search for information on environmental citizenship, functioning as a platform for knowledge exchange and expertise mapping. GAIA promotes also the diffusion of scientific knowledge and collaboration in new research activities. In GAIA, one can enter and find information on the following: (a) BEST PRACTICES for educational interventions, learning materials, programmes, scientific measures; (b) STAKEHOLDERS, such as public authorities, NGOs, educational institutions, such as universities and schools, and (C) USERS, such as experts, researchers and scholars, policymakers, teachers and others.

iREEC 2019 International Conference

An international conference dedicated to Education for Environmental Citizenship is being organised, for the first time, at the global level. The iREEC 2019 International Conference will take place at the University of Malaga, Spain. In the conference, research papers, theoretical papers and reports from all around the world that relate to education for environmental citizenship can be presented at all levels (pre-primary, primary, lower secondary, upper secondary, tertiary education) and in all forms of education (formal, non-formal and informal education). The aim of iREEC 2019 is to enhance the understanding of environmental and sustainability education through the focus on research work that examines and promotes environmental citizenship through education. Multidisciplinary research and approaches combining environmental education, sustainability education, science education, and citizenship education can also be accepted. More information can be found on the conference's website.

The iREEC 2019 Conference aims to: a) present research on scientific and educational activities that exemplify developments toward achieving environmental citizenship; b) emphasise educational research which focuses on empowering citizens to exercise their environmental rights and duties, to identify the underlying structural causes of environmental degradation, as well as to develop the competencies for critical and active civic participation; c) conduct scientific dialogue on educational challenges deriving from the theoretical foundations of environmental citizenship (as a field that integrates knowledge, skills, values, attitudes and competencies) and demonstrate how these are addressed in formal and non-formal education; d) promote and support best practices that cultivate the type of values, attitudes, skills and competencies that an environmental citizen should be equipped with in order to act and participate in society as an agent of change. The deadline for proposal submission is on the 15th of April 2019.

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Wood: reducing the impacts from harsh weather

Herje Boström, CEO of Sioo Wood Protection AB in Sweden highlights the benefits of protection systems to reduce the impact that weather has on wood

Although wood is an incredibly versatile and beautiful material it does suffer from some problems. For exterior applications in Use Classes 3.1 and 3.2 (EN 335 Part 2) wood in exposed conditions will weather to give a silvery-grey driftwood appearance. However, when wood is sheltered (such as under overhanging eaves) then the wood will retain its original colour. This leads to a very unsightly appearance with uneven weathering, examples of which are not hard to find. The weathering of wood has been researched for over 100 years, and although we understand very well why it happens and what causes it, there has never been a solution developed. Wood is composed of three structural polymers: cellulose, hemicelluloses and lignin. It is the lignin that is the Achilles heel where wood weathering is concerned. Lignin is a crosslinked phenolic polymer that imparts a brown colour to wood and is the 'glue' that holds wood cells together and gives wood its stiffness. However, lignin also strongly absorbs ultraviolet light which causes the breaking of chemical bonds and leads to fragmentation of the lignin polymer. These lignin fragments are then washed out by rain, where they become food for staining microorganisms, leading to the familiar grey appearance. Because the lignin is no longer present, the cell walls at the surface become loose and can be washed away in the rain. Although this is not a problem with uncoated wood, it most certainly is an issue for clear coated wood because the coating no longer adheres to the wood surface, meaning regular and expensive maintenance is required.

Conventional wood coatings

Conventional wood coatings rely on adhesion to the wood surface for their integrity. Over time, the movement of the wood under the coating due to the effects of wetting and drying result in localised failure of the coating, usually at the earlywood/latewood boundary. Once this happens, liquid water is able to penetrate below the surface of the coating, which is then forced off due to hydrostatic pressure. The only remedy is to sand back to good material and re-coat. The only way to stop this from happening is to use more flexible coatings, but this is not feasible because the coating would then be tacky and pick up dirt very rapidly in service. Conventional paints and varnishes also use carbon-based chemistry, and carbon-based compounds are susceptible to UV degradation when exposed to sunlight. Clear coatings suffer from the additional problem that the wood underneath is susceptible to UV degradation, and failure can also occur because the surface layers of the wood start to lose their structural integrity as the lignin (which binds the wood cells together) degrades. Putting UV stabilisers and filters in the coatings may slow down this degradation to some extent, but it is the wood that is the Achilles heel in the clear-coating system.

The Sioo:x Wood Protection System is different; it is not a coating, but an

envelope. The protection system has two components; the first (the wood protector) penetrates the wood where it gradually forms an inert glassy polymer, by reaction with atmospheric carbon dioxide. The second component (the surface protector) acts to seal and protect the first application until it is fully cured, but it also forms an inert water-resistant envelope which penetrates the wood and gradually creates a grey surface appearance. It does not stop the lignin from degrading, but it takes the same role by keeping the wood cells glued together, essentially using the strength of glass. The Sioo:x polymers that form in the wood have silicon-oxygen bonds (the same as in glass) and are completely UV stable.

Sioo:x is a patented (WO2007111556) water-based 2-part wood surface treatment process that was developed in Sweden over 15 years ago. The wood protector undergoes a chemical reaction with atmospheric carbon dioxide to deposit insoluble silica particles into the wood. The surface protector prevents leaching of the wood protector until it is fully cured. It is the evenness of the silvery-grey appearance that is one of the most attractive features of the product. The product works best when there is good penetration of the wood material: rough sawn surfaces are always preferred and planed surfaces must be sanded to break through the machining glaze. Curing is accelerated with higher temperatures, but applying in direct sunlight is best avoided since rapid drying of the water-based product will limit diffusion into the wood. Application in damp, cold conditions is also to be avoided since curing is slowed down and there is a risk that the wood protector will be leached out before curing has occurred. For these reasons a factory-applied finish by a Sioo:x accredited treater is always the best option. The treatment can be applied using brushing or spraying and good penetration is the key to good performance.

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A call for smart support schemes to implement marine renewable energy across Europe

Peter Scheijgrond, M.Eng, M.Phil from the Dutch Marine Energy Centre calls for smart support schemes to implement marine renewable energy across Europe

The industrial opportunity for Europe presented by the marine energy sector is significant, and governments should seize it by providing a clear signal of intent to the market. The marine energy industry sees 100GW of tidal and wave capacity being built in Europe by 2050, providing 400,000 jobs and supplying 10% of the European Union's (EU) current electricity needs according to Ocean Energy Europe. Additionally, there is a huge international export market serving clean, abundant and unexploited marine resources in the Far East and Americas.

Successful marine energy projects

"Market leaders across Europe have been successfully demonstrating devices operating in real-world conditions", explains Peter Scheijgrond from Dutch Marine Energy Centre, who is leading the Interreg 2 Seas MET-CERTIFIED project since 2016. The project aims to increase the adoption of insurable and, therefore, bankable marine energy projects supported by internationally recognised standards and certification schemes.

"For example, in the Pentland Firth, four turbines of the 6 MW MeyGen array provide power for over 2500 households. The 2MW floating twin-turbine by Orbital produced over 3GWh in Orkney waters last year, and in France, Sabella's 1MW turbine is powering households on Ushant Island. After two years of intensive monitoring, four independent research institutes concluded that Tocardo's array of five turbines in the Eastern Scheldt show no significant impacts on the environment."

Certification to increase investor confidence

The industry is actively mitigating technical and financial risks by adopting international standards and independent conformity assessment with support from certification bodies DNV-GL, Lloyds Register and Bureau Veritas and test facilities like EMEC, IFREMER and DMEC. This helps to remove uncertainties, attract investments and facilitate international export.

However, securing investment for commercial arrays remains one of the main challenges the marine energy sector currently faces.

Call for support schemes

The roll-out of innovative and renewable energy technologies is part of the European Union's policy on energy. National governments are encouraged to support this by designing support schemes to ensure timely implementation of projects and meeting national targets for CO_2 reduction.

Most countries have adopted a tender or auction-based support scheme, such as 'the Contracts for Difference (CfD)' scheme in the UK and 'the Stimulation of Sustainable Energy Production (SDE+)' scheme in the Netherlands. These schemes give preference to the lowest bidders, and as such, rule out innovative technologies that produce at a higher cost per unit. So, there is a need for smart solutions to support the implementation of innovative renewable energy technologies, such as marine energy.

What can we learn from Africa?

During his work in Uganda, Peter Scheijgrond learned about the Global Energy Transfer Feed-in Tariff (GET-FIT) programme. "The GET-FIT programme was designed by multilateral donors as a 'top-up feed-in system' for more expensive projects in East Africa while respecting the feed-in tariffs set by the national governments for various forms of renewable energy production". Projects that successfully secured a national feed-in could apply for the 'top-up' from the GET-FIT programme if they met certain criteria, such as level of innovation and impact on the local economy. The project has to show the real cost of energy through open-book calculations," Peter explains. "50% of the top-up was paid directly after commissioning and

From left to right: Atlantis 1,5MW turbine for MeyGen project, 2MW Orbital Tidal, 1,5MW Tocardo Tidal Power dam-integrated installation, 1MW Sabella turbine for Ushant Island

Peter Scheijgrond from Dutch Marine Energy Centre shares his vision for a top-up feed-in scheme to support the implementation of innovative marine renewable projects across Europe

the remaining 50% was paid within the first five years of operation". In this way, the "cost of capital" is reduced, because the loan is repaid in a shorter time. Also, the system allows for a level playing field across the region: it respects national tariffs but also respects the real cost of a project regardless of location.

Can a top-up feed-in scheme work in Europe?

The concept of a 'top-up feed-in' seems an interesting solution to increase the adoption of marine energy projects across Europe. It could help create the much-desired level playing field: Regardless of where projects are built, should that be in Italy, Ireland, the Netherlands or France, projects can to get access to equal finance, based on actual cost of energy, irrespective of the availability or level of national support schemes.

The former NER300 support scheme had some of these aspects, but its weaknesses were a high threshold project size and heavy reliance on governmental backing for the technology. Peter Scheijgrond, therefore, suggests the design of a top-up feed-in scheme to cover the real cost of energy for innovative projects using a national or ideally, an EU fund. The threshold size for projects should not be too high (suggested 5-10Mio EUR minimum). The fund should be capped to provide support for say the first 500MW installed marine energy capacity across Europe.

Furthermore, the scheme should tie-in with available national feed-in schemes to reduce the required fund contribution and to ensure the project is pre-selected, based on national criteria (e.g. are permits in place, proof of viability etc.). The 'top-up feed-in' can then be used to cover the funding gap, based on open-book calculations and capped to a Levelised Cost of Energy as set by for example the Joint Research Centre.

Peter concludes that the efforts made by the sector to achieve independent certification in combination with the proposed top-up feed-in scheme will increase investor confidence and lead to the adoption of insurable and, therefore, bankable marine energy projects.

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Plastic in the oceans: Five steps to reduce marine litter

Maria Spyraki MEP from the European Parliament explains the five necessary steps to reduce marine litter – Engagement, Education, Empowerment, Engineering, and Enforcement – in light of the problem of plastics ending up in the oceans of the world

The problem of plastics ending up in the oceans is probably older than the 47-year-old bottle that was washed ashore a British coast in 2018. Some plastics may take up as long as 450 years to biodegrade which practically means that this bottle, which in human years would be just entering middle-age, had some good 400 years ahead of it before it decomposes. Therefore, this problem is not only an old one but also one with a life expectancy that covers more than one of our generations. As such, we must address it with decisiveness and under a strong moral obligation to our children, and to our children's children.

Maria Spyraki MEP

A study from the Ellen Macarthur Foundation showed that there are over 150 million tonnes of plastics in the oceans today and by rough calculations, if nothing changes, the prediction is that by 2025 the oceans will contain one tonne of plastic for every three tonnes of fish by 2025 and by 2050, plastic will outweigh fish in our oceans. This means that we must do something for the fish as well, some of which actually end up in our plates.

The European Union (EU) is not the major marine litter polluter, but this should not stop us from becoming the driving force behind policies that would alleviate this problem not only in our neighbourhood but also globally. In order to do this, we must focus our efforts on five distinct steps which I quote "the Five E's" of tackling marine litter. Those are Engagement, Education, Empowerment, Engineering, and Enforcement.

First of all, we need to engage all involved stakeholders and take them onboard, including consumers, the industry, as well as public authorities, both at the national, as well as at the local level. Engagement breaks down into deliberating with those stakeholders and then creating sustainable and enforceable (more on that latter) policies that address the problem.

> "The Commission's proposal to reduce the environmental impact of single-use plastics is part of a greater cause, which requires a holistic approach and strong dedication from citizens, the industry, the public sector, and policymakers. To that end, it seems very promising and balanced."

Then we come to education. It is commonplace to name education as the panacea of all evils. When it comes to making behavioural changes in the consumption of plastics, however, education has a double meaning. Through educational campaigns, we raise awareness not only on how we must use plastics as consumers, that have an increased likelihood in becoming marine litter but also on how we recycle and reuse those plastics and empower the circular economy.

Empowerment is, therefore, the third pillar of tackling marine litter. We need to empower the industry in making the paradigm shift towards what I call the circular

transformation. Therefore, we must support the industry with policies and financial means in order to transform their business models towards a more sustainable one, while encouraging entrepreneurship on innovative and eco-friendly start-ups.

> "Some plastics may take up as long as 450 years to biodegrade which practically means that this bottle, which in human years would be just entering middle-age, had some good 400 years ahead of it before it decomposes."

Entering engineering, which follows the empowerment of the industry. Through that, we must invest heavily in research and development of new products, which are bio-degradable, less-polluting, and easier to recycle. Such engineering orientation should also focus on administrative processes in order to facilitate recycling at all levels of production and consumption.

Last but not least, there must be enforcement. If all else fails or does not suffice to protect our future generations, we must be bold enough to make the decisions for the greater good. To give an example, it has been estimated that the Commission's proposal on single-use plastics bears compliance costs for business (€2 billion) and waste management (€510 million), but it would allow consumers to save money (€6.5 billion) while saving the equivalent of 2.6 million tonnes of CO_2. It is a lose-win in the short term, but a win-win in the long haul.

The Commission's proposal to reduce the environmental impact of single-use plastics is part of a greater cause, which requires a holistic approach and strong dedication from citizens, the industry, the public sector, and policymakers. To that end, it seems very promising and balanced. However, there are no silver bullets, and surely not plastic ones, in tackling climate change and protecting the environment. But we need to take our best shot if we are to aim for a better future. ■

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A look below the surface of marine genomics

Nicolas Pade, Executive Director at EMBRC-ERIC (European Marine Biological Resource Centre) takes a glimpse below the surface of marine genomics, including a fascinating discussion about our oceans and their health

Prior to genomic observatories, our ability to understand our oceans, evaluate their health, and look to them for inspiration was limited. DNA studies have now advanced to a point where we can study the complete set of genes of an organism (genomics) changing the way in which we have traditionally monitored and explored the seas, opening up a plethora of new opportunities and possibilities. Genomic techniques allow us to characterise whole organisms and ecosystems, in addition to focusing on single genes and their function. Such data provide insight to how organisms, their environments, and interactions influence the functioning of whole systems, such as the oceans. Linking organisms to their habitats enables us to gain a better and deeper understanding of how ecosystems work along with making us rethink how we can access and explore the genetic potential of marine organisms.

To develop this type of research, however, protocols for data collection and entry are necessary for proper analysis and have been initiated by networks of Genomic Observatories (GOs). With ever-growing genetic documentation and monitoring, the objectives of GOs are to create an inventory of genomic biodiversity, map population distributions over time and space, and standardise methods and data, while sharing information and resources.

Setting a framework for partnerships on the basis of genomic research in the marine field, the pan European research infrastructure EMBRC (European Marine Biological Resource Centre) is working to deploy a network of GOs across its sites. It is currently storing generated data across more than 20 sites. EMBRC is aiming to facilitate access to marine genomics data from the observatories. Providing access gives everyone a chance to study the many secrets the sea has yet to reveal and offers tools for Europe to improve our understanding of the oceans.

Genetic mapping of marine species, from microbes to megafauna, also has applications in other fields far removed from the sea. Humans share genes and genetic pathways with animals and learning about their genetic makeup enables us to understand human health and find inspiration for new treatments or medication. One particular similarity is mutualistic relationships with microbes. We rely on these microorganisms for digestion and our immunity in a similar manner to octopus and squid.

Furthermore, some organisms have unique immune traits, such as the great white shark's exceptional healing abilities and their reduced susceptibility to cancer makes their DNA an excellent target for developing future gene therapies. Understanding the intricacies of their DNA and targeting the sections shared with humans has the potential to develop a novel treat-

Image: © Stazione Zoologica Anton Dohrn di Napoli

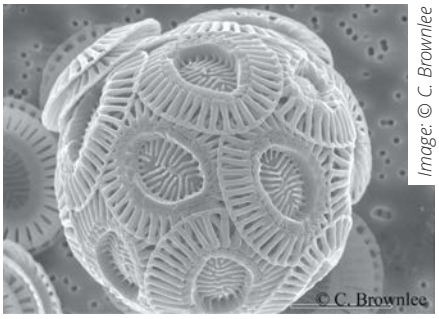

Image: © C. Brownlee

ment for humans. While genomic information from the marine environment is useful for our own health, it can also be applied to the health of the ocean. For example, DNA analysis can be used to identify the prey from a predator's stomach content to understand where an animal fits in a food web. Knowledge of the source of food of an organism gives us information on the dynamics and behaviours of specific ecosystems. Data from GOs can also be applied on a large scale for environmental monitoring. Similar to taking temperature around the world, these types of measurements can be compared and used to look for shifts in community structure and biodiversity of a defined period of time. In the case of drastic changes in a marine ecosystem, such as oil spills or unusually hot summers or natural disasters, records can provide baseline data for monitoring ecological recovery.

Findings from genomic research of marine environments not only allow us to understand our planet but can be utilised to protect it. They are used to measure many of the indicators that make up the Marine Strategy Framework Directive of the Marine Commission 'good environmental status' (GES). While this type of research is used for GES, other legislations using indicators on biological diversity, invasive species and food webs could benefit from GO data as a step toward their goals. The ability to distinguish species involved in trophic chains, or food chains and in ecosystems can also advance the possibilities for fish stock management and making informed regulatory decisions. Genomic research has transformed approaches in science, from ecology to medicine, knowledge on ecosystems and policymaking. With the networks of GOs growing every year, genomics data is going to be increasingly easy to access, and research building on DNA of marine organisms is likely to flourish and revolutionise our understanding of the seas and uncover many new applications for the benefit of society.

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Innovative methods to preserve pelagic fish species

Turid Rustad, Professor at NTNU sheds light on innovative methods to preserve pelagic fish species

Pelagic fish species, such as anchovies, sardines, mackerel, tuna, shad and menhaden are all valuable as food sources. They contain both valuable and easily digestible proteins, have a high content of essential fatty acids, such as DHA and EPA, and contain fat-soluble vitamins (E and D). However, this also makes the pelagic raw material highly susceptible to degradation (quality loss) during storage. Since the fisheries for many of the pelagic species are seasonal, this leads to a need for efficient preservation methods. The composition and stability of pelagic fish are also varying with both the seasons and fishing ground. This is also challenging with regard to finding efficient preservation methods.

"Today, consumers want healthy food products that are safe to eat, have a high nutritional value and also a very high sensory quality, are fresh-like and are free of or have a reduced content of chemical additives. This has led to an increased interest in new non-thermal food processing and preservation methods."

In the project ProHealth (Innovative processing to preserve positive health effects in pelagic fish products), a project under the Joint programming initiative, a Healthy diet for a healthy life (JPIHDHL) has focused on developing new and improved methods for extending the shelf life of pelagic fish. The aim of the project is to develop a comprehensive toolbox of optimised existing and novel technologies for developing healthy, high quality, safe and sustainable fish products from pelagic fish species. The project has partners from Norway (NTNU and SINTEF), Ireland (Teagasc), Poland (NMFRI) and Italy (University of Perugia).

One of the most efficient methods for long-term preservation of pelagic fish is freezing and frozen storage. Freezing is one of the best and most used methods for storing and reserving muscle food for long periods of time. Freezing and frozen storage of mackerel have been shown to preserve the lipid quality while proteins are oxidised after long time storage. This could lead to reduced raw material quality, such as reduced water holding capacity.

Fresh mackerel has a short shelf life as a chilled product. Fresh fish is usually transported and sold on flaked ice, resulting in a temperature of close to 0°C. Cooling and refrigeration will increase shelf life by slowing down both microbial growth and enzymatic reactions, but it will not kill microorganisms or stop enzymatic reactions. It is important to start cooling as soon as possible after catch/harvest. In addition to chilling on ice flakes, chilled seawater (a mixture of ice and seawater) or mechanically refrigerated seawater is used to chill fish onboard fishing vessels. This has been shown to be more efficient in preserving fish than the use of ice.

Studies on sardine have shown reduced oxidation and lower development of trimethylamine nitrogen (microbial development) (Sampels, 2015). Slurry ice (or chilling on ice) can also be combined with the addition of natural antioxidants, ozone or organic acids.

Superchilling or deep chilling is defined as chilling the products to a temperature close to or below the initial freezing point. For fish, this is usually between -0.5 to -2.5 °C. Superchilling can inhibit most autolytic and microbial changes in fish compared to normal chilling.

Partial freezing of the water in the fish will lead to increased concentrations of solutes in the unfrozen phase. This may again result in increased enzymatic activity and protein denaturation. In the project Prohealth, it has been shown that superchilling will prolong the microbial shelf life of mackerel – however, some challenges related to protein denaturation needs to be solved by optimising the process and the storage conditions.

Today, consumers want healthy food products that are safe to eat, have a high nutritional value and also a very high sensory quality, are fresh-like and are free of or have a reduced content of chemical additives. This has led to an increased interest in new non-thermal food processing and preservation methods. These include high- pressure

processing (HPP), ultrasound (US), pulsed electric field (PEF) pulsed light (PL), cold plasma (CP) and ozone.

One of the most promising of these methods is high-pressure processing (Zhao et al., 2018). This is a process where the food or the raw material is treated with pressures from 200 to 800 MPa at temperatures between 5°C and 35°C. HPP leads to inactivation of microbes because of changes to the cell membrane, denaturation of proteins. This includes the inactivation of enzymes and changes to the structure of the cell. HPP will lead to inactivation of living bacteria while spores are highly resistant. HPP is usually done on packaged products and this reduces the probability of recontamination of the products.

The use of HPP has been studied on several fish species, including herring and mackerel. Results as reviewed by Zhao et al. show that HPP can significantly extend the microbial shelf life of herring and mackerel using pressures from 200 to 450 MPa. Higher pressures lead to a longer extension of shelf life, but it also to larger changes in the sensory quality of the fish. HPP leads to some lipid oxidation and colour changes. Work in Pro-Health has shown that HPP can be used for pretreatment of smoked mackerel to extend its shelf life. The use of HPP can also be used for stabilisation of fish mince, but pressures that are too high lead to a reduction of the gelling properties of mince.

Cold plasma is another method that has been investigated as a preservation method for fish. Plasma is defined as the fourth state of matter in addition to solid, liquid and gas (Zhao et al.; 2018). Cold plasma was found to reduce the number of spoilage bacteria on mackerel while the pH and colour remained stable. However, the treatment leads to increased lipid oxidation. The treatment should, therefore, be combined with the use of antioxidants.

Several of the novel preservation methods are promising – but a better understanding of the mechanisms behind these methods is needed. It is also very important to remember that a low temperature in the value chain is essential.

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For healthier oceans and seas, we need a good dialogue between policy and science

Monika Stankiewicz, HELCOM Executive Secretary argues that for healthier oceans and seas, we need a good dialogue between policy and science

In current times, where accurate and reliable science is needed more than ever to help craft solutions to the environmental challenges we are facing, science needs to find its way into the policy world. For us at HELCOM, an intergovernmental organisation in the Baltic Sea mandated to protect its marine environment, this is no different.

Policy decisions need to be based on solid scientific underpinnings. Pressures on the seas and oceans need to be better understood, and measures currently in place to improve the ecological status of our waters need to be well analysed: What are the ecological trends? Do the current actions addressing the ecological challenges work as expected? Are we on the right track towards our goals of healthy oceans and seas?

Scientific assessments, such as the recently concluded HELCOM Second Holistic Assessment of the Baltic Sea provide answers to these questions. For the Baltic, with this assessment, we now have a clear picture of the ecological state of the sea and the pressures affecting it. (In short, we still need to do more for a healthy Baltic Sea.)

In this particular case, the findings from the assessment led to the decision at the HELCOM Ministerial level to update the Baltic Sea Action Plan – HELCOM's strategic programme of measures for a healthy Baltic Sea – beyond its initial end date in 2021.

In addition to showing trends on known pressures, such as eutrophication or hazardous substances, or

the state of the Baltic Sea's biodiversity, the assessment also helped to identify the extent of emerging pressures. Indeed, to name but a few, plastic pollution, pharmaceutical residues, underwater noise, and loss of seabed have become an increasing cause for concern in the Baltic. As a result, these pressures will now be included in the updated action plan. Here, science clearly helped to guide the policy decision.

"Policy decisions need to be based on solid scientific underpinnings. Pressures on the seas and oceans need to be better understood, and measures currently in place to improve the ecological status of our waters need to be well analysed: What are the ecological trends? Do the current actions addressing the ecological challenges work as expected? Are we on the right track towards our goals of healthy oceans and seas?"

On the other hand, science needs to understand what the policy side needs for making the right choices and how to communicate the research results. For instance, more research on social and economic aspects is needed to support the implementation and development of marines policies. Furthermore, cost-effectiveness and feasibility are typically taken into account when crafting measures for improving the environmental status of seas and oceans.

Therefore, for actions that work, mechanisms need to be in place to allow for constant dialogue between science and policy. The overlap between policy and science needs to be encouraged in as many instances as possible. In the Baltic Sea, HELCOM provides such an interface, and one of the main guiding principles to which the HELCOM members committed is the use of best available science and technology.

The HELCOM structure of expert networks, working groups and policy decision bodies might seem complex at first glance, but allows for continual contact between policy and science, at various degrees and levels. Decisions taken in HELCOM are not only based on political consensus, but on a strong scientific foundation that is the result of a continuous exchange between policy and science.

Furthermore, in the Baltic Sea region, several frameworks overlap: national legislation, regional objectives as defined by HELCOM or the European Union's Marine Strategy Framework Directive, and, at a global level, the UN's Sustainable Development Goals and the Aichi Biodiversity Targets. Even if the ultimate goal is similar for both – namely, a healthy sea – resources and work need to be carefully coordinated for synergy effects and best results. And that can only happen through functioning policy-science interaction.

About HELCOM

HELCOM is a Regional Sea Convention in the Baltic Sea, consisting of Denmark, Estonia, Finland, Germany, the European Union, Latvia, Lithuania, Poland, Russia and Sweden. HELCOM works for a healthy Baltic Sea, and its mandate stems from a regional treaty (the Helsinki Convention adopted in 1974 and amended in 1992) that covers the whole sea area including the sea bed and the resident biota, and pollution sources that may influence the sea. The HELCOM Secretariat is located in Helsinki, Finland. ■

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Containing radioiodine in a solid phase for radioactive waste disposal

In this report Professor Peter H. Santschi, Texas A&M University at Galveston, highlights the challenges when containing iodine in a solid phase for radioactive waste disposal

Silver-impregnated zeolite (AgIZ) has been used for removing radioiodine from contaminated groundwater and nuclear waste streams and the worldwide inventory of such secondary waste is rapidly increasing. To contain long-lived radioactive iodine (16 Mio year half-life of ^{129}I) from nuclear waste, various methods have been employed, with various success.

One of the ways ^{129}I can be immobilized is through the formation of insoluble silver iodide solid, AgI, which is only possible in the presence of oxygen (Fig. 1). The silver technology is commonly deployed by coating silver on zeolites, AgZ, and then putting it contact with the aqueous or gaseous ^{129}I waste stream. The objective of a recent study [Kaplan et al., 2019] was to quantify the effectiveness of two grout waste formulations for disposing of the used AgIZ (Table 1). The grout formulations were with and without slag, an ingredient used to reduce porosity and to create a strong chemically reducing environment to immobilize redox reactive contaminants).

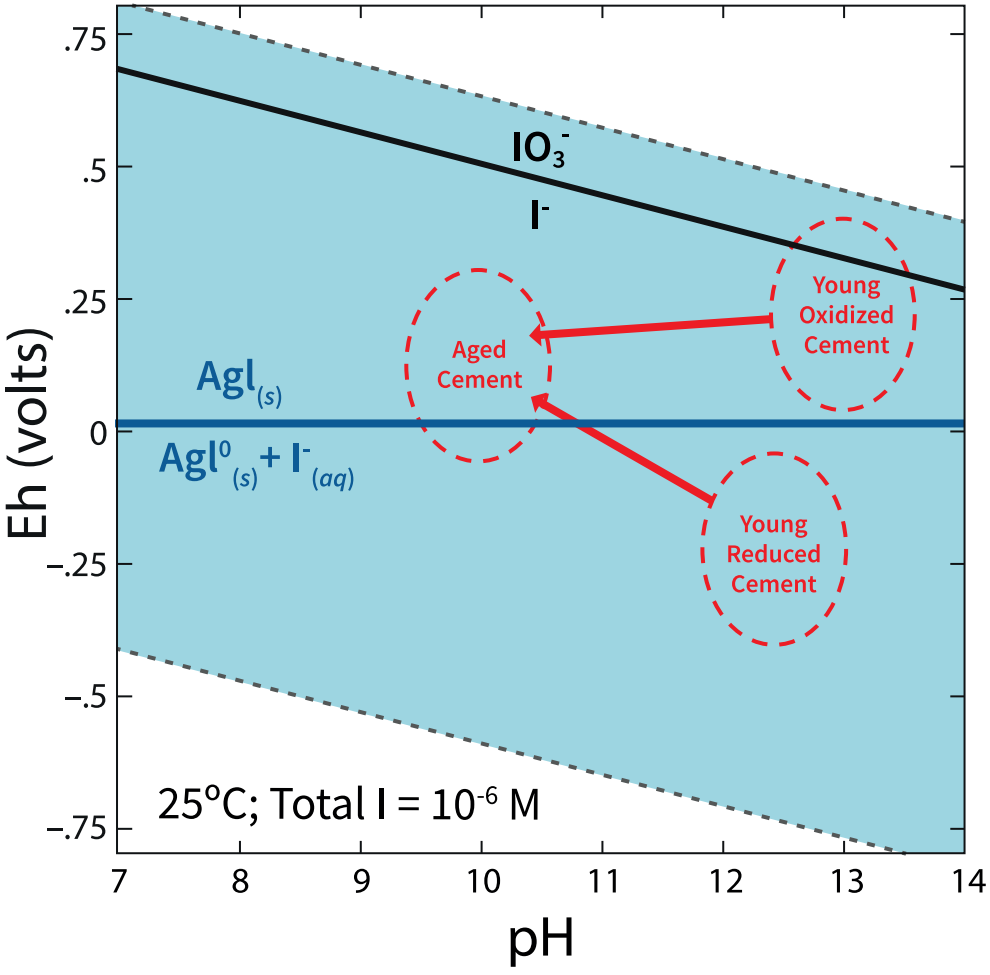

Fig. 1. Pourbaix diagram of iodine speciation showing general regions for grouts with and without slag, indicating that redox potential of 'Young Reduced Cement' containing grout, falls within the zone that predicts reduction of Ag.

A second objective was to determine the iodine speciation leached from AgIZ encapsulated in grout. Iodine commonly exists concurrently as three species in the same environment: iodide (I^-), iodate (IO_3^-), and organo-iodine (org-I). To predict the toxicity and the rate at which ^{129}I travels, it is important to know the iodine speciation in the system. A 60-day kinetic batch experiment demonstrated that AgIZ encapsulated in slag-free grout was extremely effective at immobilizing iodine and silver, a potential non-radioactive carcinogen.

However, AgIZ encapsulated in slag-containing grout, the most common type of grout used for low-level radioactive waste disposal, was entirely ineffective at immobilizing iodine. While the slag-free grout with AgIZ released only 3.3 µg/L total iodine into the contact solution, the slag-containing grout released 19,269 µg/L total

Table 1. Ingredients and proportions used to make the grout samples

Ingredients*	$Grout_{-slag}$ (wt%)	$Grout_{+slag}$ (wt%)	$Grout_{-slag+AgIZ}$ (wt%)	$Grout_{+slag+AgIZ}$ (wt%)
Cement	19	6	16	4
Fly ash	59	32	47	26
Slag	0	31	0	25
AgIZb**	0	0	16	14
Water	22	31	22	31
Liquid:Dry Blend	0.29	0.45	0.29	0.45

** Expressing the above receipts in terms of percent of the dry blend: $Grout_{-slag}$ is composed of 25% cement, 75 wt% fly ash, 0 wt% slag; $Grout_{+slag}$ is composed of 8% cement, 47 wt% fly ash, 45 wt% slag; $Grout_{-slag+AgIZ}$ is 20 wt% cement, 0 wt% slag, 60 wt% fly ash, and 20 wt% AgIZ; and $Grout_{+slag+AgIZ}$ is 6 wt% cement, 36 wt% slag, 38 wt% fly ash, and 20 wt% AgIZ.*

*** AgIZ is the Ag-zeolite (AgZ) amended with I^-.*

iodine. Based on thermodynamic calculations, the strongly reducing conditions of the slag-containing system (Eh was -392 mV) promoted the reductive dissolution of the AgI solid, forming a dissolved form of silver, $Ag^0_{(aq)}$, and releasing iodide into the aqueous phase. The slag-free grout system was maintained under more oxidizing conditions (Eh was 439 mV) and a minimal amount of iodine was released from the grout.

In both grout systems, the aqueous iodine, originally added to the AgZ as iodide, was composed primarily of iodide and org-I, and essentially no iodate was detected. More organo-I was detected in the slag-free than the slag-containing grout system, because the high redox potential of the former system was more conducive to the formation of oxidized I species, such as I_2 and HIO, which may be intermediates in the covalent bonding of iodine with organic carbon in grout. Spectroscopic analysis (X-ray Absorption Near Edge Structure analysis) of the two AgIZ-grout samples indicated that the iodine existed exclusively as silver iodide.

Together, these results show that subsurface grout disposal of AgIZ waste should be done under oxidizing conditions and that radioiodide released from AgIZ can undergo speciation transformations (leading to organoformation) that have important implications on subsequent mobility and estimated risk. **[Kaplan, D.I., Price, K., Xu, C., Li, D., Lin, P., Xing, W., Nichols, R., Schwehr, K.A., Seaman, J.C., Ohnuki, T., Chen, N., Santschi, P.H. 2019. Iodine Speciation in a Silver-Amended Cementitious System. Environment International, in press]**

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The diversity and beauty of UK marine wildlife

Dr Lissa Batey, Senior Policy Manager, The Wildlife Trusts shares with us the highlights of the extraordinary diversity and beauty of UK marine wildlife

The Wildlife Trusts' first ever annual UK marine review is a timely reminder of how precious our seas are; not just for their amazing range of marine wildlife, but for people too. Plankton in the oceans provide oxygen for us to breath, and from family rock pool rambles to fresh fish for the table, healthy and sustainably managed waters around our coast are key to our future.

Whether it's community groups like Guardians of the Deep, Coastbusters, or ShoreThing, people are grasping the importance of our seas. Last year, thousands of marine volunteers and citizen scientists helped Wildlife Trusts survey sea and coast.

With its diversity and beauty, UK marine wildlife matches more 'exotic' species found in distant oceans; after all, the sea is home to half of our wildlife. It was a bumper year for divers' sightings of intelligent hunters like the curled octopus, which uses colour changing camouflage to stalk prey, and brightly coloured solar-powered sea slugs called nudibranchs.

For the first time, Ulster Wildlife surveyed a vast seagrass bed on the floor of Glenarm Bay, an underwater meadow which is a vital nursery for young fish like gurnard, and flatfish. In Cornwall alone, over 3,000 records of marine species were submitted including seals, dolphins and baleen whales.

Shore surveys covered beaches, gathering information and monitoring areas with special marine protection. Last year, for the first time in 33 years, one of the UK's rarest seabirds, the diminutive Little Tern, successfully fledged chicks at Cumbria Wildlife Trust's South Walney Nature Reserve. Nesting on a gravelly shore, the reserve offered a quiet and wild place, free from disturbance, which is vital to help these birds recover.

At Gibraltar point, an unspoilt coastline looked after by Lincolnshire Wildlife Trust, August saw an unprecedented number of sanderlings return, small wading birds which dance about the waterline searching for crabs and fish. Over 10,000 were counted in one roost, which may be the highest count for sanderling in the UK.

Alongside recording wildlife treasure, volunteers tackled the trash; litter and in particular plastic which is so damaging to birds and marine creatures.

On Alderney, for example, plastic is now present in almost 100% of gannet nests largely from fishing industry rope or line. This plastic mass continues to build up, posing a significant risk to chicks and adults alike as they become entangled or end up eating it.

Community beach cleans removed thousands of bags of rubbish, Northumberland Wildlife Trust alone cleaned up 24.5 tonnes, even from remote and wild shores; whilst 60 shopping trolleys were reclaimed from the Kentish coast!

Although individual conservation action is vital, it's national policy which will drive lasting and sustainable change. For the past 10 years, The Wildlife Trusts have campaigned to secure a 'blue belt' of protected sea areas off UK coasts, with positive results.

The Lyme Bay Reefs, in waters off the Dorset and Devon coast, are one of Britain's most spectacular marine landscapes – yet they were once in danger of complete destruction. More than 300 species of plant and animals live there, including the nationally protected pink sea fan and the extremely rare sunset cup coral; Devon Wildlife Trust's long-term survey work in the Bay helped establish the need for protection.

After years of campaigns, fishing gear which was towed along the sea bed for scallop dredging was banned in the area, protecting the fragile sea bed. Just two years later the wildlife had begun to recover, sea fans and sponges returned, covering the sea floor in colour. Species thought to live only on reefs began to grow between cobbles and pebbles, able to thrive on this habitat once the pressure of dredging was removed. Lyme Bay was subsequently designated as a Special Area of Conservation.

In 2009 an act was passed, paving the way for a new type of protected area in English seas – Marine Conservation Zones (MCZs). The first was created in 2013, and there are now 50. Each MCZ is unique, but

Image: © Alexander Mustard/2020 VISION

one of the first, the Manacles MCZ, on the southern coast of Cornwall shows what can be achieved.

Covering a series of rocky outcrops, the Manacles MCZ protects delicate beds of maerl – a type of hard seaweed that forms living reefs, with species like the threatened spiny lobster, and the stalked jellyfish. Once the Manacles became an MCZ, the use of bottom towed fishing gear was prohibited within the area, protecting these fragile and threatened features.

We need more examples like this to drive recovery. Fifty MCZs are a great start, but to truly look after our seas we need a complete network of protected areas around the UK, covering examples of every kind of habitat and threatened species. This year, we're looking forward to another set of Marine Conservation Zones being created. The UK Government is currently considering 41 new MCZ's, which together with those already in place, would go a long way to reverse current marine wildlife declines, making a vital contribution to restoring healthy seas. ■

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Air pollution: A major environmental risk to health

In this in-depth question and answer interview with Charles Ndika Akong, Technical Officer and Dr Magaran Bagayoko, Senior Scientist at the World Health Organization (WHO) Regional Office for Africa (AFRO), we find out why air pollution is a major environmental risk to health

According to The World Health Organization (WHO) Regional Office for Africa, air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution.

Pollutants of major public health concern include particulate matter (PM), carbon monoxide, ozone, nitrogen dioxide and sulphur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases, which can be fatal. We find out more about air pollution in this interview with Charles Ndika Akong and Magaran Monzon Bagayoko from the World Health Organization (WHO) Regional Office for Africa (AFRO).

Tell us about air pollution and how would you define it? What are the pollutants of major public health concern?

Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma.

In 2016, nine out of 10 people breathed air in which the concentration of air pollutants is above the limit set up by the WHO guidelines, and about 7 million people

died of diseases attributable to air pollution.[1] Ambient (outdoor air pollution) in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016.

About 3.8 million deaths globally were attributed to household air pollution, with 734,000 of those deaths occurring in Africa because of the domestic use of solid fuels and kerosene for cooking, lighting and heating. Ambient air pollution caused approximately 439,000 deaths in the region.

The main air pollutants of public health concerns are:

- Particulate matter (PM);
- Ozone (O_3);
- Nitrogen dioxide (NO_2) and;
- Sulphur dioxide (SO_2).

By reducing air pollution levels, how can countries reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma?

The 2005 *WHO Air quality guidelines* offer global guidance on thresholds and limits for key air pollutants that pose health risks. The guidelines indicate that by reducing particulate matter (PM10) pollution from 70 to 20 micrograms per cubic metre (µg/m), we can cut air pollution-related deaths by around 15%.

In low- and middle- income countries including Africa, exposure to pollutants in and around homes from the household combustion of polluting fuels on open fires or traditional stoves for cooking, heating and lighting further increases the risk for air pollution-related diseases, including acute lower respiratory infections, cardiovascular disease, chronic obstructive pulmonary disease and lung cancer.

There are serious risks to health not only from exposure to PM, but also from exposure to ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). As with PM, concentrations are often highest largely in the urban areas of low- and middle-income countries. Ozone is a major factor in asthma morbidity and mortality, while nitrogen dioxide and sulphur dioxide also can play a role in asthma, bronchial symptoms, lung inflammation and reduced lung function.

Worldwide ambient air pollution accounts for:

- 29% of all deaths and disease from lung cancer;
- 17% of all deaths and disease from acute lower respiratory infection;
- 24% of all deaths from stroke;
- 25% of all deaths and disease from ischaemic heart disease;
- 43% of all deaths and disease from chronic obstructive pulmonary disease.

How do you think that policies and investments supporting cleaner transport, energy-efficient housing, power generation, for example, would reduce key sources of urban outdoor air pollution?

Cooperation across sectors and at different levels – city, regional and national – is crucial to effectively address air pollution. Policies and investments supporting cleaner transport and power generation, as well as energy-efficient housing and municipal waste management can reduce key sources of outdoor air pollution. These interventions would not only improve health but also reduce climate pollutants and serve as a catalyst for local economic development and the promotion of healthy urban lifestyles.

Some of the key sector-based health-enhancing strategies against air pollution include:

- Prioritising rapid urban transit, walking and cycling networks in cities, as well as rail interurban freight and passenger travel;
- Shifting to cleaner heavy-duty diesel vehicles and low-emissions vehicles and fuels, including fuels with reduced sulphur content;
- Creating green spaces that help remove PM and reduce the heat island effect;
- Improving urban waste management, including the capture of methane gas emitted from waste sites as an alternative to incineration;
- Replacing traditional household solid fuel with lower-emission cookstoves and/or cleaner fuels;
- Shifting away kerosene and;
- Improving the energy efficiency of homes and commercial buildings through insulation and passive design principles, such as natural ventilation and lighting.

Tell us about how the WHO Member States have adopted a resolution and a roadmap for an enhanced global response to the adverse health effects of air pollution?

In 2015, for the first time, the World Health Assembly (WHA) unanimously adopted a resolution to accelerate global action to address household air pollution. The following year, the WHA adopted a "Roadmap for Enhanced Action", calling for increased cross-sector cooperation to address the health risks of air pollution.

This roadmap set out a practical course for implementing the resolution, through building the knowledge base, strengthening institutional capacity, improving monitoring and reporting, and emphasising global

leadership and coordination. It focuses on four priority areas of action:

- Expanding the knowledge base about the impacts of air pollution on health;
- Monitoring and reporting on health trends and progress towards the air pollution-related targets of the Sustainable Development Goals;
- Leveraging the health sector to raise awareness of health benefits from air pollution reduction measures;
- Enhancing the health sector's capacity to work with other sectors and at all levels – local, national, regional and global – to help address the adverse health effects of air pollution through training, guidelines and national action plans.

Finally, when it comes to WHO's response to air pollution, what are your priorities? For example, tell us about the detailed health-related assessments of different types of air pollutants, including particulates and black carbon particles, ozone, etc that you create.

In 2017, WHO Africa Region adopted a regional strategy for the management of environmental determinants of human health. The strategy outlines priorities for tackling the burden of air pollution in a comprehensive manner in countries from 2017-2021. Priority activities include:

- Supporting national legislation and regulatory instruments on public health, including harmonisation and implementation of legislation to promote the use of clean energy sources for cooking, heating and lighting.
- Promoting access to sustainable and clean/renewable energy in healthcare facilities, and enhancing sustainable urban policies in energy, transport, waste management and industry in order to reduce the emission of short-lived climate pollutants;
- Promoting air pollution monitoring and consolidating evidence on its impact on human health, in line with resolution WHA68.822 and SDGs 7 and 11.5

Is there anything you would like to add?

It is imperative to also incorporate the economic angle, in particular, the hidden and visible costs of doing nothing or little to address air pollution. Economic analysis shows that health-enhancing preventive strategies for tackling air pollution could pay themselves in Africa. The World Bank estimates that air pollution cost Sub-Saharan Africa 3.8% of gross domestic product growth in 2013, around $114 billion. These health-driven expenses are expected to grow faster than GDP if nothing is done. Air pollution is leading to more days spent in the hospital and out of the workforce. Just the cost of lost labour in the region from air pollution exposure is about $6.8 billion – on a per capita basis, it is the highest in the world.

Given the growing burden of diseases associated with air pollution, African countries will need to step up efforts including mobilising domestic resources. The International Energy Agency estimates that ensuring universal access to cleaner and healthier cooking fuels in Sub-Saharan Africa by 2030 would cost $1.7 billion annually. While this would be a substantial investment, it could easily be covered by a decrease in fossil fuel subsidies in countries, which in 2015, was estimated at $26 billion in the region. ■

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Sustainable shipping into the next decade

Mr Kitack Lim, Secretary-General of the International Maritime Organization (IMO), looks ahead to the challenges for international shipping as the next decade approaches

Shipping is the backbone of international trade, with 10.7 billion tonnes of commodities carried by sea annually. Forecasts are for sustained growth. Passenger ships carry millions of people each year.

As the global regulator for shipping, the International Maritime Organization (IMO), a specialised agency of the United Nations, has a clear responsibility to ensure shipping is safe, secure, efficient and sustainable. The IMO has been very successful to date in developing a comprehensive set of standards covering everything from ship design and construction through to seafarer training and environmental issues.

During 2019, the shipping industry must prepare for a milestone ruling which will cut sulphur oxide emissions from ships substantially from 1 January 2020, with significant benefits to human health and the environment. Simply put, the rule will cut harmful air pollution from ships. The 80% cut in the upper limit of the sulphur content in ships' fuel-oil (to 0.50% m/m from 3.5% m/m) has become known universally as "IMO 2020".

First taken in 2008 and then confirmed in 2016, this landmark decision shows IMO's continuing commitment to ensuring shipping meets its environmental obligations. Everyone involved, including refineries, shipowners and bunker suppliers (who supply fuel oil to ships) must act to implement the change during 2019. The majority of ships will need to clean their fuel tanks and then load them with compliant fuel oil before 1 January 2020.

On the broader emissions agenda, IMO Member States adopted, in 2018, a breakthrough initial strategy for reducing greenhouse gas emissions from international shipping. Under the identified "levels of ambition", the initial strategy envisages for the first time a reduction in total GHG emissions from international shipping which, it says, should peak as soon as possible. And it aims to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out entirely. The strategy includes a specific reference to "a pathway of CO2 emissions reduction consistent with the Paris Agreement temperature goals", referring to the Paris Agreement on climate change.

The initial GHG strategy (to be revised by 2023) provides an overall framework for technical discussions. Detailed work on exactly how to achieve the ambitions has now begun. Member States are expected to build on their initial strategy by presenting firm, concrete proposals. These will include a strengthening of the already-adopted energy efficiency design index (EEDI) requirements, which require new ships to be designed and built to be increasingly more energy efficient. This year also sees the initiation of the fourth IMO GHG study. And, since 1 January 2019, ships over 5,000 gross tonnes (which between them account for 85% of GHG emissions from international shipping) have begun collecting data on their fuel-oil consumption, implementing a mandatory scheme adopted in 2016.

IMO's work to support capacity-building and technology transfer also continues apace. Five regional maritime technology cooperation centres established under the IMO-executed global GMN network project, which is funded by the European Union, will continue their work on pilot projects related to emission data gathering and technologies. The Global Industry Alliance (GIA), a public-private partnership initiative of IMO under the framework of the Global Environment Facility (GEF)-United Nations Development Programme (UNDP)-IMO global maritime energy efficiencies (GloMEEP) project,


Kitack Lim, Secretary-General

will focus on energy efficiency technologies and operational best practices, alternative fuels and digitalisation.

All these efforts put IMO firmly on track to support the United Nations Sustainable Development Goal on combating climate change (SDG 13). But IMO's work extends across many other SDGs, including SDG 14 related to the sustainable use of the oceans, as well as many others on infrastructure, work, and partnerships.

An important environmental treaty, known as the Ballast Water Management Convention, sees key amendments take effect from 8th September 2019, bringing in a schedule for ships to meet strict requirements to manage their ballast water, in order to prevent the transfer of potentially harmful aquatic invasive species. For many ships, this will mean installing a ballast water management system on board.

The industry will also be gearing up for the entry into force, on 1 January 2020, of a raft of technical amendments to IMO's International Convention for the Safety of Life at Sea (SOLAS), aimed at making shipping safer and updating requirements for transport of dangerous goods.

Looking at broader trade issues, from April 2019, under the revised FAL Convention, ships and ports must exchange data electronically, preferably using the so-called "single window" concept, which will help improve trade flows. It is another step towards harnessing the full potential of the "blue economy".

This is just a small example of a much wider digital revolution that is already beginning to change the face of shipping. Artificial intelligence (AI), data-supported remote management and autonomous operation are all becoming realities. IMO must ensure that shipping's regulatory framework enables the realisation of their full advantages, without compromising on safety or environmental performance and always taking into account the impact on the human element, including the world's 1.5 million seafarers.

IMO's World Maritime Day theme this year is "Empowering Women in the Maritime Community". We aim to raise awareness of the importance of gender equality, in line with the United Nations' SDG 5 and highlight the vital – and under-utilised – contribution of women within the maritime sector.

IMO is also continuing its own process of review and reform. This a key element of the IMO's strategic plan for the 2018-2023 timeframe. The overall aim is to ensure that the IMO is truly fit for purpose. This is especially challenging today, when the world around us is changing so rapidly and the public expectations of organisations like IMO are, quite rightly, becoming ever more demanding.

Looking ahead to the next decade, as we work towards supporting the achievement of the United Nations 2030 Agenda for Sustainable Development and its SDGs, it is clear that the organisation and the shipping industry face a number of challenges, as outlined above, as well as opportunities.

I am hopeful that the Member States will respond appropriately and ensure IMO has the mandate, structure and resources it needs to be well positioned to serve the growing global population – a population that relies on a clean and safe shipping industry. ■

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What can we learn from the Baltic SECA concerning future shipping environmental regulation?

Sari Repka from Centre for Maritime Studies, University of Turku asks what can we learn from the Baltic SECA with respect to future shipping environmental regulation and provides a compelling response

The EnviSuM project is reaching its completion. This spring, we analysed the different aspects of the impact of the Sulphur Emission Control Area (SECA), from technical issues to social and economic effects in the Baltic Sea Region (BSR). Among the motivations behind EnvisuM, was the need for updated science-based information to guide future legislation on emissions from ships.

One can ask...what are the lessons learned from the Baltic Sea SECA to the upcoming global regulation Sulphur Cap 2020?

With some uncertainty, we can extrapolate some of the EnviSuM findings. We can safely say that the feared negative economic consequences that were heatedly debated by the shipping sector before the regulation did not, for many reasons, materialise. In contrast, the expected environmental benefits did.

Shipping in the Baltic Sea differs greatly from shipping in other parts of the world. The Baltic Sea shipping is short sea shipping and competes with road traffic. In addition, the entrance of vessels to the Baltic Sea are size-limited due to the overall shallow depths of Danish straits. Since the feared modal shift from sea to land due to cost increase from the SECA was not observed in the BSR, we do not expect that to be an issue in other parts of the world either.

What are the compliance costs in the BSR? According to rough calculations, the annual cost is around €595 million. However regardless, according to our and other studies these costs are only a minor detail in the natural market variation of shipping. Undoubtedly, shipowners bear these costs and transfer them to their customers. Before the regulation entered into force, it was speculated that some industries, such as paper or metal industries, in the northernmost part of the Baltic Sea, would suffer the most – and even relocate. The costs of transport have increased, partly due to SECA, but no relocations in the industries can be attributed to that.

What about the administrative costs of SECA to society? According to our results, the annual costs for the 1500 vessels in the Baltic Sea the administrative costs are around €3 million which are negligible but can be extrapolated to other regions.

Many challenges have arisen with respect to the different methods to comply (Fig. 1). Air pollution control devices, such as scrubbers, cannot cut CO_2 emissions, do not fully reduce particulate emissions (c. 50%) and cannot match long term MARPOL 6 deadlines, which requires a drastic reduction of both SOx and NOx (scrubbers can cut only one exhaust at a time). Liquefied Natural Gas (LNG) as ship fuel is cleaner than the traditional bunker fuel or marine diesel, but methane slip is a clear disadvantage for upcoming greenhouse gas emissions regulations. Therefore, more work, research and innovations are needed as compliance is also a business opportunity.

> "The reduction in sulphur emissions will benefit the world's health and environment. For the countries bordering the Baltic Sea, The EnviSuM project estimates that 500 – 1000 premature deaths annually have been prevented."

Non-compliance can be lucrative from economic aspects. Thus, monitoring and sanctioning is important to ensure a level playing field. In general, compliance in the Baltic Sea is around 95% or better since the shipowners have internalised the values of environmental regulation. However, when outside of territorial waters or far from known sniffers, the percentage of compliant vessels somewhat drops. Based on this, we expect less compliance in high seas as they can be difficult to monitor.

Image: © Nina Visnes

Fig. 1: Different options for powering ships. Source: DNV GL (2017). Illustration by Nina Visnes

Finally, what are the benefits of the SECA regulation? In the Baltic Sea, the transition from 1.0% to 0.1% sulphur content in fuel was made in 2015. This is a reduction of 90%. Globally, we will see a transition from 2.5 to 0.5 in 2020. Are the effects of regulation linear for sulphur deposition? In the BSR, the sulphur emissions from shipping were a factor of 8.16 higher in 2014 compared to 2016. Not a factor of 10 – assuming purely 1% to 0.1%. This is understandable because already in 2014 some vessels were using low sulphur options.

For the countries bordering the Baltic Sea, The EnviSuM project estimates that 500 – 1000 premature deaths annually have been prevented. In addition, a large number of non-lethal cases of heart attacks and stroke have been prevented, also in countries further away. The decrease in mortality was estimated to be at least €500 million for SECA and the decrease in acidification would result in gains of €145 million. These figures still miss the effects of morbidity. However, as the global cap will influence deep sea shipping far away from the coasts, most of the pollutants will be deposited to the ocean and not reach the coasts. Therefore, we expect the benefits for human health and land ecosystems to be relatively less than in the BSR. Besides, SECA has induced innovation in the BSR and improved reputation of the area, recognised as frontrunners of clean shipping worldwide (Fig. 1). This position may help marketing the in practice tested compliance methods in the BSR.

In summary, controlling sulphur emissions from shipping in the BSR has been the biggest environmental effort in that sector to date. Accepting and internalising this regulation has changed the attitude of the shipping industry towards environmental issues and can be regarded as a paradigm shift. Regional regulation for the global problem of sulphur was considered unfair and risky for the shipping sector in the BSR, however, in the Baltic Sea, we have been able to show that it can be done and the business thrives.

Welcome to our Final Conference in Copenhagen on 24th April 2019! More info and registration: http://mdc.center/events/2019/4/24/impacts-from-seca-and-global-cap-2020

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Canada: Reducing emissions and taking action on climate change

Patricia Fuller, Canada's Ambassador for Climate Change, explains how Canada is taking action to reduce emissions and tackle climate change

In a past edition of Open Access Government, Minister of Environment and Climate Change in Canada, Catherine McKenna detailed the country's plan to reduce carbon emissions and strengthen their clean growth economy. Minister McKenna believes that governments can assist people to thrive in a changing climate. "Governments everywhere want to protect their citizens from climate risks. They want to build resilient communities, protect investments, reduce costs and ensure people thrive in a changing climate", she says.

In March this year, we were very fortunate to enjoy a conversation with Canada's Ambassador for Climate Change, Patricia Fuller, to find out how the Government of Canada is working together with Canadian businesses to grow Canada's clean economy. In this interview, we discover how Canadians coming up with innovative methods to increase energy efficiency and reduce emissions, saving people money and creating good jobs. Looking ahead, we learn about the importance of investing in projects that will help Canada reduce emissions and take action on climate change.

Supporting innovation and the development of clean technologies

We know that there are a wide range of programmes in place to support innovation and the development of clean technologies by the Government of Canada. Innovation is supported from early-stage R&D right through to commercialisation and Patricia notes that in recent federal Budgets, support in this vein was expanded through the Business Development Bank of Canada (BDC) and Export Development Canada (EDC). They have both created special teams focused on financing clean technology companies, but there are also many other forms of support being given, Patricia tells us.

"Another important institution that works within this area is Sustainable Development Technology Canada and they are supporting companies that are looking to develop and demonstrate clean technologies."

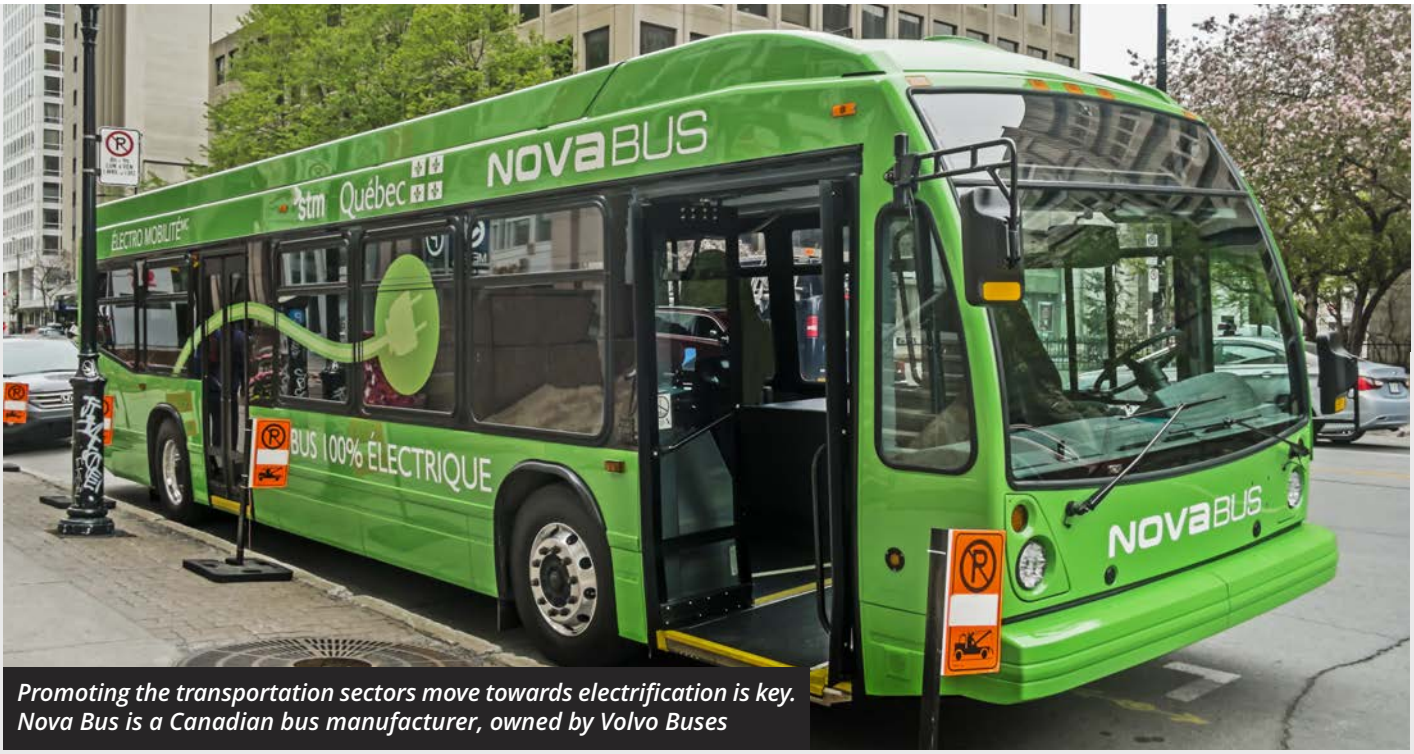
Innovative ways to increase energy efficiency and reduce emissions

The conversation then moves to explain how Canadians coming up with innovative methods to increase energy efficiency and reduce emissions will save people money and create good jobs. Patricia underlines that in Canada today, innovation is being evidenced in all sectors of the economy in light of that fact that both clean technology and clean growth encompass many areas. One example is the industrial sector, where there are innovations around saving companies energy costs through innovation in processes. Patricia then keenly gives additional examples in her own words.

"A whole area of innovation we are seeing a lot of is in the application of IT and the Internet of things (IoT) so that industry can become much more efficient in how they use resources. We are seeing the IT and data analytics space innovating very strongly.

"Also, in the area of electricity generation, we see the application of IT and artificial intelligence (AI) to the management of electricity grids. There is the whole area of smart grid technology and grid modelling, that enables much more use of renewable energy because the electricity grid can become much more decentralised.

"In the area of energy efficiency when it comes to buildings and homes, we have a number of innovations in terms of how to get those projects off the ground. For example, we have seen rapid growth occurring in Toronto over the last 15-20 years in terms of high rise



Promoting the transportation sectors move towards electrification is key. Nova Bus is a Canadian bus manufacturer, owned by Volvo Buses

Image: © Michel Bussieres | Dreamstime.com

buildings while energy demand remains constant, because of improved insulation and lighting, for example, which drives down the use of energy.

"Then, of course, there is the transportation sector where the move towards electrification is key and, we see greater use of electric vehicles and we are supporting charging stations. Canadian companies are also developing electric buses and exporting those internationally, so that is a very exciting area of innovation.

"It's also important to share innovation in the oil and gas sector where companies are investing to drive down the energy-intensity of oil and gas production, as well as developing carbon capture and use technologies. There is the example of a company, Carbon Cure, who puts CO_2 in concrete to make is stronger so that it will create value, and you can see other examples of uses for CO_2 and the potential of a market for that."

Reducing emissions and tackling climate change

As we look to the future, Patricia explains why it is important to invest in projects that will help Canada reduce emissions and to take action on climate change. Investment in these areas creates a "win-win" situation when it comes to Canada reducing their emissions, reaching targets under the Paris Agreement, and helping Canada to be competitive in the global transition towards a low carbon economy.

"We know that all countries are investing in these areas as well and we want to ensure that Canadian industry is positioned to be competitive and to have a leadership role in areas where we have strength. We know that this supports long-term prosperity, as well as the creation of very good jobs today."

Supporting developing countries

From our earlier article by Minister of Environment and Climate Change in Canada, Catherine McKenna, we learn that Canada is assisting developing countries to access clean energy and climate solutions. In 2016, we learn that the Government of Canada committed to contributing $2.65 billion up to 2021 towards the achievement of this goal. Patricia offers her own thoughts on this aspect of policy as the interview draws to a close.

"We are very aware that developed countries need to support developing countries in making the transition and in adapting to the effects of climate change that are already potentially catastrophic for development goals. So, we are investing in programmes that support developing countries to adapt to climate change." ■

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The changing Arctic ice caps

Professor Martin Sharp, University of Alberta, explores the processes, rates and impacts of the changing Arctic ice caps due to global warming

Professor Martin Sharp, University of Alberta

I am a glaciologist with specific interests in the glaciers of the Canadian high Arctic. My work focuses on the rates, processes and impacts of glacier change, glacier hydrology and hydrochemistry, microbial life in glacial environments, and the dynamics of polar glaciers. I am equally interested in communicating about these phenomena, and how they are affected by global climate change, to the broader public, and have been involved in writing several major scientific assessments of Arctic climate change and its impacts. I am also the Director of the Canadian Ice Core Archive at the University of Alberta. This is an ice core research facility that also houses the Canadian national ice core collection.

In the Arctic, semi-permanent ice exists at the Earth's surface in various forms - the seasonal snow cover, as ground ice within permafrost regions, as freshwater ice on lakes and rivers, and as glaciers, ice caps and the continental ice sheet on Greenland. All these forms of ice are susceptible to melting in a warming climate and many of them are already decreasing in extent because the northern high latitudes are among the most rapidly warming regions on Earth.

At present, excluding the Greenland ice sheet, there are estimated to be 64,296 ice caps and glaciers in the Arctic, with a total area of nearly 422,000 km^2. The most heavily glaciated regions are the Canadian Arctic Islands (~146,000 km^2), Alaska (86,725 km^2), Greenland (excluding the Greenland ice sheet, 89,717 km^2), and the Russian Arctic Islands of Novaya Zemlya, Severnaya Zemlya and Franz Josef Land (51,592 km^2). Glaciers cover a further ~ 48,000 km^2 in the Norwegian Arctic (Svalbard and Jan Mayen Island), Iceland, and Northern Scandinavia (Box, Sharp et al., 2017). For the whole Arctic, excluding Greenland, the total volume of glacier ice is estimated to be nearly 115,000 km^3. This volume of ice would be enough to raise the global mean sea level by about 29 cm if all the glaciers melted completely.

Over the period 2003-2009, Arctic ice caps and glaciers were losing mass at a rate of about -176 gigatons (Gt) every year, with the highest rates of total mass loss being estimated for the Canadian Arctic Islands (-60 Gt/yr), Alaska (-50 Gt/yr), and Greenland (excluding the ice sheet, -38 Gt/yr). A further -28 Gt/yr came from glaciers in the Russian Arctic Islands, Svalbard, Jan Mayen Island, Iceland and northern Scandinavia. For reference, one Gt is a billion metric tonnes.

For the longer period 2003-2015, best estimates based on satellite gravity

measurements from the GRACE satellites suggest regional mean rates of -66.8 Gt/yr for Arctic Canada, -42.5 Gt/yr for Alaska, -16.0 Gt/yr for the Russian Arctic, -8.9 Gt/yr for Iceland, and -7.6 Gt/yr for Svalbard (Box, Sharp et al., 2017, following Wouters et al., 2008). Together, these longer-term rates equate to a rate of sea level rise of ~ 3.92 mm/yr. To put these present-day rates of mass loss into some perspective, data derived from analysis of ice cores from the Canadian Arctic ice caps suggest that current rates of melting are the highest in the past 4,000 years, and that they were last exceeded about 9,000 years ago during the Holocene climatic optimum (Fisher et al., 2012).

An increase in global mean sea level is probably the most widely recognised

consequence of melting of glaciers, ice caps and ice sheets, although thermal expansion of ocean waters due to ocean warming also contributes to this. Such sea level rise is a matter of concern because of the high concentrations of human populations, property, and infrastructure at low elevations close to the ocean, where they are potentially vulnerable to coastal inundation driven by rising sea levels.

Large and rapid changes in the rates at which glaciers, ice caps and ice sheets melt can have substantial impacts on the aquatic ecosystems of downstream lakes, rivers, floodplains, and wetlands. These include changes in both mean and extreme water levels, the magnitude and timing of flood events, stream water temperatures, chemistry and sediment loading, and have the potential to impact the full range of organisms that inhabit these environments. Glacial meltwaters can transport large amounts of dissolved and particle-bound nutrients that play an important role in supporting productivity in downstream freshwater and marine environments. For instance, the termini of "tidewater" glaciers that terminate in the ocean are often important feeding grounds for seabirds and marine mammals.

However, higher rates of melt, runoff and sediment transport from glaciers will typically result in more turbid water columns in downstream rivers, lakes, and nearshore marine environments and this can reduce light penetration into the water column and limit photosynthetic activity, primary production, and water temperatures. There are therefore many reasons to be concerned about the consequences of accelerating rates of glacier and ice cap melt in the Arctic as these can be felt well beyond the present-day limits of the ice masses themselves.

Other potential impacts include the release of legacy pollutants that have been deposited on glaciers, ice caps and the Greenland Ice Sheet over time and stored within the upper layers of the snow and firn (snow that is on its way to becoming glacier ice) in high elevation regions where snow typically accumulates year-on-year and is gradually transformed into glacier ice. As atmospheric warming progresses, however, surface melting spreads to higher and higher elevations and eventually mobilises the accumulated reservoir of pollutants and transfers it to downstream aquatic systems, where it may be assimilated into the food chain. As has been demonstrated in the Canadian Rockies, European Alps and Antarctica, this can result in the reappearance in living organisms of pollutants that have been banned and not actively used for decades.

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New and green and fair? Feeling our way towards greener and more inclusive economies

Steven Stone, Chief, Resources and Markets Branch, UN Environment asks if we are making progress towards greener and more inclusive economies

Deals are in the air right now; New Deals, Green Deals, even New Green Deals have been proposed in governments around the world. All suggesting the need to renew existing social contracts and the license to operate for business.

But those deals aren't exactly as new as they sound. It was Franklin D. Roosevelt who introduced the original New Deal in the United States (U.S.) back in the 1930s to reset the clock on capitalism, reshape the economy and install social floors to save millions of Americans from poverty after the Great Depression.

Today, as we witness wave after wave of economic nationalism and global retrenchment, putting into question the foundations of the post-World War II multilateral system, we are also seeing a resurgence of initiatives that put the environment and sustainability at the core of economic policy and growth strategies. Just as Roosevelt's New Deal responded to an economic crisis, these New Deals respond to a critical period for our environment.

And not a moment too soon. The vital signs of our planet are stark enough – every day we hear about rising concentrations of plastic in our oceans, surface temperatures that are causing extreme weather, and air quality statistics that defy belief. Such as the fact that over 90% of the world's population now lives and breathes in areas beyond World Health Organization (WHO) safety standards.

How did we reach such an impasse? And how we will rise above it? The answer goes back to a very simple adage that has featured in U.S. politics over the decades: it's the economy, stupid.

It really is the economy. As early as March 2009, just after the financial meltdown wiped 50% out of the value of stock-markets and left governments scrambling to maintain stability and confidence and liquidity, UN Environment and its partners launched the Global Green New Deal, focusing on how managing the stimulus-response in this new economic reality could both jump-start jobs and lead to growth and good environmental outcomes. Like investing in energy efficiency in buildings leads both to a reduction in heating and cooling costs and energy consumption – and investing in solar and wind spur job growth and local development and new energy markets.

> "The circular economy and how we produce and consume was front and centre to the discussion: a clear sign that governments are ready to re-evaluate the models that have dominated our economic landscapes for decades."

The Global Green New Deal became the basis for the Green Economy Initiative, from which a wider partnership was born: the Partnership for Action on Green Economy or PAGE – a place where thought leaders, sustainability champions and the curious can converge to compare notes on what is both a global challenge and national imperative: creating economies that are fit for purpose in the 21st century. Economies that create wealth and income, without drawing down the base of our natural endowment or the living conditions that sustain us.

The inclusive green economy has emerged as an alternative to the status quo that creates growth by liquidating natural assets, investing in people and ecological infrastructure as a source of future innovation, revenue,

and growth. And one that is based on circularity, resource efficiency and resilience.

Over 70 countries around the world currently have green growth or green economy plans in place, and many others are considering them. Among them are the green deals that frame national policy in the Netherlands; the Solar Alliance at play in India; the framing of Ecological Civilization in China; and the New Green Deal recently tabled in the U.S. Congress.

> "To make our economies greener, fairer, and more inclusive, we need to seriously re-evaluate the economic policies that have resulted in the pollution of our air, water and food, and that are resulting in social inequalities not seen since the 1920s."

The tension between investing in technologies that enhance national and global welfare and the temptation to put local and national interests first is likely to rise as the environment deteriorates and more people are forced to migrate. Which is why it has never been more important to embrace the two most important international deals of the past decade: the Sustainable Development Goals, and the Paris Agreement.

The goals set out a common agenda and establish a roadmap and targets for 2030 – including the necessary ingredients for establishing a social floor of access to water, food, shelter, education and health. And the climate agreement is just plain good sense because it protects the resources, we all share: the air we breathe and the atmosphere that knows no other boundary except the one imposed by the stratosphere.

To make our economies greener, fairer, and more inclusive, we need to seriously re-evaluate the economic policies that have resulted in the pollution of our air, water and food, and that are resulting in social inequalities not seen since the 1920s.

This includes reversing fiscal policies that reward polluters and further concentrate wealth, and a reassessment of our over-reliance on consumer-led growth to keep economic motors humming. Growth that has created the illusion of progress and prosperity while in fact eroding the very basis of inclusive wealth.

Sooner or later, the bills will come. Mother Nature has been pretty lenient with us, giving us time to make mistakes, learn, and feel our way forward. But its time now to put the pieces together, to solve the puzzle of creating prosperity that does not undermine our chances for a prosperous future.

In March 2019, world leaders gathered in Nairobi, Kenya for the Fourth UN Environment Assembly. The circular economy and how we produce and consume was front and centre to the discussion: a clear sign that governments are ready to re-evaluate the models that have dominated our economic landscapes for decades.

Which brings us back to new deals, and new ways of dealing with our damaged and polluted planet as we seek to create a world in which our children will have a chance for a better life.

And that sounds like a deal we can all get behind. ■

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The return of global governance: This time it comes with many faces

The ocean's pollution with plastics has stirred multiple promising responses across the globe. Are we on the verge of a new type of global governance? Prof Dr Raimund Bleischwitz explains how such governance may look and what is still missing

It is hard to catch up on the news about plastics in the ocean, and the many solutions that are underway. Here are just a few: San Diego, other cities and local councils are banning Styrofoam food and drink containers; the EU, Washington D.C. and others are banning plastic straws; Visitors will no longer be allowed to carry in single-use plastics into Peru's 76 natural and cultural protected areas; and the list goes on. While some of this may look like regulation reloaded, the overall picture is quite forward-oriented.

More than 250 organisations have joined a "new plastics economy global commitment" with partnerships from H&M, Unilever, PepsiCo, L'Oreal, Nestle, Coca-Cola, a number of cities and political actors. It is a collaboration with the United Nations and is being led by the Ellen MacArthur Foundation. Other partners include the World-Wide Fund for Nature (WWF), the World Economic Forum (WEF), the Consumer Goods Forum, financial institutions and venture capital funds, and 40 academic institutions, including UCL. Targets include to:

- Eliminate problematic or unnecessary plastic packaging and move from single-use to reuse packaging models.
- Innovate to ensure 100% of plastic packaging can be easily and safely reused, recycled, or composted by 2025 (see e.g. the UCL Plastics Waste Innovation Hub and plastics heritage).
- Circulate the plastic produced, by significantly increasing the amounts of plastics reused or recycled and made into new packaging or products.

No foresight analysis predicted this surge of global activities; rather, it can be seen as unprecedented compared to the many years it took in the 1990s to set up international climate action based on science and political will. Some driving forces for phasing out plastic waste so vividly, however, are now easy to spot. Discoveries of fish with a stomach full of plastic went viral via media, and voices like Sir David Attenborough urging for action after filming Blue Planet II in 2017 were heard across the globe. In addition, the political shockwave created through China's crackdown on the import of plastic waste in early 2018 fuelled the tsunami wave of action. Thus, it's been high pressure to act created through media and China as a global player triggering action.

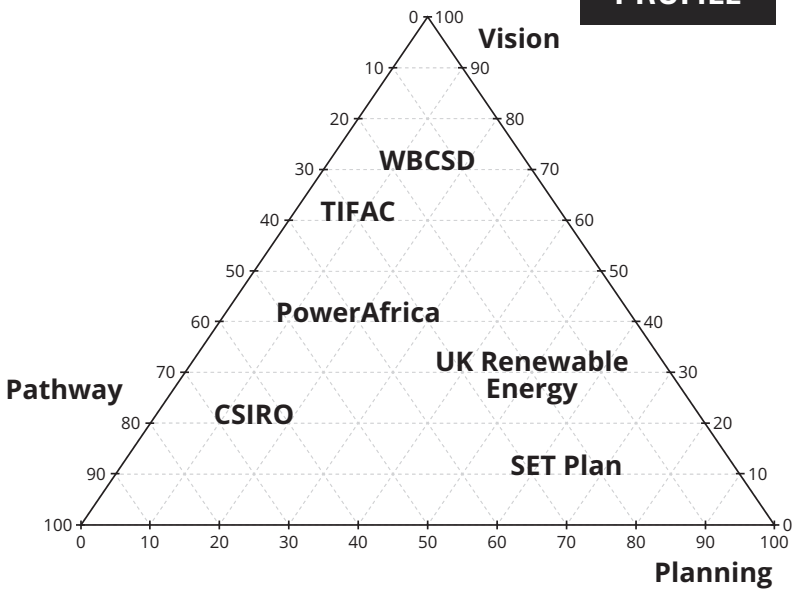
Wicked challenges

Challenges like this are often called "super wicked". Characterised by time running out, those causing the problem needed to become part of a solution, and authority on decision-making missing, they require new types of governance approaches with immediate action and a long-term perspective. UCL researchers David Coen and Tom Pelgram propose a third generation of global governance research able to transcend multilateral gridlocks and addressing transboundary problems. We may borrow here the importance of scales (e.g. how does the plastic end up in the ocean?), the relevance of a comparative perspective (e.g. how do action and outcomes differ, if done in a quite different country?), and the focus on "what works" in unsettled times driven by a range of actors under a range of circumstances.

Yet, it will take one more ingredient to fully address the wicked challenge of too much plastic ending up in unhealthy conditions. It is necessary to go beyond symbolic action and address the long-term perspective. Good global governance needs a vision of what it seeks to achieve combined with an aspiration for broader public purposes. The vision of a plastic-free ocean is simple and compelling, it speaks to environmentalists, businesses able to contribute, and policy-makers concerned with the clean-up. Like in the iconic inaugural presidential address of John F. Kennedy, it poses a question to individual citizens – what YOU can do to achieve such a goal.

Visions and roadmaps

A vision is seen as elementary in transition research to raise aspirations and ambitions, it helps to align individual activities with collective action, and it inspires product designers and business developers. It is important to realise such visions can be formulated



Mapping policy roadmaps: blending visions, pathways and planning

Source: Miedzinski, McDowall, Fahnestock, Rataj (2018) How to design STI policy roadmaps to foster innovation for sustainable development? Inno4SD Policy Outlook: 10. WBCSD = World Business Council for Sustainable Development and their Vision 2050; TIFAC = 2035 Technology Vision (India); SET = European Strategic Energy Technology Plan; CSIRO = Low Emissions Technology Roadmap by the Commonwealth Scientific and Industrial Research Organisation.

based on incomplete information about negative impacts that need to be avoided, e.g. what exactly is the impact on marine ecosystems and human health stemming from plastic in the ocean. In order to create new knowledge, such vision ought to be open and pluralistic, and it needs to be embedded in transition strategies.

The EU-funded project "Inno4SD" – the Innovation for Sustainable Development Network – has pulled together a library of evidence on what works in a comparative perspective, with excellent insights into policy and market development. One of the Inno4SD policy outlooks reviews a range of policy roadmaps in their attempts to drive innovation for sustainable development. A key is the blending of visions, pathways and planning (see figure) – and their interactions. Compared to heroic statements of the past such as "land a man on the moon before the decade closes", the wicked challenges of today require multiple experiments, social learning from success and mistakes, and core values of pluralism, openness, and inclusion.

The Technology Facilitation Mechanism and their work on roadmaps are useful. The risk of new path dependencies and lock-ins can be counteracted by comprehensive assessments and by interactions between research and stakeholders.

On the verge of a new type of global governance

Are we on the verge of a new type of global governance? In light of increasing fragmentation, sweeping populism and phobia against "others" all around, our "yes, perhaps" might come as a surprise. Yet, the encouraging activities to combat plastic in the ocean and the pattern it reveals could well indicate a dawn for the next-generation of global governance, if emerging gaps are addressed by effective arrangements. The research from above suggests a strengthening along the following lines:

- The key account actors, together with Europe and China and international organisations, could turn pledges into a platform able to harmonise standards, remove barriers and trigger market development for innovative plastic products, as well as help blending finance mechanisms;
- Research and key stakeholders could establish roadmaps aligning visions on plastic-free ecosystems, transformative pathways for today's throw-away business models and participatory planning processes with special features on regions and a knowledge hub on "lessons learned"'.
- Novel methods and mechanisms on impact assessment could address health, biosphere integrity and socio-economic impacts, both resulting from current trends as well as from new roadmaps.

Research has a role to play in enabling knowledge, innovation and transformation. Higher education can pioneer future pathways through international partnerships and an active role in continuous professional development – and shape the global governance architecture towards a plastic-free ocean and the Sustainable Development Goals.

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A new and exciting age in polar science

Kelly K. Falkner, Director of the Office of Polar Programs (OPP), National Science Foundation, shares her thoughts on a new and exciting age in the field of polar science

We are embarked on a new and exciting age in polar science; the National Science Foundation, I am proud to say, is solidly committed to keeping the U.S. at the forefront of this new era.

A bit over a century ago, nations viewed the poles primarily as areas for heroic exploration with designs for geographical conquest. While some nations certainly put a higher priority on science in that context than others, the vast white unknowns were thought of as "places to claim".

Even as recently as a generation ago, attention was not widely focused on the polar regions as scientifically significant; the research may have been interesting to those in the know, but "marginal" compared to advances in other fields and seemingly isolated from other parts of the globe.

I have lived through and continue to experience a sea change in those attitudes – both in my previous professional life as a working polar scientist, and more recently as the director of NSF's Office of Polar Pro-

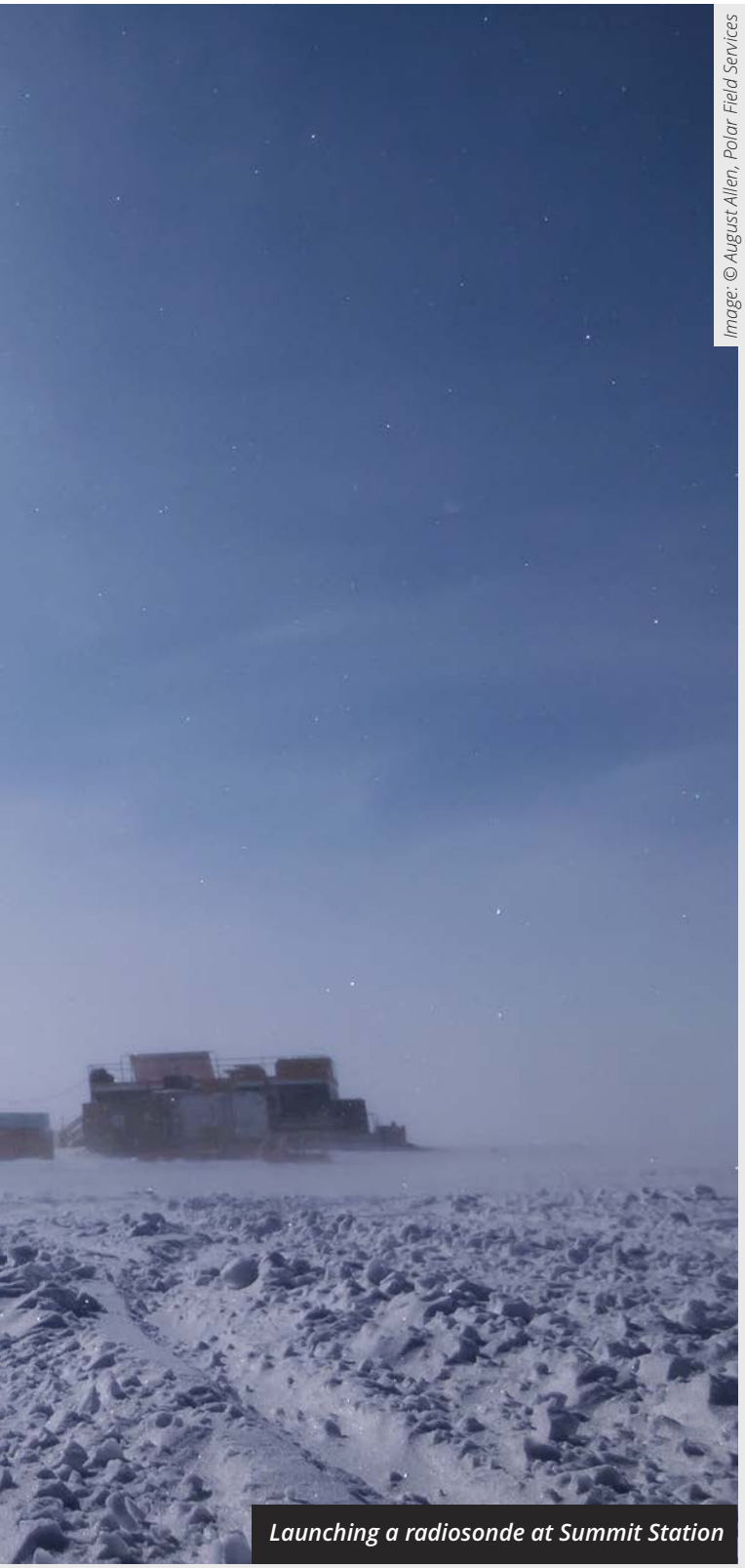

Image: © August Allen, Polar Field Services

Launching a radiosonde at Summit Station

grams (OPP). It is clear today that changes in the polar regions affect the rest of the globe, and the need to understand and try to predict and even remediate those changes has become a national and international priority. Moreover, polar regions provide unrivalled platforms from which to conduct many types of truly ground-breaking research.

At the same time, the face of polar science both literally and figuratively is changing. Women now contribute significantly to research that previously was male-dominated – and even literally off-limits to them – less than 50 years ago.

Technology, meanwhile, continues to open observational and experimental horizons.

Let me give a bit of the context to support these assertions and then touch briefly on some developments underway at NSF that will help polar science evolve to make the U.S. an even more inclusive leader in global innovation.

NSF's involvement in polar science began just a few years after the agency's creation, to help plan and support the U.S. science program for the 1957-58 International Geophysical Year (IGY).

Today, NSF, through OPP, manages the U.S. Antarctic Program on behalf of the Nation. OPP's Arctic Sciences Section supports research throughout the Arctic from Greenland to Alaska, on land, ice, sea and above. At both ends of the globe, we maintain vital partnerships with the private sector and federal partners including research agencies and the Department of Defense to accomplish field-based research. This also entails extensive international engagement.

By nearly every measure, U.S. polar scientists are among the most productive in the world. For example, the U.S. has always and still solidly leads in number and quality of peer-reviewed scientific publications.

To be in this position, we owe a debt to the pioneers of the U.S. polar science presence. Keep in mind the context that the ability to withstand the rigours of polar winters while carrying out research is a relatively recent phenomenon. The first overwintering team at the South Pole consisting of 18 men under the joint leadership of civilian Paul Siple and Lt John Tuck was deployed only in the late 1950s.

Given how logistically challenging it remains to work at the poles even to this day, it would be easiest to continue to do the things we already know how to do. To remain at the forefront, however, we must continue to strive beyond our comfort zones. We must continue to evolve new technologies and capabilities that allow us to tackle

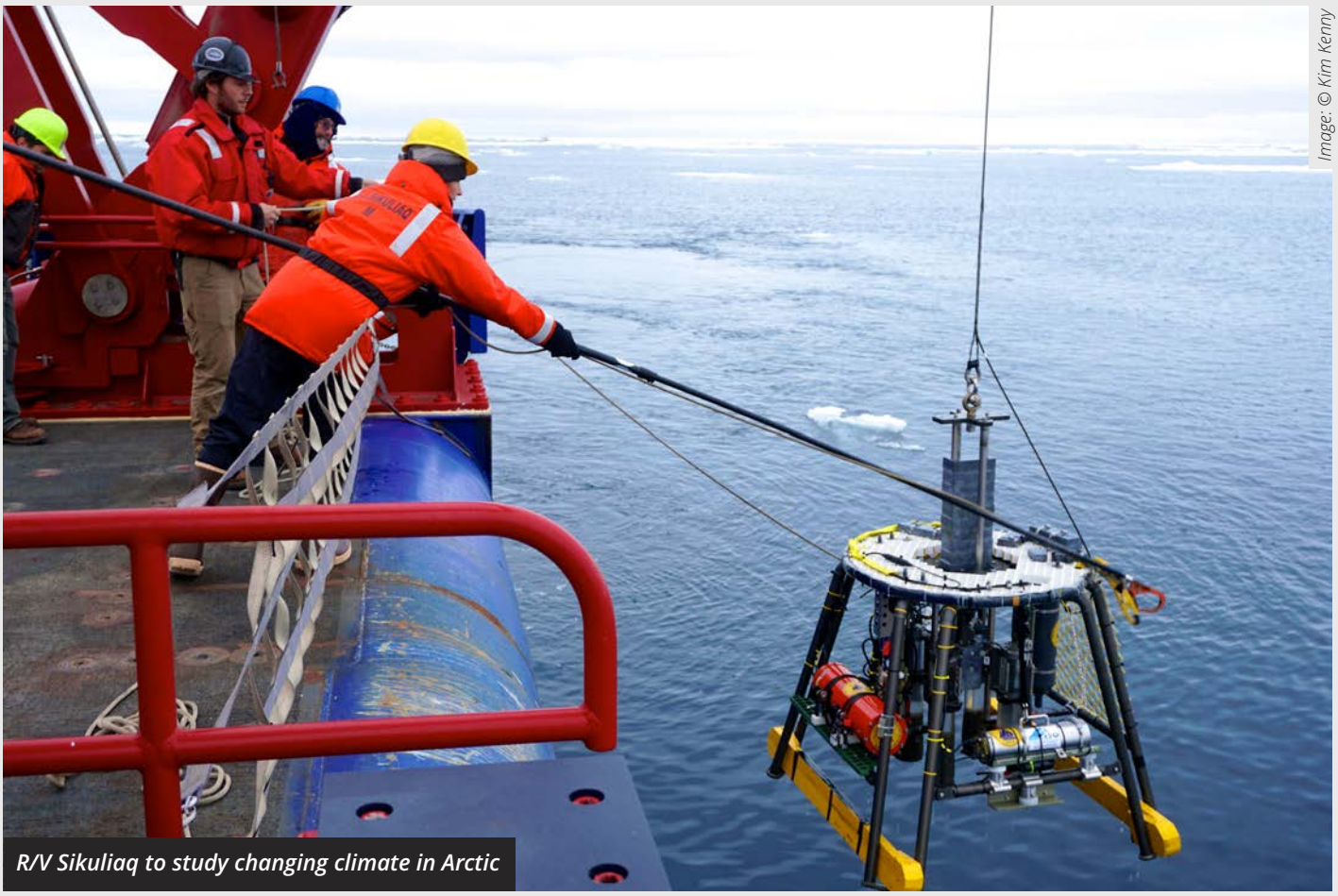

Image: © Kim Kenny

R/V Sikuliaq to study changing climate in Arctic

questions at a much larger scope and scale than ever before. And very importantly, we must continue to engage and support our Nation's most creative and motivated scientists.

Today, polar science remains a vital – and growing – part of the NSF research portfolio. Some current examples of exciting NSF-supported science include:

- Two papers published in Science Magazine in July 2018 described the detection of extremely high energy neutrinos by the IceCube detector at South Pole Station that led to the identification of blazar as the source. We finally achieved at least a first answer to the 106-year old mystery of the origin of cosmic rays!

- State-of-the-art autonomous robots deployed by the Southern Ocean Carbon and Climate Observations and Modeling program, have generated first-ever, year-round coverage of physical and chemical properties of the Southern Ocean, revealing that the system is far more dynamic than previously assumed. Stay tuned to learn what that means for our global climate system.

- A partnership of 17 nations, the MOSAiC Observatory, a ship frozen into the ice, will drift with the Arctic sea-ice pack for a full annual cycle, starting in September 2019, to observe atmospheric and oceanic processes that affect the sea-ice as it evolves from new first-year ice to multi-year ice and, eventually, decays.

- A $25-million joint U.S. and U.K. expedition to the Thwaites Glacier will prod and poke the system from myriad approaches over the next five years in order to understand why it is speeding up and what we can expect in the future. Since the portion of the West Antarctic Ice Sheet held back by the glacier rests below sea level, it is thought to be particularly vulnerable to accelerated melt with the potential to raise sea level by 3-m or more.

- NSF is taking an All-Hands-On-Deck approach to accelerating the pace of Arctic science to address the widescale and rapid changes occurring there, through an initiative we call "Navigating the New Arctic". Or NNA. This is currently among NSF's top ten priority strategic investment areas several of which are expected to complement NNA. We are looking forward

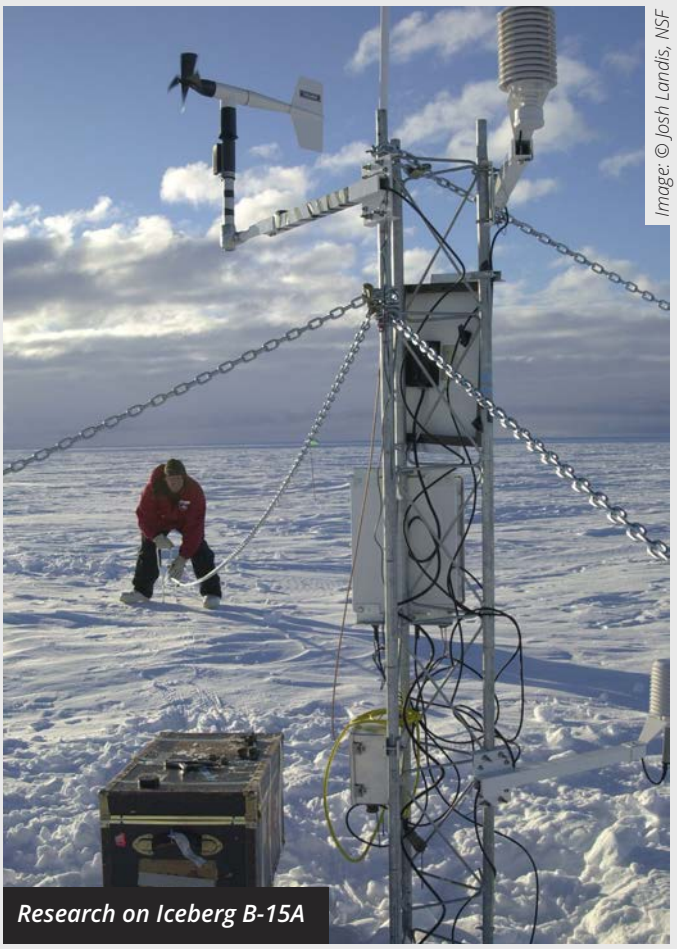

Image: © Josh Landis, NSF

Research on Iceberg B-15A

to the results of a solicitation for proposals backed by $30 million in new funds that closed on 4th March 2019, and targets science at the intersection of the social, natural and built environments.

Meanwhile, the quality and pace of polar science in the Arctic and the Antarctic continue to rely as heavily on critical infrastructure as it did in the IGY. We must be ever forward-looking. As one case in point, NSF has launched new state-of-the-art polar capable research vessel, Sikuliaq, run by the University of Alaska, primarily to explore the Arctic.

At the other end of the globe, at Antarctica's McMurdo Station, NSF's Antarctic logistics hub, expanded as needs arose since it was established during the IGY into a hodge-podge of 104 structures spread out over a 1.5 square-mile campus.

A 2012 Blue Ribbon Panel rightfully pointed out resulting inefficiencies in McMurdo's operations. In February, the National Science Board, NSF's governing body, gave the agency the nod to begin the Antarctic Infrastructure Modernization for Science (AIMS) project, which over 10 years will consolidate the station footprint to enhance safety and flexibly streamline science support for the next 35-50 years.

Last but not least, this coming Antarctic season marks the 50th anniversary of the first women to set foot at the South Pole. Not until 1978-79 did a female overwinter there.

I am happy to report that women now participate in polar science, science support and leadership throughout the world. But the polar research community remains a long way from being as diverse as the society that supports us. Research clearly tells us that diverse groups make more robust decisions. And one never knows from whom the next brightest scientific advance may emerge. Which brings me to my take-home message:

For the U.S. polar science community to meet the needs of the coming century and beyond, we must:

- Nurture a more diverse research and research-support community;
- Keep peering over the horizon for infrastructure & logistics needs;
- Drive innovation in technology, including technologies and approaches to manage and profit from extracting the "big picture from big data;
- Build productive partnerships wherever we do better and more together. ■

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Observations to action: Informing understanding and responses to rapid Arctic change

When it comes to observations to action, The International Arctic Research Center informs understanding and responses to rapid Arctic change, as we discover here

By way of an introduction, the Arctic is the most rapidly changing environment on Earth and is already experiencing transformations in its marine and terrestrial environments and social-environmental systems. Effective responses to such changes require a thorough understanding of drivers and impacts, based on sustained observations that guide model development and improve predictive capacity.

The International Arctic Research Center (IARC) at the University of Alaska Fairbanks was founded to address the key challenges of Arctic observing science, particularly at scales that require international collaboration. One key to IARC's success is rigorous engagement with stakeholders making decisions in and about a rapidly changing Arctic, requiring expertise and resources in science communication and the co-production of knowledge.

IARC research

Marine science

The Nansen and Amundsen Basins Observational System (NABOS) was conceived at IARC in 2002 to track remarkable changes in the Eurasian Basin of the Arctic Ocean. Since then, ten comprehensive multidisciplinary cruises have delivered critical information for documenting and understanding oceanic, atmospheric, and sea-ice change. Moorings anchored to the ocean floor beneath sea ice for several years have provided long-term continuous records, augmented by summer oceanographic surveys to provide spatial context.

Graduate students, high-school teachers, and summer schools are key elements of broad outreach during NABOS cruises. From its beginning to the most recent cruise in 2018, this programme has been a multinational endeavour, with scientists from many different countries working hand-in-hand to measure, analyse, and deliver complex data and information.

NABOS has provided critical information about unprecedented Arctic Ocean changes, likely representing a fundamental shift to a new, less stable, more dynamic marine environment. By the mid-2010s, the halocline in the eastern Arctic Ocean (an oceanographic feature separating surface from deeper waters) had lost its ability to serve as a lid preventing Atlantic Water heat at depth from reaching up to the sea ice bottom. Progressively deeper winter mixing has brought up more heat – diminishing the ice cover. Continued observations and analysis will establish whether this might be the onset of major winter sea-ice loss altering northern hemisphere weather patterns.

Terrestrial research

A massive green band spanning the high northern latitudes, the boreal forest stores immense amounts of soil carbon. Decomposition is slowly releasing this carbon to the atmosphere and exacerbating climate change, wildfires can accelerate this process.

Interior Alaska wildfires are burning bigger and hotter than in the past, and more frequent 'mega-fire' seasons challenge the region's fire managers. With over 80% of Alaska's population residing in or near the forest and wildlands, fire managers need science and technology to operate safely and efficiently. IARC meets these needs by developing locally relevant, accurate models and forecasts of Alaska's changing fire regimes and impacts.

In a large, observation-limited state, this means using a sophisticated modelling approach known as dynamical downscaling. A coarse-resolution global climate model is linked to a regional model incorporating local climate information, providing "downscaled" model output with much finer resolution.

Managers welcome this new tool as part of their ongoing science-based effort to protect life and property in Alaska's unique landscape. IARC is

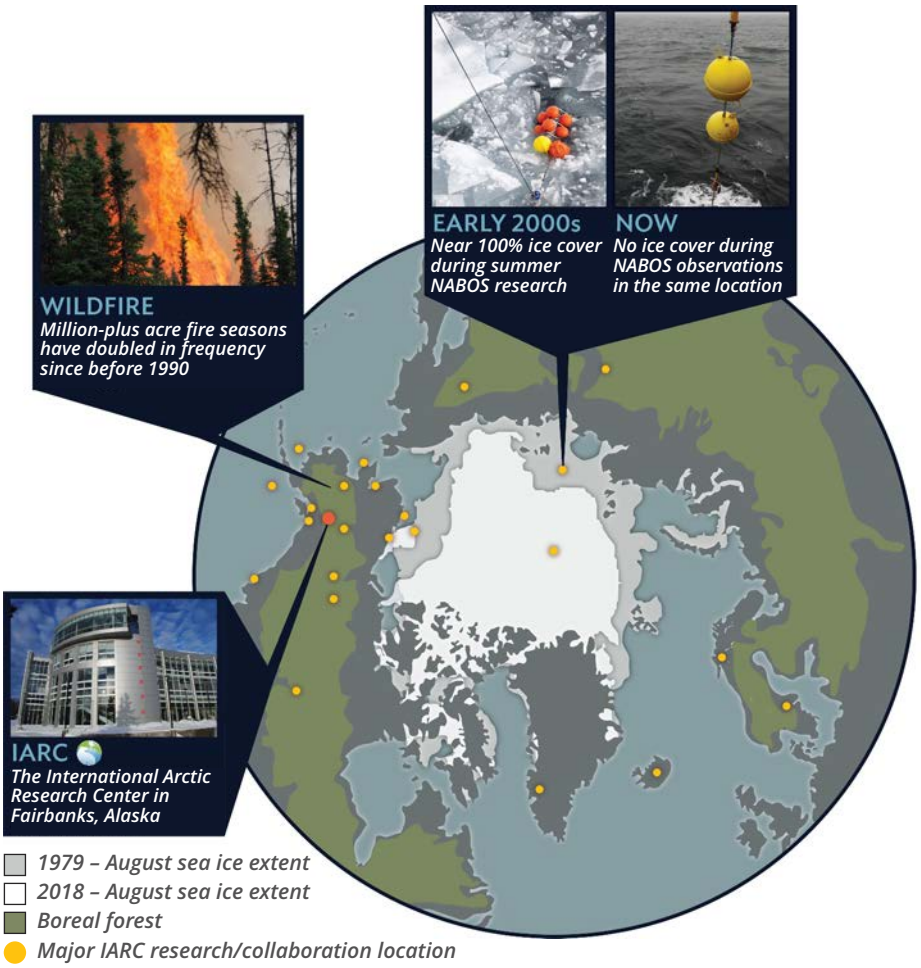

Fig. 1: The International Arctic Research Center has research and collaborations around the circumpolar north to help the world understand transformative changes in the Arctic

also exploring new ways to use fire weather predictions to assess the level of risk for upcoming fire seasons, supporting fire-response logistics and budget planning.

The role of government in responding to rapid Arctic change

The current capacity for local, state, and national governments to respond to a warmer, less predictable Arctic is weak. Observations and models may chart marine and terrestrial trajectories over the next half-century, but governments in the U.S. operate on far shorter time horizons. Furthermore, federalism splits responsibilities for environmental management, resulting in only incremental change for most government policies and services.

IARC supports the use of more observations by the government, across more scales, in the development of programmes and the enforcement of rules. IARC has the ability to translate and communicate complex changes across Arctic environments, so government officials and agency employees charged with fulfilling the mandates of government can connect today's data with future desirable outcomes.

There must be an incentive for understanding: why should any politician care about something that falls outside of their constituents' interests? Because humans are social-environmentally interdependent, even if our governments of states and localities split us up, Arctic warming affects North America and the world as a whole.

These challenges call for models and maps that are time appropriate for government cycles; transmittal of data demonstrating effects of Arctic change on lower latitudes; and linking local and Indigenous knowledge to promote a broader and deeper understanding of change.

Future outlook for the Arctic

Across all facets and functions at IARC and the global North, there is increasing recognition that solutions to Arctic problems require multi-sector, multi-stakeholder/actor approaches. IARC helps chart pathways, by building collaborative networks across the Arctic and non-Arctic nations, and by supporting efforts, such as the Arctic Observing Summit. Disruption from climate change in the North challenges our current institutional systems and governments. Observations of Arctic change both calls for and support key decisions in this decade to forestall future problems.

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Water: The essential global resource

Dr Mbayo Guy Kakumbi, Technical Officer and Dr Bagayoko Magaran,
Senior Scientist from The World Health Organization (WHO) Regional Office for Africa
reveal their stance on the essential global resource of water

Human society depends on biodiversity – the variety and complexity of life on earth – to provide food and medicine. Human existence and activity on earth are tributaries to the availability of water to ensure vital productivity functions, such as agriculture, industry, energy, transport and environmental biodiversity. Water is indeed essential for life. The uneven distribution of fresh water is becoming one of the most important global resource issues. The availability and quality of water resources are key to alleviating poverty and the growth of societies. Social progress rests on economic development. This, in turn, depends on energy, for which the world's demand continues to grow year by year. It is principally about wealth creation and managing this efficiently will provide critical value for future generations.

Bacteria, viruses, parasites and fungi (including mushrooms) are microorganisms that can induce diseases and are known as pathogens. These lower forms of life can be causative agents for certain diseases, that is, bacteria (classical waterborne diseases, for example, cholera, typhoid), viruses (smallpox, yellow fever, the common cold), animal parasites: protozoa (amoebae, plasmodia), helminths (hook/tapeworms, blood/liver flukes) and fungi (athlete's foot). Protozoa are a large collection of organisms with considerable morphological and physiological diversity; they are found in almost every aquatic environment and are widely distributed. They play an important role in all aspects of sanitary microbiology ranging from their health impacts as human pathogens and through to their role in the treatment of potable waters and wastewaters.

Infection is the invasion of the host by some other form of life followed by the growth and multiplication of the invading organism within the body of the host.

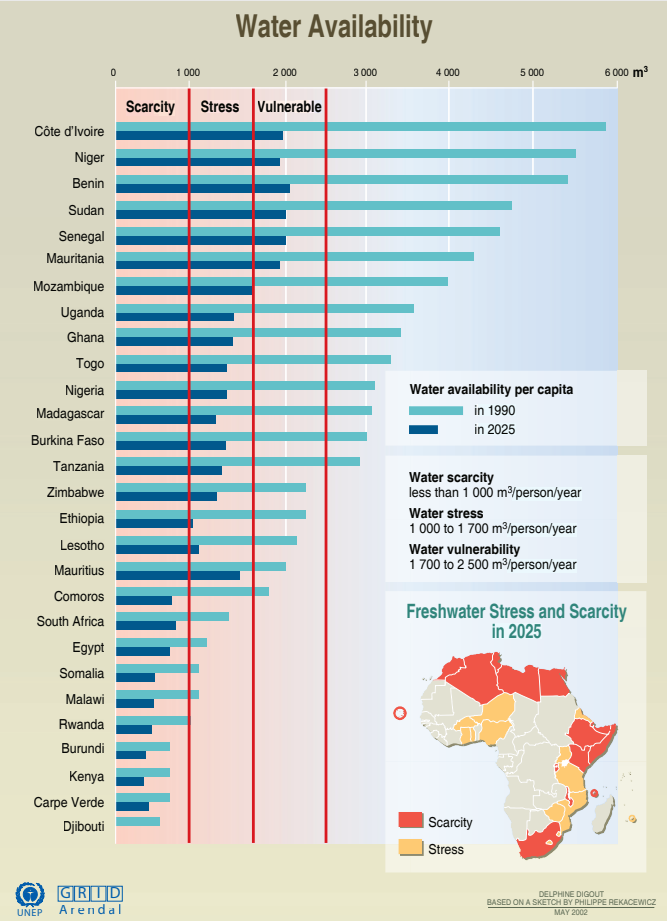
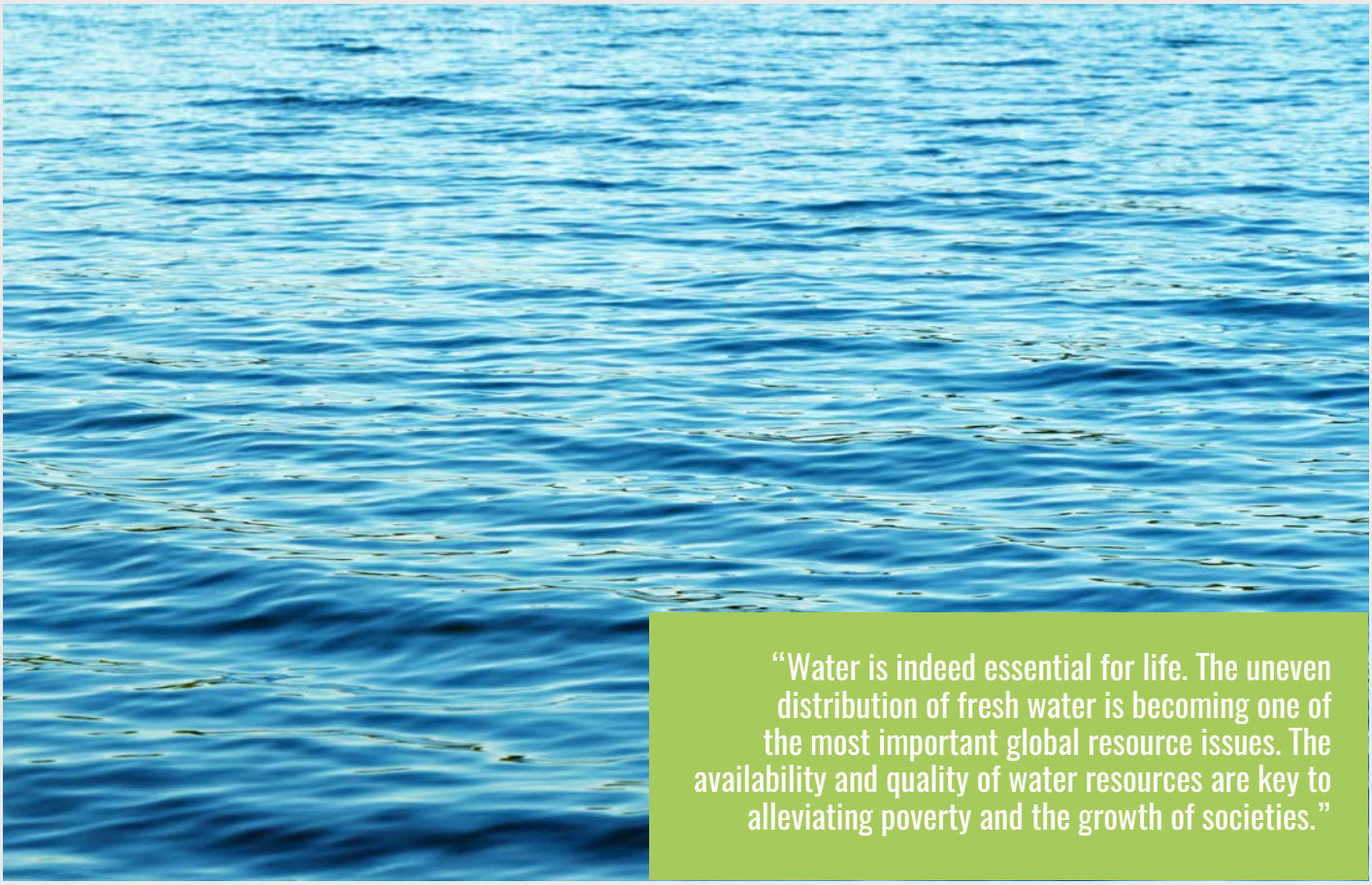


Figure 1: No water, no future. Report of HRH Prince of Orange, 2002.

Source: United Nations Economic Commission for Africa (UNECA), Addis Abeba; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

Soil, animals and humans can be reservoirs that carry infections. The avenues for escape could be respiratory tracts, urinary tract, digestive tract, open wound or mechanical escape by bloody sucking insects. Transfer of infection could occur by direct transmission (man-to-man) or by indirect transmission through animate (vectors) or inanimate (fluids, air or soil) vehicles. Portals



"Water is indeed essential for life. The uneven distribution of fresh water is becoming one of the most important global resource issues. The availability and quality of water resources are key to alleviating poverty and the growth of societies."

of entry to the new host are usually respiratory tracts, percutaneous entry (via a bite, for rabies or malaria); direct penetration of the skin by causative agents (e.g. hookworms, schistosome cercariae), gastrointestinal tract (ingestion of contaminated food or drink) and direct infection of membranes. Disease will effectively follow in the host only according to the level of vulnerability – resistance and immunity of the host.

Whilst "better water and sanitation were associated with an improved rate of linear growth and a decreased risk of diarrhoea" (The Lancet, 2004), in Africa, diseases caused by pathogenic microorganisms associated with water are the most important as they cause more deaths and illnesses. Proliferation of these microorganisms in the environment due to poor handling of the environment (inadequate sanitation leading to contamination of fresh water, desertification and soil erosion leading to diminution of lens of fresh water or chemical spill leading to pollution of fresh water stocks) is very likely to induce lack of sufficient safe water especially considering the current of population growth. Water scarcity is assessed by the national availability in a country of an average of less than 1000 m^3 per capita per year to meet all life water needs (see figure 1). Sub-Saharan Africa counted the greatest number of water-stressed countries in 2006 with up to 300 million individuals being affected. To sustain life, people will have no choice than to resort to unsafe water sources. More often, people tend to store water in their dwelling, increasing the risk of poor water handling that occasion bacterial contamination and better breading of vectors, such as mosquitoes responsible for malaria or dengue fever.

The report on "Water scarcity in Africa: issue and challenges" anticipated that the situation will worsen with between 75 to 250 million people expected to reside in high water-stressed areas by 2030 with the potential to create displacement and the cohort of problems that come along. Despite being at the same time, the most lethal, treatable and preventable, most water-borne illnesses are also the major common disease to affect Africans especially their infants, children and women. Water scarcity has a huge negative impact on health, on hygiene, on economic productivity as they also hijack resources that could be used for other purposes for the sake of treating these water-borne diseases; this undermines countries harmonious development but perpetuates poverty.

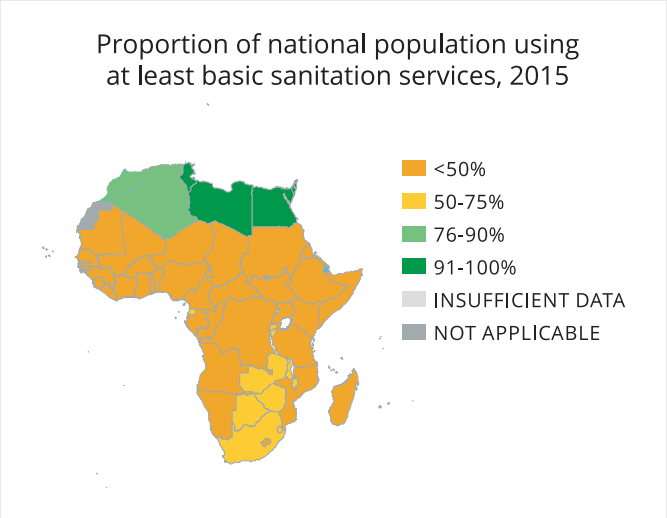


Figure 2: Africa's level of access to basic sanitation services as of end 2015 (Source: WHO-UNICEF JMP2017)

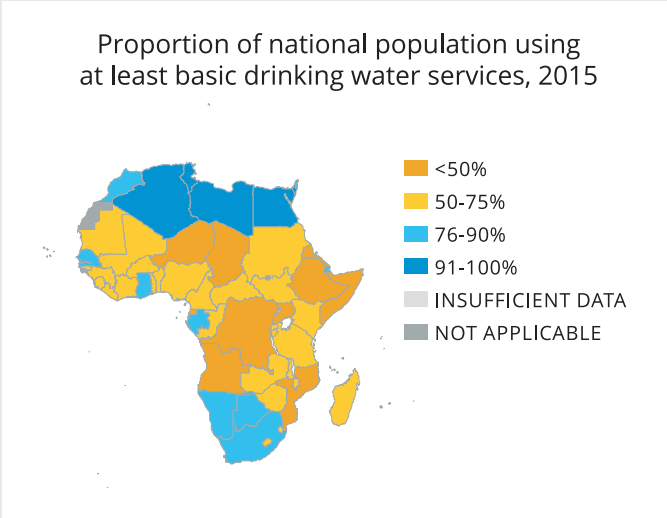


Figure 3: Africa's level of access to basic drinking water services as of end 2015 (Source: WHO-UNICEF JMP2017)

The gender division of labour usually practiced in the Africa region put women and girls at disadvantage compared to men. The latter group is not usually responsible for the collection, management, and the safeguard of water, especially at the household level. By carrying these heavy loads made of jerrycan full of water as women and girls do over long distances on daily basis, adverse health consequences fall upon them, such as permanent skeletal damage which leads to more stress, more time needed for recovery from illnesses, and less time and ability to attend school.

According to UN Environment, out of 2.5% of fresh water that exists in the world, groundwater makes up for at least 30.8% whilst lakes and rivers, 0.3% and the remaining 68.9 % are locked into glaciers.

Hygiene education seeks to alter inappropriate beliefs and practices by communicating the right messages in an appropriate way. Hand washing with soap reduces water-washed diseases and acute respiratory infections (ARIs) [Cairncross, 2003]. Hygiene is a vital issue which was missing from the MDGs framework and which is tackled under SDGs in the post-2015.

Diarrhoea is still the most important public health challenge at the moment. It is the major reason of death up to the age of 15 years, whilst the five first years of life are the most at risk. Repeated diarrhoea (and heavy parasitic infection) in infancy leads to stunting (= low weight-for-age) and, very importantly, to poor cognition in later childhood [Berkman et al, The Lancet, 2002].

23% of all deaths in Africa are linked to the environment. That's 2.2 million people. On a per capita basis (deaths per 100,000 people), Africa is the region with the highest burden of deaths in the world. Environmental impacts on health are uneven across age. 26% of children under five and 25% of adults between the ages of 50 and 75 died prematurely from environment-related causes.

According to the WHO-UNICEF joint monitoring programme report 2017, 669 million people did use an improved drinking water source 26% of people in sub-Saharan Africa use safely managed water services representing some 257 million as of end 2015. At the same time, 695 million people in the Sub-Saharan Africa region did not have access to improved sanitation facilities – 217 million of whom practiced open defecation.

In 2015, 404 million people (40%) in the African region (AFRO) lacked a basic drinking water service. 83.3% of the urban population and 43.7% of the rural population used a basic drinking water service. At the same period, some 687 million people (70%) in the African

region lacked a basic sanitation service with 216 million people practicing open defecation. 44% of the urban population and 21.4% of the rural population used a basic sanitation service.

When the millennium development goals (MDGs) era started, target 7.C was set for countries to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. In 1990, 48% of people living in sub-Saharan Africa had access to improved drinking water sources and the global MDG target for drinking water was met five years ahead of schedule. In the other end, in 1990, the proportion of people using an improved sanitation facility in sub-Saharan Africa was only 24%.

Climate change is expected during this century to lead to a temperature rise between 1.8 to 4.0°C; in the worst case scenario, it can raise up to 6.4°C depending on how quickly and drastically the world manages to reduce carbon emissions by deeply modifying its production and consumption patterns. The increase of global mean temperatures will lead to a change in global climatic patterns and consequently, in regional and local water balances. The clearest predicted impacts are an increase in the variability, intensity and frequency of floods, droughts and extreme weather events. However, the impacts of climate change on water, sanitation and hygiene go beyond floods and droughts and include:

- Adverse impacts on water quality and availability;
- Increased water stress;
- Changes in groundwater recharge patterns;
- Greater rates of erosion;
- Increase landslide-associated casualties and;
- The poor performance of sanitation systems, leaving the population with no sanitary protection.

This state of affairs will certainly exacerbate water scarcity impact considering projected population growth in general, and migration of population towards urban settings. The majority of the world's children will soon be living in urban areas – in Africa like in Asia, most of these in slums. The pace of urbanisation is so fast that intervention design often cannot keep pace with implementation especially if there are already evident infrastructure gaps as in most African cities today.

To mitigate all the above, Water Safety Plans (WSPs) were first introduced by WHO through the 2004 Guidelines for Drinking-water Quality as the most effective means of consistently ensuring the safety of a drinking-water supply. WSPs require a risk assessment, encompassing all steps in water supply from catchment to consumer, followed by incremental implementation and sustained monitoring of corrective control measures. WHO partnered with many organisations (such as the International Water Association, UNICEF and others) to organise series of training on this approach for Member States staffs across the continent. To date, several pilot projects are carried out in Senegal, Ethiopia, Liberia and Ghana in order to contextualise and crystalise this strategy. ■

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Understanding freshwater resource problems

Experts from Stroud Water Research Center and Kansas State University highlight the importance of addressing today's freshwater resource problems and how to achieve sustainable watershed management

Freshwater resource problems are ubiquitous across the globe despite decades of focused watershed management efforts targeting drinking water treatment, water use efficiency and point-source pollution reductions. Severe challenges remain with respect to more diffuse and less easily treated problems that begin with land use and water use decisions by humans living, working, developing and farming watersheds increasingly altered by anthropogenic climate change.

To address today's freshwater resource problems, we must understand the role of humans in freshwater systems, including their culturally influenced decision-making processes. Integrative analysis of natural and social systems has been an international sustainability science goal for many years. However, full integration in regard to the role of culture is often still missing from the complex water sustainability equation.

Achieving more sustainable watershed management depends in large part on the ability to better understand the social learning processes that drive adaptive environmental decision-making, as well as the causal chains linking culturally influenced environmental values to environmental behaviours. Integrative mechanistic models are needed that account explicitly for human-landscape interactions and incorporate detailed, well-developed, coupled models of hydrosystem, aquatic ecosystem, and human system responses to changing climate (Figure 1).

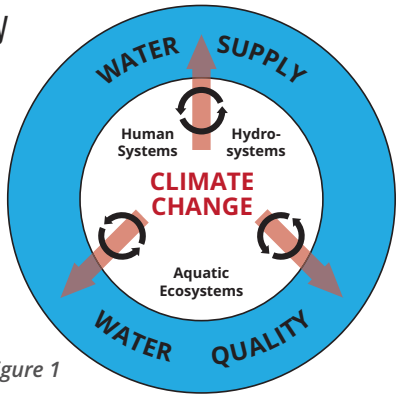

Figure 1

Our research approach interactively couples mechanistic models of three systems – the hydrosystem, the human system, and the aquatic ecosystem – controlling water supply and water quality in the Central Great Plains of North America, a region with long-standing water quality and quantity concerns. In this arid, highly erodible and agriculturally intensive region, historical natural climate fluctuations have been extreme, and the coupling between the dynamic climate and human systems is close, as witnessed during the Dust Bowl environmental disaster of the 1930s. This classic example of the intersection among climatic variables, human land use, and unexpected societal impacts illustrates the economic, demographic, and cultural consequences for a region and nation when unsustainable land use collides with unanticipated climatic change.

We demonstrate our integrative modelling framework in the study of a coupled human and natural system in a surface water-dependent agricultural watershed with a highly climate-sensitive surface water flow regime influenced by human-induced land-use and climate change. The hydrosystem serves as the foundation of our model, which focuses on integrating climate, ecosystem and human decision scenarios as boundary conditions for a watershed response model. This enables us to predict future surface water regimes that inform an aquatic ecological model.

Since cultural influences can drive people to either adopt or reject sustainability policies, our human-systems model empirically includes culture. Humans use culture to learn and inform their decision-making processes, but human culture is often seen as too difficult to incorporate into environmental system models.

At its most fundamental, culture is comprised of shared values, beliefs, and norms through which humans visualise, interpret, or assign meaning to actions, concepts, and their environments. Despite this complexity, developing mechanisms to empirically model the cultural influences that drive region- or community-specific responses to management efforts is critically important.

We model policy decision-making processes grounded in culture within

a framework of coupled human and natural systems, quantifying cultural influence using the Values-Beliefs-Norms (VBN) framework informed by an extensive survey of the local population. Within an agent-based model, agents vote to adopt or reject environmental policies.

Heterogeneity among agents is derived from demographics, VBN factors, and the environment. Each human agent is populated by attributes extracted from an extensive survey of the local population. Attributes include demographic characteristics (gender, education, income, age, and occupation), values characteristics (altruistic toward humans, altruistic toward biodiversity, traditional, self, and openness to change), environmental worldviews, political ideology, and environmental knowledge.

The agents' decision-making processes are informed by cultural, hydrological, and aquatic biodiversity models. The fully integrated model (Figure 2) is then used to evaluate whole-system response to climate variation scenarios derived from historical data and downscaled climate projections. This integrative model represents a functional coupling of natural and human systems, allowing for biophysical feedbacks to directly affect agents' decision-making processes and enabling us to evaluate the sustainability outcomes delivered by different policy scenarios.

Our findings demonstrate that policy support is grounded in cultural values, and cultural differences explain preferences for conservation policies designed to conserve and protect water resources and aquatic ecosystems. The array of values invoked to make decisions about policies, and the social-psychological pathways

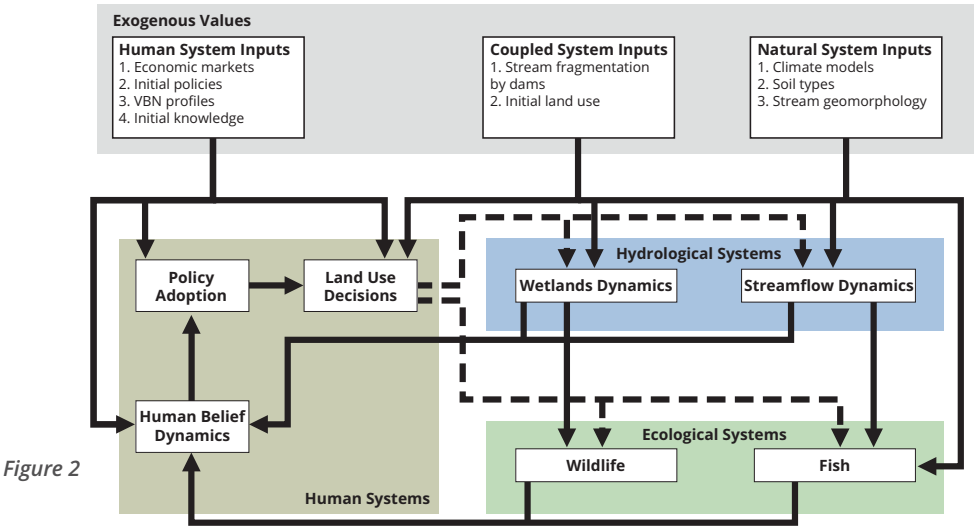

Figure 2

linking values to policy support can vary across policies and types of agents (e.g. farmers and non-farmers).

In contrast, some human system factors, such as financial obligation, are the strongest and most consistent explanation of support for conservation policies among members of both groups. These dynamic linkages between cultural and environmental factors reveal new pathways for actions that support sustainability.

Our results indicate resistance to environmental policy, suggesting that the local cultural framework may result in rejection of sustainability policies and prevention of needed support even under potentially extreme climate conditions.

However, our model also showed that the best opportunities for policy acceptance immediately follow extreme events. This underlines the need for influencing culture and pro-environmental behaviour via interventions and monitoring to benefit from the increased acceptance of environmental policies during and immediately following severe environmental conditions. This work provides the foundation necessary for future research to explore rich questions about coupled system dynamics and sustainability policy.

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The battle to save Africa's most threatened wildlife species

The battle to save Africa's most threatened wildlife species even as the continent develops, is the view put forward here by CEO of African Wildlife Foundation, Kaddu Sebunya

Africa is endowed with many wildlife species that occur in its various biomes and habitats. This rich diversity is Africa's heritage; the very substrate that will drive the continent's sustainable development. How Africa chooses to treat its natural environment (therefore, its people), will determine its development at all levels – local, national and continental.

Africa is already developing rapidly, boasting of megabucks infrastructure projects and some of the fastest growing economies in the world. The continent does not need to make a choice between conservation and development; the decision it needs to make is how to conserve natural resources and develop sustainably without taking away from the rights of future generations to enjoy wildlife in its natural habitat.

As CEO of the African Wildlife Foundation (AWF), I believe that the wildlife and wild lands of Africa will thrive in modern Africa. My optimism is backed by reality on the ground.

First, we have to acknowledge the problem; over the last 60 years all but a few of Africa's wildlife species have been steadily declining, and some have become extinct. But Africa is not alone in losing species. On a global scale, humanity is reported to have wiped out 60% of animal populations since the 1970s with huge costs even as the world feeds its burgeoning human population.

In the 1960s, most African countries earned their political independence and with it the custodianship over natural

resources including wildlife. The results have been a mixed bag. Africa currently has an estimated 5,000 black rhino of the 65,000 in the 1960s, 415,000 of 1.2 million elephants and 20,000 of 200,000 lions. Even Africa's tallest animal, the giraffe, has not been spared.

We have a good understanding of why our wildlife is declining – from habitat loss to illegal killings – we know enough to act. According to the latest statistics, the proportion of illegally killed elephants (PIKE) has remained at about 50% since 2002, rising to its highest in 2011 (75%) then declining to this day due to concerted conservation action. Rhinos, on the other hand, disproportionately die as a result of poaching.

Our aim must be to recover the declining species populations and to maintain those that are thriving in their natural environments, therefore, ensuring that these animals continue to rightfully contribute to Africa's sustainable development and the wellbeing of her people.

Conservation interventions must first of all be data-driven and evidence-based. Adaptive management, for instance, which designs projects in such a way that mistakes are corrected as they occur, is a feedback-driven model that ensures conservation efforts are dynamic and change according to the needs of the landscapes on which they are deployed.

Secondly, work in African wildlife conservation over the last five decades shows that local community involvement is crucial for success and that at this level too, we must not equate development to the destruction of nature. Involving communities means good governance of natural resources and augurs well with any science-led innovative approach.

If you reduce the cost of living with animals, you turn local communities into conservation participants. Those of us who work in this field need to remember that Africans take pride in their wildlife and have been living with it since the dawn of time. Community knowledge about animal behaviour and habitat protection, therefore, is invaluable towards designing interventions.

Not only should conservation aim to reduce human-wildlife conflicts, but it should also provide a means of livelihood through several revenue streams. Aside from tourism, other sources of income include commercialisation of non-timber forest products, bee-keeping, sustainable fishing and fodder production.

Using a combination of these approaches, AWF has managed to turn around the declining wildlife population in several landscapes across the continent. For instance, AWF funding has supported 14 elephant populations across nine African countries with an estimated cumulative population size of almost 190,000 individual elephants. Ten of these populations are stable or increasing. AWF has also supported 10 rhino populations across six African countries with an estimated cumulative population size of over 4,600 individual rhinos. All are stable or increasing.

Less appreciated by conservationists and others alike are the crucial roles played by wildlife species, wildlands and natural ecosystems in the wider development agenda. Without healthy natural ecosystems, Africa will be unable to provide food, water security and nutrition for its people. How will that be possible without the insects, and bats that pollinate our crops and trees? Africa's wildlife and wild lands hold great potential as undiscovered biodiversity banks; as an insurance policy and risk mitigation for future needs.

It is key to integrate the science and the practice at all stages of conservation and development – in our planning, prioritisation, implementation, reporting and communication. This effort cannot be left to conservationists only. African leaders must rise to the challenge and include Africa's wildlife and wildlands in their development agenda; young people must step up and take space as active participants in conservation at the highest levels - they are not the leaders of tomorrow, but the leaders of today; development partners must ensure that their involvement and investments or aid addresses the connections between development and conservation. This must be the African voice. ■

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Wildlife migrations are collapsing in East Africa

In Kenya, wildlife numbers declined by 68% in the 40-year period from 1977 to 2016 both outside and inside protected areas, writes Dr Joseph Ogutu, Senior Statistician at the University of Hohenheim

Wildlife numbers are declining sharply across Africa, including migratory populations. In Kenya, wildlife numbers declined by 68% in the 40-year period from 1977 to 2016 both outside and inside protected areas.

Most wildlife still occurs on private and communal lands outside protected areas, which cover only 10% of Kenya's land surface. As with other parts of Africa, protected areas are too small to meet all the needs of their wildlife populations all year in East Africa. Many wildlife species, therefore, spend part or all of the year outside protected areas.

To understand the status of and threats to wildlife migrations in East Africa, we recently reviewed the extent of historical wildebeest migrations and analysed trends in numbers of five migratory wildebeest populations. This understanding can also shed light on the other wildlife species that migrate with wildebeest in East Africa, namely zebra and Thomson's gazelle. We quantified changes in numbers of the five remaining populations of migratory wildebeest in East Africa using aerial survey monitoring data collected from 1957 to 2016 in Kenya and Tanzania.

The five populations occur in the following five ecosystems within which wildebeest still migrate in East Africa. (1) Greater Serengeti-Mara and (2) Greater Amboseli, both of which straddle the international boundary between Kenya and Tanzania. (3) Athi-Kaputiei near Nairobi in central Kenya. (4) Mara-Loita in south-western Kenya. (5) Tarangire-Manyara in Northern Tanzania.

The ecosystems cover areas that range in size from 40,000 km^2 for Serengeti-Mara, 7,730 km^2 for Amboseli, 7,500 km^2 for Mara-Loita, 2,200 km^2 for Athi-Kaputiei to 35,000 km^2 for Tarangire-Manyara plus its adjoining lands accessible to wildlife.

Extreme declines in migratory wildebeest populations in East Africa

Except for the Serengeti-Mara population, migratory wildebeest numbers declined extremely in Kenya and Tanzania during the 60-year period from 1957 to 2016.

The Serengeti-Mara population initially increased from 190,000 animals in 1957 to 1.3 million animals in 1977 and fluctuated about this number until 2016.

The Mara-Loita population crashed by 81% from over 123,000 animals in 1977 to under 20,000 animals in 2016.

Similarly, the number of wildebeest migrating from the Serengeti to the Masai Mara reduced by 73% from 588,000 animals in 1979 to 157,000 in 2016.

The Athi-Kaputiei population fell by 95% from 27,000 animals in 1977 to less than 3,000 in 2014.

The Amboseli population declined by 85% from 16,300 animals in 1977 to under 2,400 in 2014.

The Tarangire-Manyara population initially increased from 24,400 animals in 1987 to 48,800 in 1990 and then decreased by 72% to 13,600 animals in 2016.

As a result, four of the five contemporary migrations in East Africa are severely threatened and have virtually collapsed. Far fewer wildebeest take part in the four migrations today than used to a few decades ago. The Athi-Kaputiei, Amboseli and Mara-Loita migrations are the most severely threatened.

Leading threats to wildlife migrations in East Africa

Human population increase and activities are the leading causes of the decrease in numbers of migratory wildlife and collapse of wildlife migrations in East Africa.

The disturbing loss of wildebeest and the virtual collapse of their migrations are caused by several processes that vary in their importance and intensity

across the five populations. The major processes are the unplanned expansion of agriculture, fences, settlements, urban centres, roads and other infrastructures, poaching and competition with livestock for food, space and drinking water. These processes are driven, in turn, by increasing human and livestock numbers, changing land tenure and land subdivision.

Additional key drivers are the failure of settlement policies, wildlife conservation and management policies, wildlife management institutions and wildlife markets.

The virtual collapse of four of the five remaining wildebeest migrations increases the risk of local extinctions of wildebeest in the four premier East African Ecosystems.

What can be done to save wildlife migrations in East Africa?

Urgent action is required to save these migrations. Unfortunately, such warnings are too often ignored.

Saving the migrations requires regulating livestock numbers, unplanned expansion of fences, settlements, farms, roads and other land use developments that degrade areas used by migratory wildlife.

Degraded rangelands should also be restored. Fences have blocked most migratory routes for the Athi-Kaputiei wildebeest and are sadly also expanding fast in the Mara-Loita ecosystem.

The obstructions to migrations are increasing at a time when migratory species require greater mobility and flexibility to cope with frequent and intense droughts associated with climate change. These obstructions, therefore, pose grave risks to migratory wildlife and require immediate remedial action. This would allow migratory wildlife species to continue moving over large areas in search of food and water.

Major roads that cut across migratory routes should include under or overpasses for migrating wildlife.

Robust law enforcement is required to reduce illegal hunting for bushmeat.

Wildlife conservancies formed by private landowners or landholders are expanding conservation outside protected areas and protecting migratory pathways while providing land rents and jobs to local communities. More support is needed to plan, expand and manage these conservancies. The success of the common conservancy model depends on sustainable wildlife tourism making it worthwhile for landowners to allow conservancies to be set up on their lands. Because such conservancy models can only be viable where tourism potential is high, other models should be explored for areas with low tourism potential.

Wildlife benefits to local communities should be enhanced to enlist greater local community support for conservation and reduce incentives for poaching and habitat degradation.

Land purchases or permanent conservation easements should be considered to keep land open for wildlife. Temporary conservation land leases for wildlife are likely to be too expensive to be sustainable over large areas and also because the value of land appreciates over time.

Coherent policies that cut across bureaucratic lines on settlements, land use developments, tenure and subdivision, wildlife conservation, management and markets are required to make land use compatible with conservation in perpetuity. Similarly, institutions that conserve and manage wildlife should be restructured, strengthened and better funded to better protect wildlife outside protected areas.

Greater coordination and collaboration are needed between Kenya and Tanzania to conserve the trans-boundary migrations.

Because some of the changes in the five ecosystems are so dramatic and fast, urgent action is required to save the very few remaining migrating animals. Otherwise, some of the migratory populations may soon be lost for good. This has happened to migrations of zebra and Thomson's gazelle in Kenya's Rift Valley and elephants across Kenya.

Every effort should be made by all to prevent a similar fate from befalling the remaining migrations in East Africa.

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Sustainability begins in the workplace: How businesses can help reduce their carbon footprint

Wulfric Blackwell, Habitats Project Manager at Thomson environmental consultants argues that sustainability begins in the workplace and reveals how businesses can help reduce their carbon footprint

As an environmental consultancy, we take sustainability seriously and as the world wakes up to the fact that the throwaway society that we live in has long-term consequences for the planet and for all our futures, it is incumbent upon all of us to become more sustainable in the ways that we live and work. The impact of television programmes like David Attenborough's Blue Planet have helped the world to see the how climate change is changing our environment and the way that materials like plastic are causing long-term damage to rivers and oceans.

We are gradually becoming more aware of the fact that the way we travel from A to B, what we eat, what we wear and how we light and heat our homes can have direct consequences for the future of our planet. At a government level, change is slow but a global action plan to limit damage from climate change was adopted by almost 200 nations in December 2018 at the last UN climate change conference in Poland.

As governments around the world start to take action, businesses are waking up to the fact that sustainability is vital for future business success and that they can act faster to make a difference now by starting to adopt sustainable practices within the workplace. Many larger businesses now have in house sustainability teams to help guide policy in this area but there are also many ways that employers and employees of SMEs can help to make the workplace more sustainable too.

Here are a few ideas which are not costly, but which recognise that we can all make a difference if we make an effort.

Brief your staff

Make sure that all new employees are advised on the steps that they can take to help reduce their carbon footprint and how vitally important this is in a time where climate change and global warming are at the forefront of political and social agendas.

> "We've donated old survey equipment to local conservation groups instead of just retiring them, and we've also gone into local schools to do talks on species, habitats and the marine work we do."

Flexible working

By encouraging flexible working and working from home, you can help to cut car travel and unnecessary travel. Encourage employees to use public transport, to car share or to cycle when they do travel to work. Maybe set up schemes that encourage them to do this.

Think before you print

Dual screen computers cut down the need for documents to be printed. Make sure that your employees understand about the environmental impact of printing in colour as compared to printing in grey-scale and limit colour printing as much as possible. An idea we're currently trialling is the use of tough pads by our site teams and field surveyors. This is helping reduce the amount of paper used for onsite health and safety files.

Make supply chains sustainable

Make sure that your internal and external supply chains demonstrate sustainability. Do your suppliers have environmental credentials? Many businesses now work hard to ensure that their supply chains demonstrate

green credentials. This means that it is more important than ever to have a strong environmental policy as part of your bid for contracts. If you can demonstrate your green credentials, you could have a better chance of winning the business.

> "As governments around the world start to take action, businesses are waking up to the fact that sustainability is vital for future business success and that they can act faster to make a difference now by starting to adopt sustainable practices within the workplace."

Recycling

Set up a comprehensive recycling scheme in the workplace. Install recycle bins that include paper and card combined with plastics that have been washed and are freed of food waste. You can also add glass and plastic bags to your weekly recycling and arrange for a local waste company to pick it up. If no local company will collect it, maybe organise a rota where each employee gets involved in taking it to a collection point. You want to get to the point where recycling outweighs general waste disposal week to week.

Community efforts

Charity begins at home...and at work. Seek out local conservation groups and charities and offer to help their causes.

For example, the staff at Thomson undertake a beach clean every year to support Surfers Against Sewage. In this year's plans, we're embarking on a river clean up local at our head office in Surrey. We also support charities such as the Wildfowl and Wetlands Trust, and this year we're supporting WaterAid. Our teams regularly come together to raise money for these charities with cake bakes, pumpkin carving and other office-based activities.

We've donated old survey equipment to local conservation groups instead of just retiring them, and we've also gone into local schools to do talks on species, habitats and the marine work we do.

Why not organise a local litter pick and consider ways of reducing waste when out and about too?

Search to give

We encourage our employees to use a search engine called Ecosia. Through conducting their web searches via this platform, the site uses sponsored advertising to contribute money to planting millions of trees across the globe.

Accreditations

Thomson holds the ISO 14001 Environmental Management Service accreditation which shows we truly believe in making an informed and planned difference to the way in which business is conducted environmentally.

Sustainability is an issue that should be on everyone's mind. Quite simply, with an ever-increasing number of developments and a growing population, we must act now to help protect our environment for future generations. ■

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Climate change: Urban transformation and the relevance of critical infrastructure

Urban transformation and the relevance of critical infrastructure is placed under the spotlight here by Prof Dr Daniela Jacob at Climate Service Centre Germany (GERICS)

The IPCC special report "Global Warming of 1.5°C" has shown that a warming of 1.5°C compared to pre-industrial levels will lead to strong impacts of climate change. The regional economic damage by 2100 will be higher if global warming exceeds 1.5ºC and reaches 2ºC. In turn, all emission paths for the target of 1.5°C require rapid and far-reaching emission reductions and system transitions in many socially and economically significant areas, exhibiting synergies with the goals for sustainable development of the United Nations (SDGs).

Therefore, cities and urban areas are one of the critical global systems that can accelerate and upscale climate action. This requires a fundamental transformation of central supply infrastructures in urban areas, as well as an improved understanding and comprehensive consideration of the interactions of these critical infrastructures under changing climatic conditions and the interaction of cities and their surroundings.

Critical infrastructures are defined as organisations and facilities of great importance to the state. Their failure or impairment would result in serious supply shortages, considerable disruption of public safety, or other dramatic consequences. The following sectors are among the most prominent parts of critical infrastructures: i) transportation (aviation, inland and ocean shipping, rail and road transport, logistics), ii) energy (electricity, oil, gas), iii) water (public water supply, public waste water management) und iv) information technology and telecommunication.

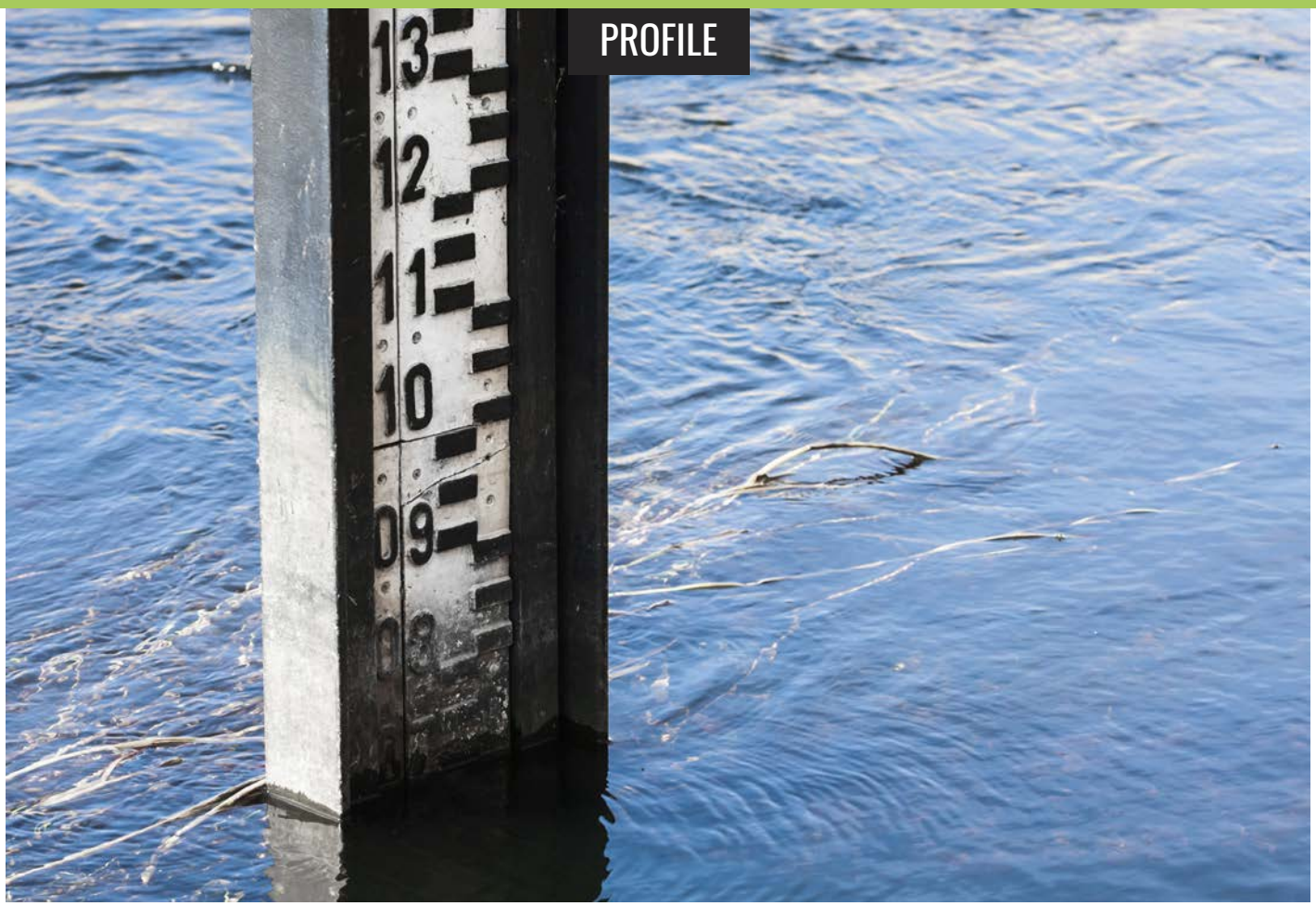
> "The important role of both climate change mitigation and adaptation is also highlighted in the Global Risk Report 2018, in which the risk categories "extreme weather events", "natural disasters" and "failure of climate change mitigation and adaptation" are among the "top 5" in terms of likelihood and impact."

Furthermore, interactions between critical infrastructure elements have become a growing phenomenon in practise. Therefore, the main types of failures describing the interdependencies of critical infrastructure are i) cascading (manifestation of nth-order-effects), ii) escalating (disruption in one infrastructure causes a larger disruption for another infrastructure) and iii) common cause (disruption in several infrastructures at the same time, e.g. due to geographical interdependencies). In particular, a cascading effect occurs when a disruption in one infrastructure causes the failure of a component in a second infrastructure, which subsequently causes a disruption in the second infrastructure.

In general, critical infrastructure is exposed to various kinds of threats. There are man-made or technical (terrorism, sabotage, software failures etc.) and natural threats. The latter differ from geological (mass movements, earthquakes etc.) to hydro-meteorological hazards (climate change impacts). The effect generates a sequence of events in human subsystems that result in physical, social and/or economic disruption. Thus, an initial impact can trigger other incidents that lead to consequences with significant magnitude.

For example, the relations and interactions between the water supply and energy sector shows how a malfunction within the energy supply chain – starting from power production over distribution and transformation stations to power lines – can affect water supply. Pumps, control elements, water treatment and digital communication do not work without electricity. Finally, this leads to a breakdown of the water works. The outage of the water supply in itself has significant impacts on other further public facilities such as health care. With respect to wastewater treatment, the lack of water supply initiates a second cascading step, because the malfunction of sewerage system elements – like sewerage treatment plants – has further impacts on other public facilities too.

In order to reduce these vulnerabilities in the context of climate change, cities need to focus more on the whole system, including the complex interactions between non-climatic



and climatic drivers, as well as all critical infrastructure elements and the relevance of the surrounding area. The transformation of supply infrastructures – which is necessary for successful climate mitigation and a sustainable societal transformation – should therefore also be used for the long-term adaptation of critical infrastructure to climate change.

The important role of both climate change mitigation and adaptation is also highlighted in the Global Risk Report 2018, in which the risk categories "extreme weather events", "natural disasters" and "failure of climate change mitigation and adaptation" are among the "top 5" in terms of likelihood and impact. Furthermore, it is highlighted that one of the major challenges is dealing with complex risks in systems characterized by feedback loops and tipping points.

Limiting global warming to 1.5°C compared to pre-industrial levels requires immediate action within and across sectors, as well as multilevel governance. Hence, successful city-level climate action urgently needs to take the next step from integrating strategies – often already in place worldwide – into robust climate action within the next two decades. Therefore, decision-makers in cities and urban areas are key and need strong political leadership.

Furthermore, increasing a cities' resilience to climate change impacts is highly context-specific due to its geographical location, structure, institutions, inhabitants, available information and operational capability. As different infrastructure networks also become more interdependent, there is a growing – and currently often still underrated – scope for systemic failures to cascade across different networks and affect society in multiple ways. Therefore, there is a strong need to better understand risks and resilience jointly by focussing on systemic risks regarding critical infrastructure and cascading effects.

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Climate change impacts and greenhouse gases in Japan: A policy perspective

The Ministry of the Environment's ambitions in Japan are detailed here, with a special focus on climate change impacts and greenhouse gases policy

The Ministry of the Environment, Government of Japan is responsible for global environmental conservation, nature conservation and pollution control and was created in 2001 from the sub-cabinet level Environmental Agency that was set up during 1971[1]. This article will look at examples of the Ministry's work around the topic of climate, including discussion of Japan's National Greenhouse Gas Emission, GOSAT (Greenhouse gases Observing SATellite), as well as climate change impacts.

Japan's greenhouse gas emissions

The Ministry, along with the National Institute for Environmental Studies released Japan's National Greenhouse Gas Emissions (preliminary figures) for the fiscal year (FY) 2017 in November 2018. These figures tell us that the total emissions in 2017 were found to be 1,294 million tonnes of carbon dioxide equivalents (Mt CO_2 eq.), a 1% decrease compared to those of FY2016; an 8.2% decrease compared to FY2013 and a 6.2% decrease compared to FY2005. The Ministry's website offers their own thoughts on these figures.

"The main factor for the lower emissions as compared to FY2016 is the decrease in energy-related CO_2 emissions due to the increase in the share of non-fossil fuels within the domestic energy supply brought by the wider adoption of renewable energy such as solar and wind power and the resumption of nuclear power plant operation.

"This is a decrease of 1.0% (12 Mt CO2 eq.) when compared to the FY2016 emissions (1,307 Mt CO2 eq.), mainly because of the decrease in energy-related CO2 emissions due to the increase in the share of non-fossil fuels within the domestic energy supply brought by the wider adoption of renewable energy such as solar and wind power and the resumption of nuclear power plant operation, despite the increase in hydrofluorocarbon emissions from refrigerants that substitute for ozone-depleting substances.

"This is also a decrease of 8.2% (115 Mt CO_2 eq.) when compared to the FY2013 emissions (1,409 Mt CO_2 eq.), mainly because of the decrease in energy-related CO_2 emissions due to the increase in the share of non-fossil fuels within the domestic energy supply brought by the wider adoption of renewable energy such as solar and wind power and the resumption of nuclear power plant operation, and the decrease in energy consumption, despite the increase in hydrofluorocarbon emissions."

We also discovered that there has been a decrease of 6.2% (86 Mt CO_2 eq.) in comparison with to the 2005 emissions (1,380 Mt CO_2 eq.), primarily due to the decrease in energy-related CO_2 emissions as a result of the decrease in energy consumption, even though there has been an increase in hydrofluorocarbon emissions.[2]

GOSAT

Staying on the subject of climate, we also learn that GOSAT (Greenhouse gases Observing SATellite) is the world's first satellite designed specifically for monitoring greenhouse gases from space. This is indeed an exciting project and we know that GOSAT reveals details on the global distribution of methane (CH_4) concentrations and carbon dioxide (CO_2), as well as on where and how much greenhouse gases are emitted or absorbed. This was something highlighted in December 2018 by the Ministry of the Environment Government of Japan, as they detail below in their own words.

"Global atmospheric concentrations of CO_2 and CH_4 in all layers of the atmosphere from the ground surface to the top of the atmosphere rise yearly with seasonal oscillation.

"These results are contributing to the climate science and useful for climate change-related policies."

In addition, our attention is drawn to GOSAT-2, a successor of GOSAT, launched in October 2018 with tremendous success. Using this satellite, the Ministry of the Environment Government of Japan intends to observe whole-atmosphere CO_2 and CH_4 concentrations from space continuously. This is an activity that is carried out with high accuracy and can: "Estimate anthropogenic emissions from a large city and large-scale emission source, thereby contributing to further enhancing transparency and GHG emission reductions."

GOSAT and GOSAT-2 projects are promoted by the Ministry of the Environment Government of Japan, along with the Japan Aerospace Exploration Agency, and the National Institute for Environmental Studies. [3]

Climate change impacts

Finally, in recent news from January 2019 we discover that when it comes to the manifestation of climate change impacts across the world, the Intergovernmental Panel on Climate Change (IPCC)'s 1.5°C special report in October 2018 describes the future of global warming: "Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate", they said. This is indeed a challenge and the Ministry's website notes that to realise a decarbonising society, the extension of conventional efforts plus new innovation are very necessary. They believe that such innovations are now considered to be a source of growth.

"Under such situations, the Ministry of the Environment (MOE) has proceeded with technical demonstration projects of CCUS (Carbon dioxide Capture, Utilization and Storage) which can greatly reduce CO_2 from large-scale emission sources to the atmosphere." [4]

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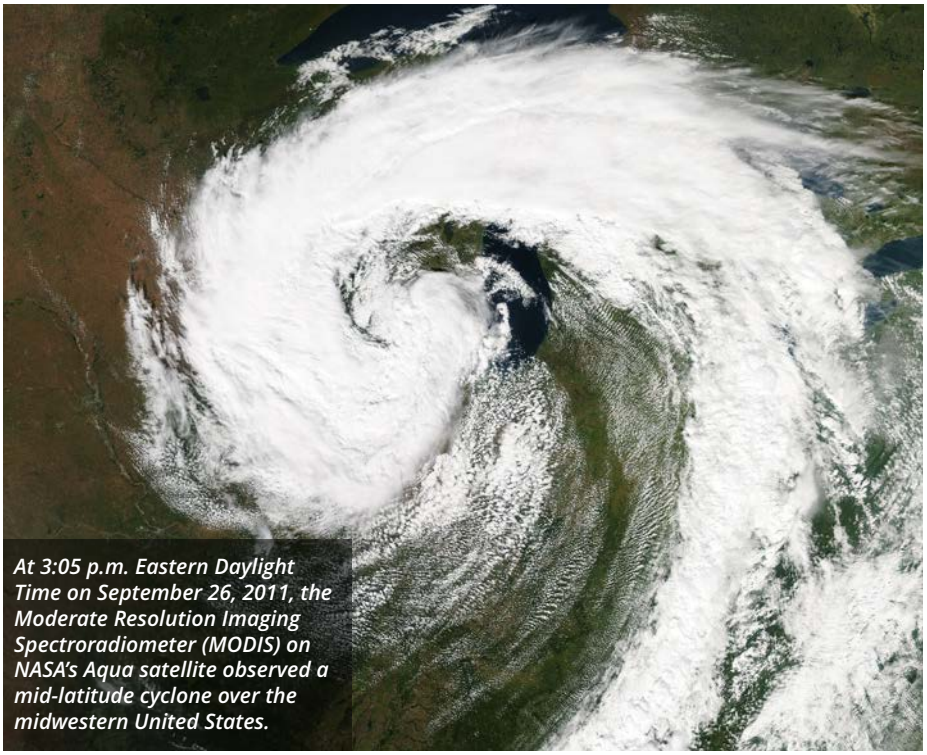
"Climatic hotspot project": Uncovering impacts of the midlatitude ocean

Uncovering impacts of the midlatitude ocean is a part of the "Climatic hotspot project, as profiled here by Professor Hisashi Nakamura from the Research Center for Advanced Science and Technology, at the University of Tokyo in Japan

By way of background, it has long been believed that the extratropical ocean is passive to atmospheric variability and, therefore, anomalies in extratropical sea-surface temperature (SST) provide no predictability in climatic condition. In fact, the current operational seasonal prediction for the extratropics finds its basis on remote influence from tropical ocean-atmosphere variability which is typified by El Niño/La Niña. This conventional notion was established on the basis of previous findings that extratropical SST anomalies form as a response to BOTH wind and temperature fluctuations, which have been derived from SST data based on in-situ observations and output data from atmospheric general circulation models with low spatial resolution.



At 3:05 p.m. Eastern Daylight Time on September 26, 2011, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite observed a mid-latitude cyclone over the midwestern United States.

NASA image courtesy Jeff Schmaltz, the MODIS Rapid Response Team at NASA GSFC

Our challenge

However, recent satellite data and high-resolution numerical modelling have started offering a different view. Utilising such high-resolution data, our project "Hotspots in the Climate System" or "Hotspot Project", aims to present convincing evidence that the mid-latitude ocean, especially, an intense warm current along the extreme western portion of each ocean basin, such as the Gulf Stream or Kuroshio, can exert thermodynamic forces on the atmosphere through heat and moisture release. The eastward extension of the warm current merges with a cold current, forming an oceanic frontal zone with a pronounced SST gradient. Variability of the frontal zone as a response of the ocean gyre to anomalous wind stress can, therefore, yield strong SST anomalies and thermodynamic forcing on the atmosphere by modifying heat and moisture release. We regard these warm western boundary currents (WBCs) and associated frontal zones as climatic 'hotspots' that must be significant in shaping the tropospheric circulation and variability.

Well-designed structure for the challenge and capacity building

Our hotspot project challenges the aforementioned established notion by exploring the climatic impacts of the WBCs and SST fronts through the effective combination of numerical, analytical and observational studies. Under five-year funding from the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the project was initiated in July 2012 as the collective endeavour of 18 universities and four research institutes, where over 100 researchers and graduate students across Japan are involved. Led by Professor Hisashi Nakamura, the project consists of nine main programmes and a dozen of smaller supplementary programmes, with umbrella projects under which

crosscutting research activity is promoted for challenging four important topics: Oceanic jets and SST fronts, Pacific decadal climate variability, and air-sea interactions under the East Asian summer/winter monsoons. The project encourages close collaborations between physical oceanographers and atmospheric/climate scientists, as well as international collaboration, therefore, offering an excellent environment for capacity building. In fact, the number of PhD students in the project increased by 150% during the five years.

Unique field observations

One of the main programmes is specially designed for field observations. Experts in the programme led observation campaigns just east of Japan, including the one in early July 2012. It featured a unique strategy where three research vessels aligned meridionally at fixed intervals crossed the Kuroshio Extension and associated SST front repeatedly from the south and north over five days, while conducting GPS sonde and expendable bathythermograph observations for the atmosphere and upper ocean, respectively and synchronously every two hours. Unlike many previous attempts by single-vessel observations, our campaign was the first to unambiguously reveal a detailed vertical structure of the SST front and cross-frontal contrasts in the atmosphere, including the vertical structure of the boundary layer and low-level clouds. These findings are valuable as a benchmark for numerical models.

Outcomes and achievements

The outcome of the hotspot project was truly substantial and represented as 400 peer-reviewed papers in international journals after a five-year funding period, and new papers are still coming out. Some of them are archived in a special section of the Journal of Oceanography (2015) and a special collection of the American Meteorological Society "Climate Implications of Frontal Scale Air–Sea Interaction". Jointly with the Japan Meteorological Agency, the project has produced a new product of global atmospheric reanalysis with high-resolution SST (JRA55-CHS). We presented solid evidence that midlatitude oceanic frontal zones favour the recurrent development of cyclones and anticyclones to form regions called “storm tracks”. Moisture supply from the warm WBCs favours explosive development of cyclones. Wintertime cyclone tracks are found sensitive to the Kuroshio meanders, modulating snowfall probability in Tokyo. Recurrent cyclone development shapes low-level cloud distribution, which influences the Earth’s radiation budget, and organises large-scale rain bands along the frontal zones. Through storm track formation, the midlatitude oceanic frontal zones influence basin-scale or even hemispheric-scale westerly jet streams and their variability. For example, persistent SST anomalies in the Kuroshio/Oyashio Extensions act to force basin-scale variability in upper-level westerlies over the Pacific and semi-permanent surface low-pressure system (the Aleutian Low), whose climatic influence extends into North America. SST frontal zones in the southern oceans are found to be essential for the dominant hemispheric-scale mode of westerly variability, through which extensive climatic trends were induced over the late 20th Century by the formation of the stratospheric Antarctic ozone hole. In summer, particularly high SSTs along the Gulf Stream or Kuroshio are found to organise deep convective clouds, especially under warm, moist air flows from the tropics, which sometimes give rise to torrential rainfall in coastal regions.

Towards the next stage

Our findings mentioned above urge the international community of climate science to promote high-resolution modelling of the ocean and atmosphere to resolve narrow midlatitude hotspots and their climatic impacts. During the 20th Century, the hotspots underwent locally enhanced warming, and their climatic role is, therefore, expected to increase under future warming. In fact, recent ocean warming around Japan appears to yield enhanced surface evaporation and, thereby, increases the likelihood of torrential precipitation over Japan. The next stage of the project is under preparation to expand its scope into clarifying the role of the climatic hotspots in a future projection of the occurrence of extreme weather and climatic conditions, under on-going global warming. We will also explore similar hotspots in the Arctic, as we have found that declining sea-ice cover in the Barents/Kara Seas acts to strengthen the Siberian High and, thereby, induce severe winters over midlatitude Eurasia.

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Quick earthquake alert notification for disaster risk reduction in Taiwan

Deputy Director of the Seismological Center Central Weather Bureau (CWB) in Taiwan, Nai-Chi Hsiao, explains how the country's quick earthquake alert system provides notification when it comes to ensuring disaster risk reduction

Taiwan is located on the boundary between the Philippine plate and the Eurasian Plate. The convergence of these two tectonic plates activity causes about 100 obvious felt earthquakes per year and 100 minor non-felt events per day around Taiwan. Several hazard earthquakes have occurred during our history. The most famous one was the 1999 Chi-Chi earthquake with Richter magnitude 7.3 in the middle of Taiwan, which killed more than 2,000 and caused mass building damage as well. The threat of an earthquake is, therefore, a serious issue today in Taiwan.

The Central Weather Bureau (CWB) is the government agency responsible for earthquake monitoring and relevant warning issues in Taiwan. More than 700 seismic sensors were deployed in and around Taiwan, including some on the ocean floor in the East Offshore Marine Area. About a quarter of these stations communicate in real-time with the headquarters at CWB at any given time. Depending on these precious ground motion signals, an automatic detection system was developed which can locate an earthquake at any time.

Besides the automated system in place, there are at least three persons on duty in the Seismological Center of CWB. They have ensured the healthy operation of the Seismic Network and the computer systems all the time, and their most important mission is to verify the correctness of all information and to issue felt-earthquake reports as quickly as possible. The report is disseminated to hazard-rescue agencies, hazard-assessment organisations, earthquake research institutions, important infrastructure systems (such as power supply, communication, and transportation), and mass media. Besides the initiative disseminated, these reports will also be published on the website of the CWB to inform the general public simultaneously. For instance, 139 obvious felt-earthquake reports were issued in 2018, and the average performance of auto detect and location takes place in about 60 seconds and issues are reported within the space of around five minutes.

> "The Central Weather Bureau (CWB) is the government agency responsible for earthquake monitoring and relevant warning issues in Taiwan. More than 700 seismic sensors were deployed in an around Taiwan, including some on the ocean bottom in the East Offshore Marine Area."

Based on the millions of earthquake data recorded and the monitoring experience in place for over 25 years, the CWB had been conscious that felt-earthquake reports are useful, but only in the hazard-rescue stage after earthquake shaking occurs. Therefore, we developed the Earthquake Early Warning System (EEW) to detect significant earthquakes quickly in order to issue a warning about 10-15 seconds after the earthquake occurrs. That means we can issue alerts for the area about 60 km away from the epicentre and provide seconds to 10s of seconds warning time for an urgent response before the destructive shaking occurs.

Since 2014, CWB has provided the EEW warning directly to all the public schools, hazard-rescue agencies and other government departments in Taiwan. Since 2016, CWB has issued EEW warnings through the Public Warning System (PWS) to wireless devices of the general public. The PWS was developed and constructed by the government and communication Corp., which is based on the Cell Broadcast Service (CBS) on the 4G network. This means that all the people in a

Image: © Minyun Zhou | Dreamstime.com

high-risk area can receive an EEW warning at the same time! CWB also collaborates with TV companies to deliver instant live pop-up messages during the transmission of programmes.

However, the warning can only help people taking action to protect themselves (Drop, Cover, and Hold on) because the warning time is limited. The main benefit of an EEW is the application of industrial auto-control, slowing down high-speed communication vehicles, suspending or halting the gas-line or power-line system, auto protection for a dangerous system such as power plants, hi-tech equipment, and so on. CWB had promoted the application of the EEW, recruited more than 10 private companies and research institutes in different domains to collaborate in order to develop warning message forwarding and customised application for requirements for any hazard mitigation purpose.

No matter what the earthquake report or the EEW warning is, we focus on improving the availability, accuracy, and efficiency of earthquake monitoring. There are several tasks that need to be promoted eagerly in the future. These include expanding the coverage of the Seismic Network and installing more advanced and robust ocean bottom seismographs on the east-south ocean of Taiwan where it is most likely that an earthquake will occur. To enhance the density of the Seismic Network: upgrading more off-line to real-time stations is required – improving the algorithm of computer modules so that it will take less time for the EEW to be issued. The ultimate goal of earthquake monitoring in Taiwan is to provide useful EEW and earthquake reports to whoever needs them, to achieve practical earthquake hazard mitigation, helping to secure the civil life and properties in the country. ■

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A new turn in the search for the origin of life

Professor Friedemann Freund, SETI Institute, explores a fascinating new discovery in the search for the origin of life, here

Sometime in the distant past, life appeared on planet Earth. Nobody knows when, but it must have been at least 3.5 billion years ago, maybe 3.8 billion or even 4.3 billion years ago, relatively soon after Earth accreted in the disk of gas, dust and planetesimals that circled the early sun.

If there is much uncertainty about the timing of the origin of life, how life actually started is even more uncertain. A sine qua non condition for life as we know it is that, somewhere on the early Earth, blobs of organic molecules must have come together to form a "system" that could copy itself and multiply. No easy task, requiring large, complex molecules made of carbon, hydrogen and oxygen with some nitrogen and sulphur thrown into the mix. Using the chemical symbols of these elements we may call them CHONS.

The challenge is to understand how Nature could have produced the large, complex CHONS, without which the first self-replicating systems could never have formed out of the chaos of the pre-biotic Earth. Those CHONS must have contained hydroxy, carboxy, amino and sulphur functional groups. They must have been able to build vesicles with cell membranes. The vesicles must have had cell membranes pitted with cross-membrane functional groups that allowed protons and ions to flow in and out in such a way as to generate concentration gradients and transmembrane potentials – a form of energy.

Unfortunately, the science community has not yet figured out how Nature might have produced the large CHONS that were surely necessary to form such protocells and to give life a shot at getting started. Smaller organic molecules? No problem. Amino acids are easy to make, for instance by electric discharges simulating lightning strikes on the early Earth. The real challenge is how Nature was able to build much larger multifunctional CHONS.

For decades, the search was on to demonstrate how such CHONS could be assembled under plausible early-Earth conditions, in the atmosphere, in freshwater or the oceans, with help from ultraviolet light or high energy x-rays and gamma rays, at high and low temperatures, at high and low pressures. Despite all efforts the goal remained elusive. The science community started to look elsewhere.

One idea that became widely accepted is that the young Earth had been intensely bombarded by the most primitive meteorites, carbonaceous chondrites, which may have accreted in the interstellar dust clouds, from which the entire solar system formed. We can see these dust clouds in the night sky forming dark bands in the luminous plane of our Milky Way galaxy.

The nano-sized mineral grains in the dust clouds bear the spectroscopic signature of delicate hydrocarbons and, indeed, carbonaceous chondrites that have fallen to Earth in recent decades were found to be amazingly rich in CHONS, including some that form vesicles when extracted with water and others that

contain carboxy, amino, and sulphur functional groups. Such CHONS would have come handy on the early Earth and they could have provided a path towards life. So, there it is – the idea that life on Earth owes its existence to organics delivered from space more than 4 billion years ago. A grand idea, quoted in the scientific literature and widely popularised.

However, when we drill down to its roots, we see that this idea came out the disappointment in the science community that, using the most advanced methods of investigation, some of the best minds in chemistry, physics, geoscience and astrobiology have not been able – despite decades of intense work – to figure out how Nature could have produced these large, complex and multifunctional CHONS, without which life as we know it could not have started.

As so often in the history of the human mind, in times of uncertainty, the imagination may turn to the even greater unknowns. This seems to have happened in the face of widespread frustration over the inability to make real progress in the area of origin of life. In this case, the imagination turned to space.

Maybe out there, in the vast expanse of space, chemical reactions are possible that have no equivalent on Earth. Maybe, when stars reach the end of their life cycle and die in cataclysmic explosions, the mineral grains condensing in the hot stellar outflows are uniquely able to produce those complex CHONS.

Maybe the organics associated with the dust clouds in the interstellar medium are such CHONS. Maybe they became incorporated into the carbonaceous chondrites, those pitch-black, organics-rich clumps of very fine-grained matrix, probably formed in these humongous dust clouds in the galactic plane. Maybe the early Earth did indeed capture many of these carbonaceous chondrites and was seeded with the CHONS, from which life would eventually arise.

Posing the question in this way exposes a flaw in the basic approach taken by so many bright chemists, physicists, geoscientists and astrobiologists, whose goal is to unravel the mystery of the origin of life. For decades their focus has been on chemical reactions that take place in the gas, liquid and fluid phases, including supercritical conditions, at gas-fluid, gas-solid and fluid-solid interfaces, even inside clay minerals.

The condensation of mineral grains in the near-vacuum of space, in the outflow of dying stars, is a distinctly different process. It is the transition from the vapour phase directly to the solid state in the presence of hydrogen, carbon monoxide, water, nitrogen and sulphur. During the process, the gaseous components become incorporated into the solid matrix. The smaller the grains, the more of the gaseous components go in. Once inside, the C, H, O, N and S interact with each other, forming chemical bonds – a step towards CHONS.

Here is where past research to unravel the mystery of the origin of life went astray. Brilliant and dedicated as they were, the scientists involved in this field never considered the possibility that the reactive gases dissolved in the magmas in the depth of Earth – water, carbon monoxide and dioxide, even nitrogen and sulphur – would become incorporated into every mineral grain that crystallizes out of terrestrial magmas. Not in high concentrations but at non-zero levels, nonetheless. During cooling, the C, H, O, N and S inside the solid matrix interact with each other and form chemical bonds – a step towards CHONS.

Therefore, there is no need to look to space and to carbonaceous chondrites to deliver CHONS to the Earth, precious organics from which life might have arisen. There is no need to worry that any such delivery could have happened only during the period of heavy bombardment of the young Earth more than 4 billion years ago. Quite to the contrary, there is the distinct alternative that rocks in the Earth's crust were producing CHONS inside the matrix of their minerals, releasing them as they weathered at the Earth's surface.

Even if the amounts of CHONS per unit volume of rock were very small, billions of cubic kilometres of rocks have weathered over the eons. In the accumulative, they must have injected huge quantities of CHONS into the Earth's surface environment. There was no shortage of potentially life-giving and life-sustaining organics.

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Incinerator for municipal waste in Hsinchu, Taiwan

The environment: Diversified waste treatment in Taiwan

The Environmental Protection Administration (Taiwan) charts their efforts when it comes to diversified waste treatment

For general garbage disposal in Taiwan, nearly 60% is recycled while 40% goes for incineration. Challenges include declining efficiency of incinerators as they approach the end of their service lives, offshore island garbage disposal and adequate diversified disposal channels for kitchen waste. In an attempt to improve the efficiency of old incinerators and to diversify treatment options, in June 2017 the Executive Yuan approved the Diversified Waste Treatment Plan proposed by the EPA. It is to be implemented over six years with a budget of NT$15.342 billion from central and local governments.

The Plan has six focus areas: upgrades of incinerator equipment; promotion of regional cooperation; offshore garbage disposal; improving the effectiveness of environmental installations; supervision of garbage clearance and; circular economy policies.

Introduction of new garbage disposal technology and incinerator upgrades and improvements

On 15 May 2018, the EPA held the Symposium on Garbage Incineration Disposal Technology. Professionals from enterprises in relevant fields were invited to talk about incinerator upgrades and improvement, as well as new waste treatment technologies. It was decided that regional platforms could be established to facilitate cooperation in addressing waste treatment problems. Diversified treatment facilities would be set up and the effectiveness of existing facilities improved through economic incentives and other assistance provided to help with the adoption of new technology.

Significant results since 2017 are as follows:

1. Assessment and planning for incinerator upgrades and construction

During the first half of 2018, the EPA invited regional bureaus, operators, and supervising units to attend meetings to promote overall equipment upgrades for incinerators and go over application procedures for future upgrades and needed construction. So far assessment and planning budgets have been approved for nine incinerator upgrades.

Plans for transporting waste from three offshore island counties were approved as well. The EPA also helped counties without incinerators to set up their own diversified disposal facilities.

2. Promotion of regional waste reutilisation facilities

(1) An NT$1.8-billion project is in place to establish, from 2017 to 2022, at least three bioenergy plants using kitchen waste, which is expected to raise kitchen waste disposal capacity to 180,000 tonnes/year and reduce carbon emissions by 17,400 tonnes/year. The project is already in motion with six regional governments, including Taipei City. In addition, construction of Waipu Green Energy Eco Park in Taichung City started on 24 October 2017, with a trial run set for September 2018.

(2) The Environmental Protection Facility Efficiency Improvement objectives of the Plan aimed at lightening incinerator loads by utilising wastes as resources and for energy through measures such as kitchen waste dehydration in pre- and mid-treatment. The EPA approved the establishment of pre-treatment facilities for dehydrating and breaking down kitchen waste, located in Tainan City, Yunlin County, and Yilan County in 2017, and in Kaohsiung City in 2018. This year a high-performance compost treatment facility was also approved to be set up in Lienchiang County. Through these measures, the EPA hopes to increase the efficiency of kitchen waste recycling and reuse, and effectively solve garbage disposal problems. In addition, they should lead to positive carbon reduction outcomes, and keep Taiwan up with international trends.

3. Bottom ash disposal and reuse

Regarding bottom ash disposal and reuse, the EPA completed trials for the reutilsation of granular materials used in the maintenance and construction of road pavement in logistics and storage zones. The Information Management Center for Reutilization of Granular Incinerator Materials has been established to ensure thorough source-to-end controls. Each government department is also asked to start using or to increase the usage of granular incinerator materials in infrastructure projects in order to expand channels for the reutilisation of waste products and promote resource recycling and reuse.

4. Promoting reutilisation of livestock waste as farmland fertilizer

Currently, 211 farms have been approved to send livestock waste for anaerobic fermentation before it is used on farmland as fertilizers. This reduces organic pollution by 5,574 metric tonnes/year, and NT$10.1 billion is also saved as this is equivalent to building 101 gravel contact oxidation treatment facilities. A total of 921,000 metric tonnes of fertilizers are used per year on 819.7 hectares of farmland, including 287 metric tonnes of nitrogen. Together farmers reduce costs on chemical fertilizers of up to NT$13.92 million. To link reutilised products with farmers' needs, the EPA has held meetings and set up an online platform, that can match over 50,000 tonnes of fertilizers with 468 hectares of usable farmland.

Future outlook

Continuing to carry out the Diversified Waste Treatment Plan, the EPA estimates that after all incinerators are overhauled, the combined increase in treatment capacity will be equivalent to an incinerator that is able to treat 900 metric tonnes/day of waste. The following tasks will also be continually promoted:

- Counties without incinerators will be assisted first to set up diversified local self-operating waste disposal facilities.
- New technology and treatment facilities are encouraged through economic incentives to raise treatment efficiency.
- Industries and new technology are combined to promote industry upgrades and open overseas markets.
- Regions are assisted to set up treatment facilities that utilise kitchen waste for bioenergy in order to improve kitchen waste disposal, open up channels and markets for reutilised products, and promote circular economy policies. ■

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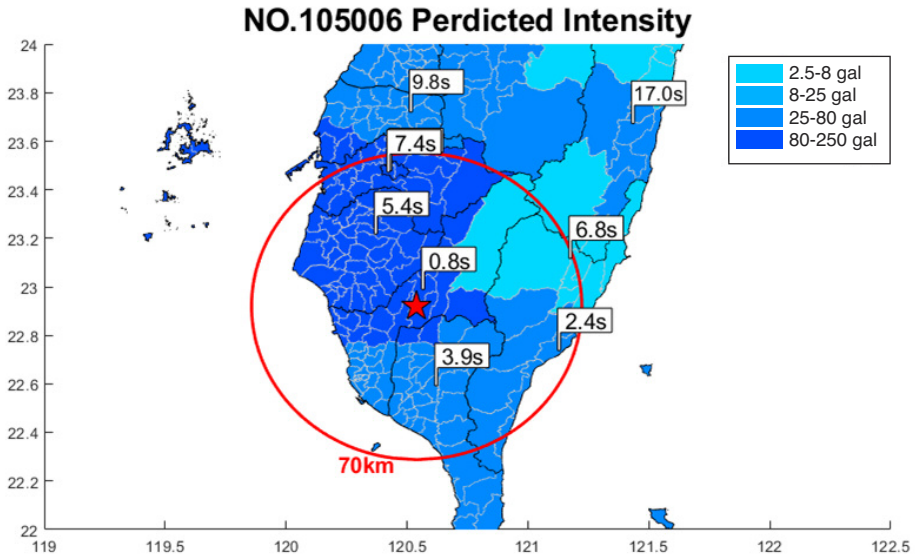
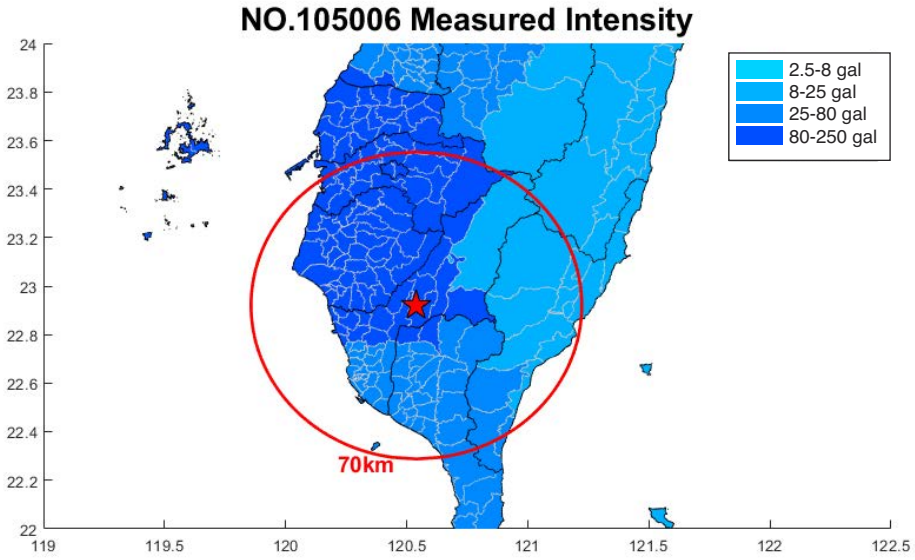
Development of the Earthquake Early Warning System (EEWS) and Structural Health Monitoring System (SHM) in Taiwan

The current status of Earthquake Early Warning System (EEWS) in Taiwan is detailed here by Pei-Yang Lin, Research Fellow at the National Center for Research on Earthquake Engineering

In Taiwan, there are two kinds earthquake early warning system (EEWS) developed for people, the first one was called the regional EEWS developed by Central Weather Bureau (CWB) and the other was the on-site EEWS developed by The National Center for Research on Earthquake Engineering (NCREE). When the earthquake event occurs, the wave propagates and the relative signal will be detected by seismometers which are closest to the epicentre and the regional EEWS collect this data to estimate the essential parameters, such as the epicentre, earthquake magnitude and intensities for influence area, etc. Then, a data centre collects the essential parameters and finally, publishes the warning information.

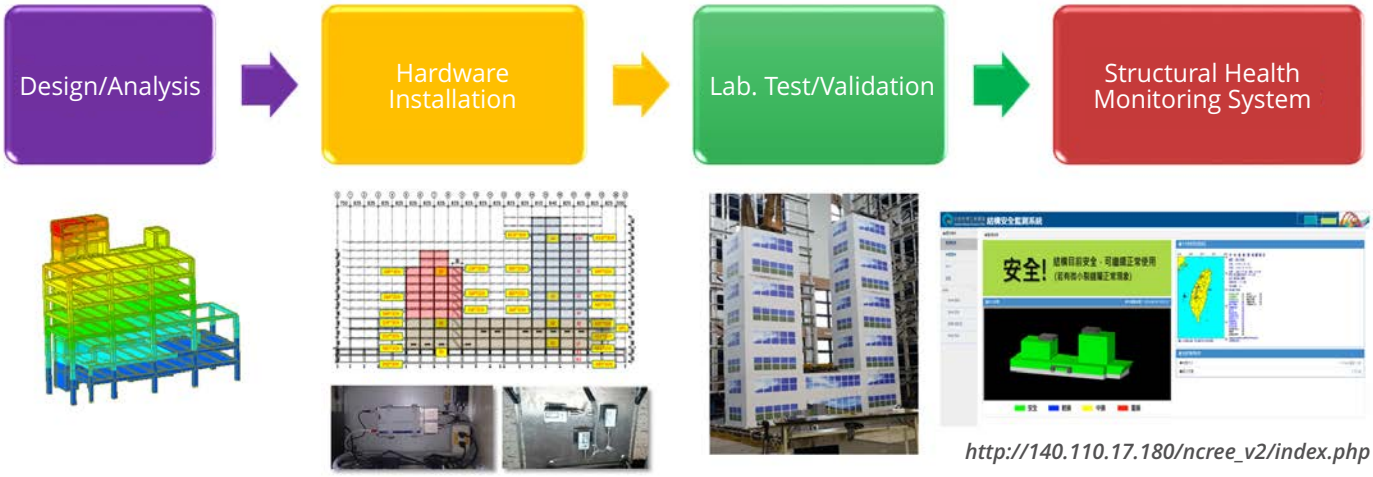




To wait for the data, transmission from seismometers and collection for analysis procedures will be costly in terms of time, in that they will delay the warning. When the earthquake event occurs inland, for example, transmission and analysis works will be about 16~20 secs when it comes to a warning. However, the seismic wave still propagating at the same time means that the influenced areas near the epicentre (influence radius small than 70 km) cannot receive the warning. Such influenced areas are also called the blind zone. The on-site EEWS was developed to reduce the blind zone, based on detecting the P-wave (1-3 secs) by only using an on-site seismometer to predict the earthquake essential parameters for publishing. Because the on-site EEWS doesn't need the transmission from several seismometers in different sites, the areas near the epicentre can receive the warning information early. The on-site EEWS can decrease the blind zone.

According to the earthquake events data during 2013-2018, the influence radius was reduced to less than 30 km.

Structural Health Monitoring System Construction Process



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And there were several successful cases which can be found in a database of on-site EEWS, which can activate the broadcast system in schools to notify people automatically to respond in the event of an emergency.

"During the past few years, NCREE provided the total solution of seismic disaster reduction."

Customised on-site EEWS

The proposed on-site EEWS can further serve the users with vibration-sensitive equipment, by providing more local, detail and accurate seismic vibration prediction and the automatic disaster reduction control system in advance. It cost $160,000~$200,000, and the target users include high-tech plants, high-speed rail, power plants ...etc. In the 2016 Meinong earthquake, the on-site EEWS succeeded in providing the famous semiconductor company in Taiwan an early warning and activated the related emergency responses to reduce seismic loss.

Considering the high costs of the on-site EEWS, NCREE developed another business model for EEW service. People or government can install one on-site EEWS and message server in a small area (~20 km radius). As the seismic intensity is similar inside the area, thousands of users inside the area can share the same early warning message with a low-cost receiver. This kind of application is suitable for the seismic hazard area which needs a warning system urgently. Only after several months of installation, can the EEWS serve thousands of users.

Applications of EEW for smart-technology

During the past few years, NCREE provided the total solution of seismic disaster reduction. Before the main shake, the EEWS can provide the warning info and activate the disaster reduction control, such as shut-off the gas, open the door, stop the elevator... etc. During the shake, the seismic-proof table and safety area provides people with a strong shelter. After the shake, the structural health monitoring system (SHM) can provide the structure healthy condition and safety report to help people carry out the post-earthquake response (return or leave the damaged structure) quickly.

In 2017, NCREE applied the on-site EEWS and SHM and in an office building in central Taiwan science park. The whole system also had been validated on the full-scale RC building shake table test. In 2018, NCREE cooperative with CWB to apply the EEWS +SHM to 10 building structures. We want to use these demonstrations to promote the proposed disaster-privation system, and wish it can be widely deployed in the near future.

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The future of Common Agricultural Policy (CAP) in Europe

Commissioner Phil Hogan details what the future has in store for the Common Agricultural Policy (CAP) in Europe, in an address to Plenary session of the EESC: "Future of CAP" on 20th February 2019

The Common Agricultural Policy is a policy designed to benefit all the peoples of Europe, and as the voice of organised civil society, the Economic and Social Committee will have a strong input into the next evolution of the policy.

Of course, polls show strong public support for maintaining agricultural policy at the European level, due to the clear advantages for guaranteeing food security and ensuring a level playing field within the single market. Our citizens recognise that when it comes to this area of policy, the EU adds value to their lives in a way that national policies alone could not achieve.

But it is also right and proper that the CAP evolves. After all, it accounts for a significant proportion of the European budget, and it must be critically assessed from the perspective of taxpayer value for money.

The question driving the evolution of the policy can, therefore, be condensed into the following:

"As well as adequate food supply, which additional public goods should the CAP provide in exchange for its privileged position in the EU budget?"

We at the European Commission are satisfied that our legislative proposal for the next CAP provides an ambitious and comprehensive answer to this question.

And let me say that we are very grateful to the Economic and Social Committee for their opinion adopted in October last, calling for a strong CAP with a strong budget, based on the European Model of Agriculture and Food Production; supporting an economically, socially and environmentally sustainable European agriculture policy and farming sector.

I want to pay particular tribute to Mr John Bryan for his outstanding work in drafting this opinion and guiding it through the Economic and Social Committee. As I know, John is a farmer himself, and he understands in a very personal way how important the CAP is for the viability of our farmers, our rural areas, and our precious environment.

Environment and climate

I am particularly pleased that the EESC opinion recognises and welcomes our increased environmental and climate ambition.

We strongly believe that our proposal, in particular, the new delivery model for achieving greater results, will be a game-changer for the climate agenda. As such, we are delivering on the Opinion drafted by Mr Bryan in this space.

Budget/MFF

In relation to the MFF, I have taken good note of the view outlined in your opinion.

You regard any proposals to reduce the CAP budget as unacceptable and support the view that the EU budget should be increased to 1.3% of GNI to provide adequate funding for the CAP and the new policy objectives and challenges identified.

While I am personally very supportive, I am sure you appreciate that the Commission's final MFF proposal was made in an extremely challenging budgetary context, taking into account the loss of an important net contributor due to Brexit as well as the need to address new challenges, such as security and migration.

Within that context, we feel the Commission made a fair and reasonable proposal, maintaining a strong budget for agriculture – the amount of €365 billion for the CAP means that 96% out of every euro paid to farmers for 2014 to 2020 is protected going forward towards 2027.

This reduction is complemented with a proposal to achieve greater equity in direct payments per hectare, notably through convergence, degressivity and capping, and a redistributive payment. This means that small and medium-sized farmers would largely escape any reductions in payments.

The reduction of Rural Development programmes can be compensated by the Member States or by transfers from Pillar One.

The MFF proposal also includes €10 billion for research & innovation in food, agriculture, rural development and the bioeconomy. This is a very significant increase for agricultural research compared to today and fits perfectly with the ambition to support the modernisation of European agriculture.

I want to emphasise the importance of a swift agreement on the MFF:

- To ensure a seamless transition between the current and the new budget;
- To provide predictability and continuity of funding and;
- To ensure that EU funds start delivering results on the ground as soon as possible.

At the December European Council, European Leaders endorsed the aim of reaching a political agreement by Autumn 2019. This will be essential to pave the way for finalising the CAP negotiations and to ensure a smooth transition to the next period.

The most important point to bear in mind in relation to the MFF is that the final decision does not lie with the Commission.

The Member States, working in co-decision with the European Parliament, have full freedom to increase their overall budget contributions with a view to keeping the CAP at its current level.

CAP legislative proposal

Let me turn next to the CAP legislative proposal. We have taken note of the decision by the Agriculture Committee of the European Parliament to hold a

committee vote but not a plenary vote ahead of the European elections in May.

In the meantime, I hope the ambitious programme outlined by the Romanian Presidency of the EU will be maintained. Solid progress on an agreement can and must be achieved during the summer months.

This will, of course, require the appropriate political will and ambition, and I am confident the co-legislators will take these responsibilities seriously.

I believe that farmers need certainty and stability regarding policy and budget. Our co-legislators have a responsibility to deliver for them quickly, particularly when there is so much concern about the future due to developments like Brexit.

In the meantime, we continue to make substantial progress in other areas of agri-food policy:

EU food chain

On December 19th, 2019, the co-legislators reached a political agreement on new rules to ban certain unfair trading practices in the food supply chain.

The agreed proposal was endorsed unanimously in the Special Committee on Agriculture on January 14th and by Comagri on January 23rd. The European Council endorsed the agreement and we now await a vote in the plenary of the European Parliament in March.

This is the first time that legislation has been adopted in this area at EU level and it represents a major win for European farmers who will now be better protected against unfair trading practices.

It reflects a Europe that protects and it will contribute to an environment where farmers are in a stronger position to claim their fair part of the value added in the chain. The profession of being a farmer will be more attractive for it.

I would like to thank the Committee and rapporteur Peter Schmidt for his opinion and contribution and the fruitful collaboration we had in working on this dossier.

I am confident that you will consider the final outcome to be a real step forward in relation to protecting the position of farmers in the food supply chain.

EU Agri-food trade

Trade is a political priority for the European Commission and a priority that I have strongly supported myself. I returned just this Monday from a trade mission to Singapore, Australia, New Zealand and the United Arab Emirates, and in all four of these countries, we have made substantial progress in delivering further trade benefits for our exporting agri-food companies.

In terms of economic partnership agreements, the EU has been very active in 2018 and will continue to work on new deals in 2019. The negotiations with Japan, Vietnam, Mexico and Singapore were all concluded last year.

In 2019 we hope to see substantial progress with Mercosur, and we expect to see significant progress in the discussions with Indonesia, Australia, New Zealand and Chile.

We should remember that for every €1 billion in agri-food exports, over 20,000 jobs are supported in rural areas and agri-businesses.

EU-Africa Cooperation

At the same time, the Commission is working very hard to improve and deepen its trade and investment relationship with the African continent.

Already today, the EU is the largest trade partner and importer of agri-food products from the world's Least Developed Countries, many of them in Africa.

Commissioner Malmstrom and I negotiated the removal of trade-distorting export subsidies at the WTO in Nairobi in 2015.

I also expect to see the conclusion of Geographical Indication agreements with CARIFORUM and China.

EPA Japan

I want to reserve a special mention for the EU-Japan

agreement. This represents one of the most successful deals ever achieved in agriculture for the EU, and the biggest concession ever granted on agriculture by Japan to any trade partner.

In relation to EU agri-food exports to Japan, around 85% of tariff lines will enter duty-free over time corresponding to about 87% of current trade value.

It was a very good outcome for geographical indications – our European rural intellectual property. Wines, beef and pig meat, cheeses and processed products are all protected now in the EU-Japan agreement.

Some well-known examples include Cognac, Irish whiskey, Champagne, Feta, and Asiago cheese, to name but a few.

Wines and sparkling wines now enjoy duty-free status since the entry into force on February 1st, and already, there is great interest from Japanese buyers of food and drink products.

Africa-Europe Alliance for Investment and Jobs

I would next like to turn to another important dimension of our international agenda: our relations with Africa. The EU proposes a paradigm shift in relations between our two continents.

It is about building a true and fair partnership focussed on mutual economic interest and fully in line with Africa's Agenda 2063 and flagship initiatives, such as the African Continental Free Trade Area. It is also about delivering on our commitments taken in Abidjan in November 2017.

Our proposed Alliance is actually all about boosting investments and creating jobs, in particular, for young Africans. As a first ambition, we want to reach 10 million jobs in the next five years.

To make real progress on this ambitious agenda, a real mobilisation of all Member States and all African partners is a pre-condition.

The Commission cannot deliver this agenda alone but will do its best to foster mobilisation and to ensure coordination of actions.

One of the concrete initiatives that can nourish this enhanced cooperation in the area of agriculture and rural development is the Task Force for Rural Africa (TFRA) launched by along with the African Union Commission.

The Task Force met throughout 2018 in Brussels and Kigali and its main recommendations for action were presented at the Africa-Europe High-Level Group in December 2018. The recommendations of the Task Force for Rural Africa will be instrumental in implementing the agricultural dimension of the new Africa-Europe Alliance.

Conclusion

In conclusion, ladies and gentlemen, I hope I have given you a good overview of the work we are doing to strengthen the CAP and support our farmer and rural areas.

I am grateful for your support in this mission, and I look forward to working with you in the coming months to deliver a good final outcome. Thank you. ■

This article is based on remarks given by Phil Hogan, Commissioner for Agriculture & Rural Development to Plenary session of the EESC: "Future of CAP" on 20th February 2019.

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Q fever: An emerging problem in low and middle-income countries (LMIC) and the need for improved vaccines

Q fever is an emerging problem in low and middle-income countries (LMIC) and, therefore, there is a need for improved vaccines, in the view of Head of Disease Control at Moredun Research Institute

Q fever, caused by the gram-negative intracellular bacteria *Coxiella burnetii*, is an important and highly contagious zoonotic disease of global importance. *C. burnetii* is thought to have a global distribution, with the exception of New Zealand and Antarctica, and is a significant cause of both human and livestock disease in many Development Assistance Committee (DAC)-listed countries. In grazing livestock, which are the main reservoir of *C. burnetii*, the infection is predominantly asymptomatic but can cause reproductive problems, such as abortion, the birth of weak offspring or infertility. In humans, the disease usually presents as a non-specific febrile illness, pneumonia and/or hepatitis which is usually self-limiting; however, around 2-5% of human cases will develop persistent infections, including endocarditis and vascular infection [1]. This non-specific nature of the disease in humans presents a significant problem for the diagnosis and treatment of the condition in humans, particularly in resource-limited settings.

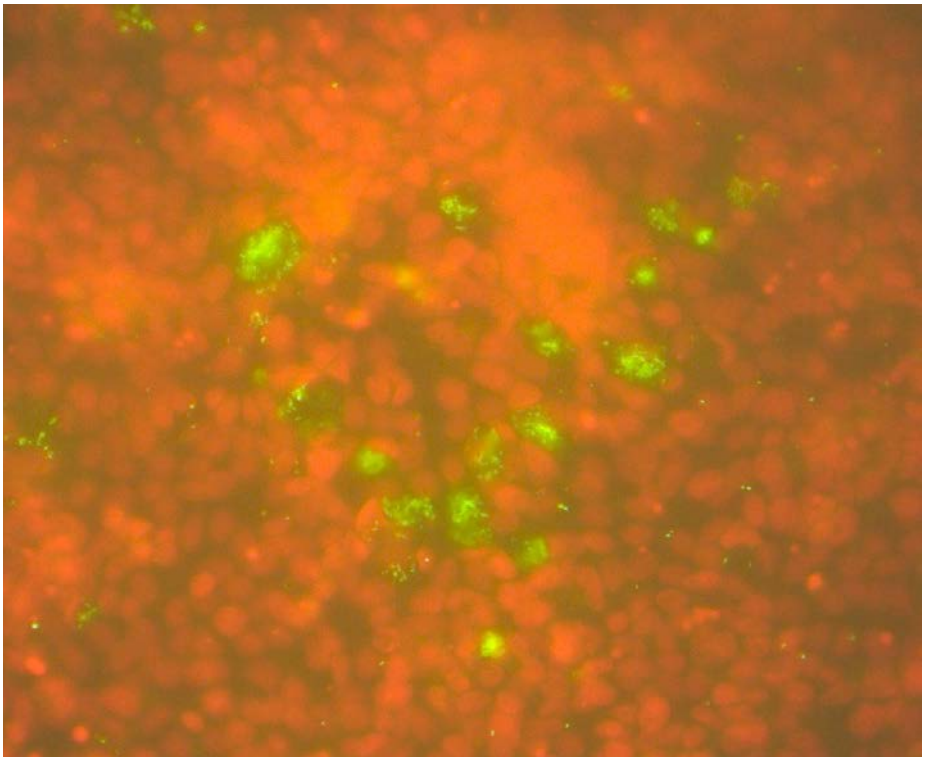
Epidemiology in ODA recipient countries

Recently, a number of epidemiological studies have been performed in countries within sub-Saharan Africa, including Tanzania, Ethiopia and Kenya, all of which are on the DAC-list of Official development assistance (ODA) recipient countries. These studies indicate endemicity of *C. burnetii* in both humans and ruminant livestock in these countries, with seroprevalence of up to 32%, 20%, 31% and 54% for humans, sheep, cattle and goats respectively, and that contact with grazing livestock is associated with increased risk of human infection [2-5].

Furthermore, studies in resource-limited settings indicate that Q fever is a common and increasingly recognised cause of febrile illness and community-acquired pneumonia [6, 7]. Indeed, a recent study of hospitalised patients in Northern Tanzania found that Q fever was a more common cause of febrile illness than malaria [8]. In addition to the direct effects of Q fever infections on human health, infections of livestock cause a reduction in productivity resulting in significant socioeconomic and indirect negative health effects on humans, particularly for smallholder farmers in resource-limited settings. Together, this indicates that Q fever is a significant public health concern in sub-Saharan Africa and that contact with grazing livestock is a significant risk factor.

Q fever control

Despite the growing evidence of the importance of Q fever in resource limited settings, there is currently little active control of Q fever in sub-Saharan Africa, which is exemplified by a recent systematic review of *C. burnetii* epidemiology in Africa which failed to identify a single disease control study in the scientific literature [4]. In addition to poor awareness of the disease, one of the major reasons for this lack of Q fever control in these countries is the lack of a safe, effective and affordable Q fever vaccine. Currently-available vaccines, while showing a useful degree of protection, are suboptimal as they need to be manufactured at high containment, meaning manufacture is both difficult and costly, and are highly reactogenic when administered to animals and humans. At present, the only licenced vaccine for use in humans is available in Australia, where only people who have not been previously exposed to *C. burnetii* can be vaccinated. Therefore, the use of the vaccine requires a complex pre-screening process in which individuals



Coxiella burnetii in cell culture. Green = Coxiella burnetii; red = cell nuclei. Image courtesy of Wageningen University & Research (The Netherlands)

require a skin and blood test (to look for cellular and antibody responses to the bacteria, respectively) prior to vaccination. The vaccine is currently limited to people, for example, slaughterhouse workers and veterinarians, at high risk of *C. burnetii* exposure.

Clearly, there is a need to develop a safe, affordable and effective vaccine which can be deployed in resource-limited settings. Epidemiological data from a recent study in Kenya suggests that targeting the vaccination of grazing livestock going through markets may be an effective means of control [9]. Reducing the burden of disease in ruminant livestock, the main reservoir of infection, would provide significant economic and welfare benefits by:

1. Increasing livestock health and productivity resulting in socioeconomic improvements to livestock keepers;
2. Improving human health by reduction of zoonotic disease and;
3. Reducing costs associated with diagnosis and treatment of human Q fever cases.

Current status of Q fever vaccines

C. burnetii exists in phase I or phase II variants. Phase I *C. burnetii*, which is the virulent form of the bacteria, is isolated from natural sources and infections, plus it is a biosafety level 3 organism. In contrast, phase II *C. burnetii* is avirulent and is selected for after serial passage of phase I *C. burnetii* in embryonated eggs or tissue culture and is a biosafety level 2 organism [10]. Currently licenced vaccines are based on formalin-inactivated phase I *C. burnetii* organisms and have proven efficacy in cattle, small ruminants and sheep.

Unfortunately, vaccines based on safer phase II *C. burnetii* are not effective [11]. A key difference between phase I and phase II *C. burnetii* is the type of lipopolysaccharide (LPS) present, with a large ~26kb deletion in the genome of the phase II strain which encodes over 20 genes involved in LPS biosynthesis. This results in a severely truncated LPS that lacks the O antigen and some core sugars [10], suggesting that LPS is one of the main components in the commercial vaccines responsible for protection. However, protection associated with the phase I vaccine is not exclusively due to LPS as fractions of phase I *C. burnetii* enriched for LPS often induce lower levels of protection compared to whole phase I organisms [12, 13]. Furthermore, an LPS based vaccine would still require manufacture at high containment, and may still induce injection site reactions.

In order to develop a safer Q fever vaccine, attempts have previously been made to develop subunit vaccines targeting key *C. burnetii* proteins (for example Type IV effector proteins which are thought to be promising antigens due to their key role in infection [14, 15]) which would be safer and cheaper to manufacture and could be engineered to induce fewer side effects following immunisation. However, current approaches to subunit vaccine development have been severely hampered by a lack of knowledge of the appropriate antigens to target. As antibodies are thought to play a critical role in protection, previous attempts at identifying antigen targets have involved antibody screening of panels of *C. burnetii* proteins expressed as either *E. coli* recombinants [16] or using *in-vitro* translation systems (IVTS) [17]; however, these approaches are costly,

limited in their ability for repeatedly being probed, unpredictable in terms of ability to express individual proteins and inherently biased by what protein targets can be expressed. To date, despite these efforts, no commercial subunit vaccine for Q fever has been developed.

Current research on Q fever vaccines

Through a BBSRC and the UK Department of Health and Social Care funded **CoxiMap** project (BB/R019975/1) involving partners from the University of Copenhagen (Demark) and Wageningen University & Research (The Netherlands), peptide chip arrays representing the complete *C. burnetii* proteome are being used to identify the key linear B cell epitopes involved in protection associated with phase I *C. burnetii* vaccines. As this approach involves synthesised peptides rather than expressed bacterial proteins, it allows an unbiased interrogation of the whole bacterial proteome. By directly comparing epitopes detected by antibodies induced following immunisation of ruminants with protective phase I *C. burnetii* vaccines with those induced following immunisation with a "non-protective" phase II *C. burnetii*-based vaccine [(11)], protein antibody targets, i.e. *C. burnetii* antigens, which are associated with protection in the phase I vaccine will be identified. It is hoped that this approach, in which the antibody response of the protective phase I vaccine is characterised at the whole *C. burnetii* proteome level, will identify lead candidates for a novel safe and effective prototype subunit vaccine to control Q fever in both human and animal populations.

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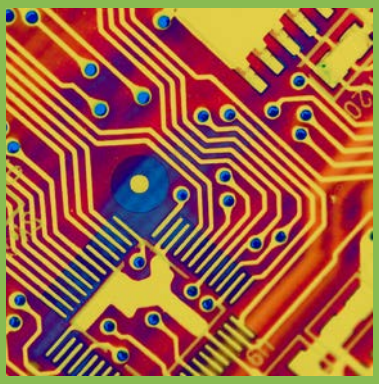





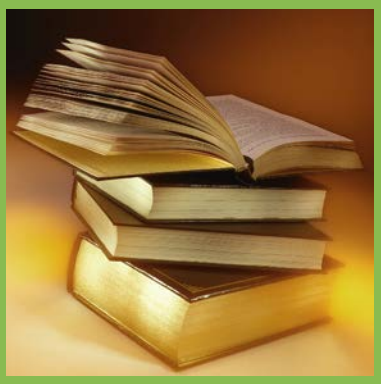

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Polder project: Coastal zone of Bangladesh

Professor Robert Aiken discusses work on food networks in this report, specifically the Polder project

"Smallholders manage over 80% of the world's estimated 500 million small farms and provide over 80%of the food consumed in a large part of the developing world, contributing significantly to poverty reduction and food security."[1] As a public agricultural scientist, this is of interest. Food security extends beyond the major food and feed grain crops (rice, wheat, corn, soybean, sorghum), many of which I study. If a substantial portion of humanity depends on food produced by smallholders, what risks do climate changes pose for these community food networks?

The sustainable intensification of smallholder food systems is the focal work of a colleague, Dr Vara Prasad.[2] His network of international collaborators is devoted to understanding the function of community food networks, and opportunities for sustainable intensification to enhance food security. Vulnerability to climate change is an integral aspect of this work.

To gain insight into food networks, I discovered the Polder project, active in the Coastal Zone of Bangladesh. The 1.2 million hectares Coastal Zone is home to 8 million Bangladesh in the delta of the Ganges river.[3] The region, typically within 10 m above sea level, is subject to tidal flooding, saltwater intrusion, and seasonal drought. Food insecurity diminishes the development of half the children in the region.

Image: © SIIL Polder Team

Previous studies indicated that increasing mothers' knowledge of nutrition contributed to improved nutritional status of children and the whole family. The SIIL Polder project established a knowledge hub on nutrition, engaging mothers of primary school children in the awareness campaign and training activities.

Image: © SIIL Polder Team

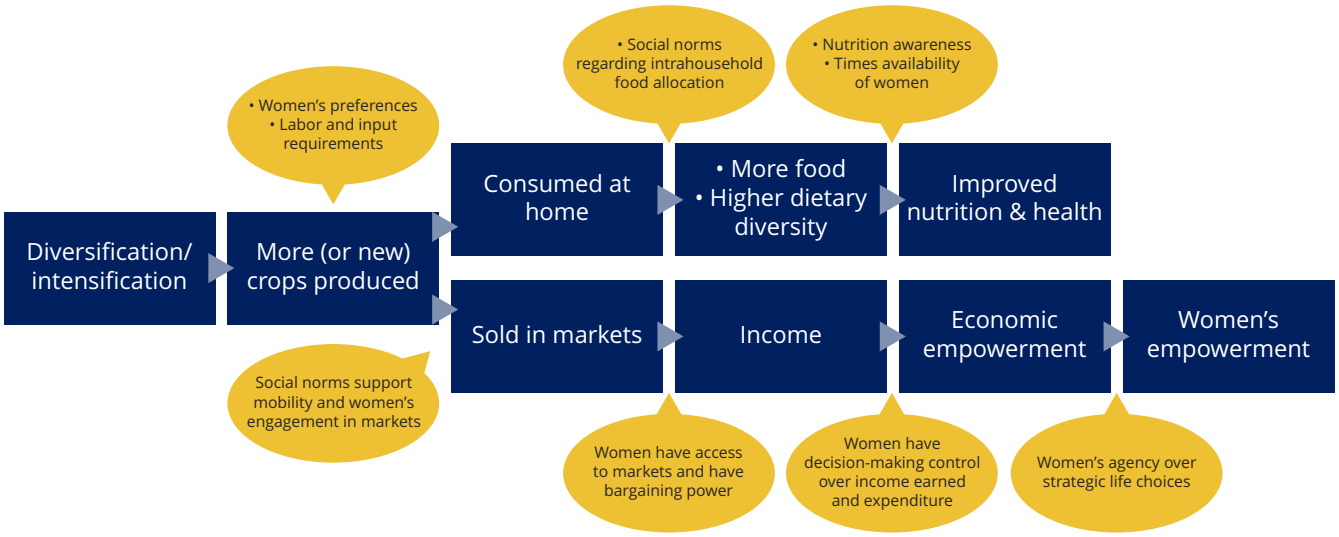
The SIIL Polder project works with communities in managing water governance – timing the opening and closing of sluice gates – in the polders. "Water management has become the key entry point in changing people's lives and triggers socioeconomic development in coastal Bangladesh" according to Sudhir Yadov, a water scientist at the International Rice Research Institute.

Water management is critical for crop growth and food security in the Coastal Zone, utilizing dikes and gates established in the 1960s and 1970s to manage large water catchments, known as 'Polders.'

Another colleague, Dr Krishna Jagadish, directs the Polder project for the K-State Sustainable Intensification Innovation Lab. Krishna's project has established a team of young scientists (nutritionists, water management, agronomy, social sciences, economics, climate-crop modelling) and sociologists who are learning about food networks in one of the nearly 130 plus polders in the Coastal Zone of Bangladesh. Learning hubs form a key component of the adaptive research pursued by these teams. Some of their findings:

Adoption of climate-resilient high-yielding rice varieties can boost grain yields by up to 50%. Incorporating fish production into the flooding phase of paddy rice supports household nutrition.

Successive cropping of hybrid corn and nutritious pulse crops can double annual food productivity. Corn grain can support emerging poultry production enterprises, while stalks provide fodder for livestock.



Crop diversification and intensification affects gender dynamics in the crop-livelihood-food systems of the Bangladesh Coastal Zone. A simplified pathway toward better nutrition, livelihoods, and women's empowerment in rural households. Image courtesy SIIL Polder Team.

Farmers who cultivated different rabi[4] crops (%)		
Cropping Patterns	2015-2016	2016-2017
Climate-resilient high-yielding varieties (HYV) of rice (SIIL intervention area)		
Rice-sesame	30.7	23.9
Rice-mungbean	14.7	32.3
Rice-okra	10.7	15.4
Rice-sunflower	6.0	14.4
Rice-maize	0	4.5
Rice-HYV rice	2.7	3.5
Rice-sweet gourd	0	5.0
Rice-other crops	0	2.5
Rice-fallow	41.3	28.4
Traditional rice (outside of SIIL project intervention)		
Rice-sesame	30.0	17.5
Rice-mungbean	5.0	12.5
Rice-okra	12.5	7.5
Rice-sunflower	0	0
Rice-HYV rice	0	0
Rice-vegetables	0	0
Rice-fallow	52.5	70.0

Impact of the SIIL Polder project on cropping patterns of the Coastal Zone of Banglasesh[5]

The burden of more intensive cropping can fall, disproportionately, on women in the household, often responsible for crop harvest. Mechanical harvest using small reapers can reduce labour requirements by 80%.

Seed storage enterprises – in rat-proof containers, provide income opportunities for women lacking access to land resources. Coordinated water management in the polders is critical for all of these developments. Learning hubs provide critical means of sharing information about new practices, successes and challenges. The students contribute insights into the polder food network while developing professional credentials and experience. Together, the project fosters learning communities where adaptive land intensification help families adapt to changing conditions.

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K-STATE Research and Extension

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Agriculture: Key to eradicating hunger and securing food

Cristina Cruz from FCiencias.Id explains why agriculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food

Agriculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food for a growing world population of 9–10 billion people by 2050, which may require the doubling of global food production in a world of increasing environmental uncertainty. So, how are we going to achieve this if currently, agriculture is, at the same time, the biggest contributor to and the most affected activity by the global changes? Agriculture is also the single largest user of freshwater in the world, with 70 % of the totally withdrawn water of almost 6000 km^3 $year^{-1}$ being diverted for agriculture, which has resulted in approximately 25 % of the world's major river basins no longer reaching the ocean. Agriculture is the world's largest contributor to altering the global nitrogen and phosphorus cycles. Anthropogenic uptake of N from the atmosphere today exceeds the natural global uptake of N for biomass growth and currently at approximately 150 Tg N $year^{-1}$ the global uptake far exceeds the safe ecological limit of 62–82 Tg N $year^{-1}$.

The challenge is obviously how to produce more food with fewer resources. Sustainable intensification, in this context, seeks to increase agricultural output while keeping the ecological footprint as small as possible. The aim is to design multi-functional agro-ecosystems that are both sustained by nature and sustainable in their nature. But to do this, we have to change our mechanistic view of the agro-ecosystem by capitalising on ecological processes in agro-ecosystems.

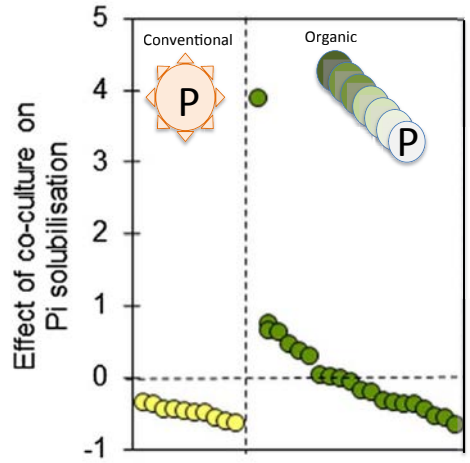

Fig. 1. The legacy of the farming system on the effect of coculture on Pi solubilisation when PSB was grown in pairs of isolates. PSB pairs resulted in significant effects of coculture on Pi solubilisation being positive (i.e. cooperation) or negative (i.e. antagonism). Symbols: yellow for combinations of PSB isolated from conventional and green for combinations of PSB isolated from organic. Conventional management is selecting for organisms with a high individual potential to solubilize Pi and organic management is selecting for food webs.

> "Agriculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food for a growing world population of 9–10 billion people by 2050, which may require the doubling of global food production in a world of increasing environmental uncertainty."

The Bioclub project (PTDC/AGR-PRO/1852/2014) aims at incorporating ecological approaches that make smart use of the natural functionalities into the agro-ecosystem management as an important part of the development of the sustainable intensification of agriculture. However, our fundamental understanding of soil ecology is still a limiting factor to a bio-based management of the agro-ecosystem. Let's take the bio-transformations of phosphorus, as an example.

The productivity of most agricultural systems is limited by phosphorus. However, in conventional farming, 60–90% of the soluble inorganic phosphate (Pi) applied to soils as fertiliser is rapidly immobilised after application, making it unavailable to plants. In contrast, organic farming replaces synthetic fertilisers and pesticides with biological inputs, so microbial processes are essential for its productivity and sustainability.

Several soil microbes have been identified as promoters of plant growth due to their ability to solubilize Pi. However, the use of Pi – solubilising inoculants provides inconsistent results, even when the microbes have the potential for high Pi solubilisation. We tested the legacy of the farming system (conventional or organic) on

the interactions among phosphate solubilising bacteria (PSB) and phosphate solubilisation. We determined the in vitro Pi solubilisation potential of bacteria isolates itself conventional and organic farming and grows them in monoculture, or in pairs, to test for their antagonism or cooperation in Pi solubilisation.

> "The productivity of most agricultural systems is limited by phosphorus. However, in conventional farming, 60–90% of the soluble inorganic phosphate (Pi) applied to soils as fertiliser is rapidly immobilised after application, making it unavailable to plants."

When grown in mono-culture, PSB isolated from conventional farming solubilised more Pi, but when grown in pairs, these PSB solubilised the least Pi. Furthermore, when the pairs included only PSB isolated from conventional farming, no Pi – solubilising cooperation was observed, that is, Pi solubilisation by pairs were lower than in monoculture. When PSB isolated from organic farming were present in the pairs, ~40% of the combinations resulted in P solubilising cooperation. This implies that the two farm management systems select distinct P solubilising microbial communities are:

- Conventional selects for more efficient individuals and;
- Organic selects for more efficient communities (soil food webs).

These results, described in more detail in Melo et al 2017, offer evidence for a farming system legacy influencing the biotic interactions among PSB. And questions arise about the best strategies to convert intensive into sustainable farm systems. But it also provides a strong driving force for a deeper understanding of the bio-transformations of the resources used in agriculture and the need for adequate farming management concerning the biological processes they promote.

This project is financially supported by Fundação para a Ciência e Tecnologia (FCT) – Portugal through the contract PTDC/AGR-PRO/1852/2014.

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Where next for the British pig industry?

Zoe Davies, Chief Executive of the National Pig Association asks where next for the British pig industry and provides a fascinating response

It's fair to say that the British pig sector has had a pretty rough ride over the last few decades but despite that, it has come out the other side determined to grow. Against a background of poor prices, competition from cheap pork imports and export losses following two notifiable disease outbreaks, the sow herd has halved in size since the late 1990s down to around 400,000 sows. Although only 40% of the pork eaten in the UK is produced here, with the remainder largely imported from the EU, our growing export market is now worth £470 million.

There are, however, many pitfalls looming and clearly, Brexit is one of the biggest. A continued lack of clarity over the future has had a significant impact, affecting confidence to invest, expand and encourage new entrants. Everything has been on hold. Many pig farmers watch with horror as politicians debate permitting pork imports from countries, such as the U.S. with standards far beneath our own. The future will undoubtedly be tough and we must rely on our high welfare credentials and stringent standards to survive.

Significantly, many are still unaware of the potential issue with the trade in cull sow meat. Almost all of this trade currently goes to the EU for further processing. Like mutton, there is no market for cull sow meat in the UK and if there is 'no deal' or even a deal that includes lengthy border and inspection checks, the trade would cease as tariffs or delays would render the business unviable. With an average 50% annual herd replacement rate, we are currently at a loss as to what the alternative would be.

Aside from all the politics, another far more insidious threat is lurking and that is African swine fever (ASF). Harmless to humans, this virus is deadly to pigs and has been present in Eastern Europe since 2011. We have watched its inexorable spread west through wild boar and smallholdings, but huge leaps have also been made by people bringing in meat from affected countries and allowing pigs to gain access to it. As a result, ASF is now in Belgium and in all but five Chinese provinces.

> "Our exports to China are now worth £70 million a year and growing. 94% of the pork in the UK is produced to Red Tractor standards, ensuring the pork is high quality, safe and traceable."

The Australian authorities have already identified ASF in imported products and prevented entry. Sadly our border control is nowhere near as stringent as theirs. Needless to say, if ASF makes its way to the UK, the impact would be devastating, not only to pig keepers but to the myriad of businesses that rely on tourism, as large areas of the countryside could be shut down in order to prevent further spread. The more we can spread the message about the threat, the less likely we are to see its arrival.

There are grounds for optimism, however. Our exports to China are now worth £70 million a year and growing. 94% of the pork in the UK is produced to Red Tractor standards, ensuring the pork is high quality, safe and traceable. Although the standards are seen as 'baseline' by some, they do in fact go over and above legislation in many areas, not least by requiring regular audits of welfare outcomes on farms, disallowing castration and instructing farmers to record medicine use electronically, which has enabled us to reduce antibiotic use by half in just two years.

Whilst we rightly focus on the issues of the day, consideration of future pig farming generations is also clearly important. Misinformation and propaganda about pig farming is increasingly being used by certain groups

taking advantage of the gradual disconnect between people and food production. This has not only contributed to a decline in support for agriculture but has also impacted on future availability of labour.

Agriculture is still sadly seen by many as the territory of straw-chewing ill-educated yokels, despite the seismic shift in the use of technology and the high level of skill required for many roles. Even Michael Gove has recognised agriculture as a STEM industry. The situation has been compounded by Brexit as we face decreased availability of willing workers from the EU and a complete lack of support in schools promoting agriculture as an exciting future career for youngsters, leaving us competing over the ever decreasing pool of people willing to work on farms. The introduction of more practically based T-levels in schools is, therefore, very welcome and we are working with the government to try and shift the deep-seated perception about this wonderful sector.

One of the most positive aspects of all this work is the rapid increase in collaboration, not only within the supply chain but also between the pig sector and the government. There are far more discussions and useful interactions than ever before and I hope that this will stand us in good stead for whatever the future throws at us. Clearly, the better we work together, the more responsive and proactive we can be to ensure a positive outcome for all. ■

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The UK pork industry: Demand, opportunities and challenges

AHDB Strategy Director – Pork, Angela Christison argues that the British pork industry has much to be proud of but while the demand is strong, so is the competition

With some of the highest health and welfare standards, food safety and quality traits, the UK pork industry has so much to be proud of.

Our wide variety of production systems provide the market with pork to suit all pockets and preferences. From state-of-the-art indoor systems to outdoor units housing over 40% of our sows in the open air, our systems differentiate British production from any other country in the world.

Markets all over the world, including our own domestic market, are becoming ever more discerning and this is driving quality in our pork production. There are over 10,000 commercial premises housing pigs and around 90% of production comes from assured farms, such as Red Tractor approved, providing consumers with the promise that the food they buy is traceable, safe and farmed with care.

Marketing the value of British Pork in the home market, as well as overseas is a key part of AHDB's work. Our TV and social media campaigns, which promote pork as a convenient and healthy midweek meal, have seen people regarding pork as a great work night option increase by eight percentage points. Other campaigns have promoted the easy appeal of pulled pork for a relaxing weekend treat. As a result of the advertising campaigns over the past two years, an additional £34 million incremental revenue has been generated for

Angela Christison

total fresh pork. Our latest campaign shows that nearly half a million more shoppers have bought fresh pork compared to the previous year.

Overseas demand for British pork is rising too. During 2018, exports reached a record high following nine years of growth and are now worth almost £490 million to the industry – adding essential value to the carcass. Cuts that are not popular at home are prized overseas. British pig meat is now sold into 97 countries. Last year, we gained access to Taiwan in a new deal estimated to be worth around £31 million in the first five years – meaning British pig farmers and pork producers can now tap into this emerging market and make the best use of their products.

Whilst the demand for pork is strong, so is the competition and it is a constant challenge for our producers to become more efficient whilst maintaining extremely high standards. We have a dedicated team working on innovations and information to help farmers especially as global trends in supply and demand affect pig prices.

And obviously, we can't ignore Brexit and the various forms that may take. With still so much uncertainty even after leaving the EU, many within the industry are still trying to make sense of what this historical event will mean to their businesses.

"Overseas demand for British pork is rising too. During 2018, exports reached a record high following nine years of growth and are now worth almost £490 million to the industry – adding essential value to the carcass."

At AHDB we have tried to help find answers to these difficult questions and have created a dedicated section on our website. There is also a pork weekly newsletter to keep everyone up-to-date. In addition, there are a host of Horizon reports on our website that our specialists have developed which can help farmers predict the potential effects on their individual business.

While we know there may be challenges ahead, history tells us that the pork sector can rise to them. ■

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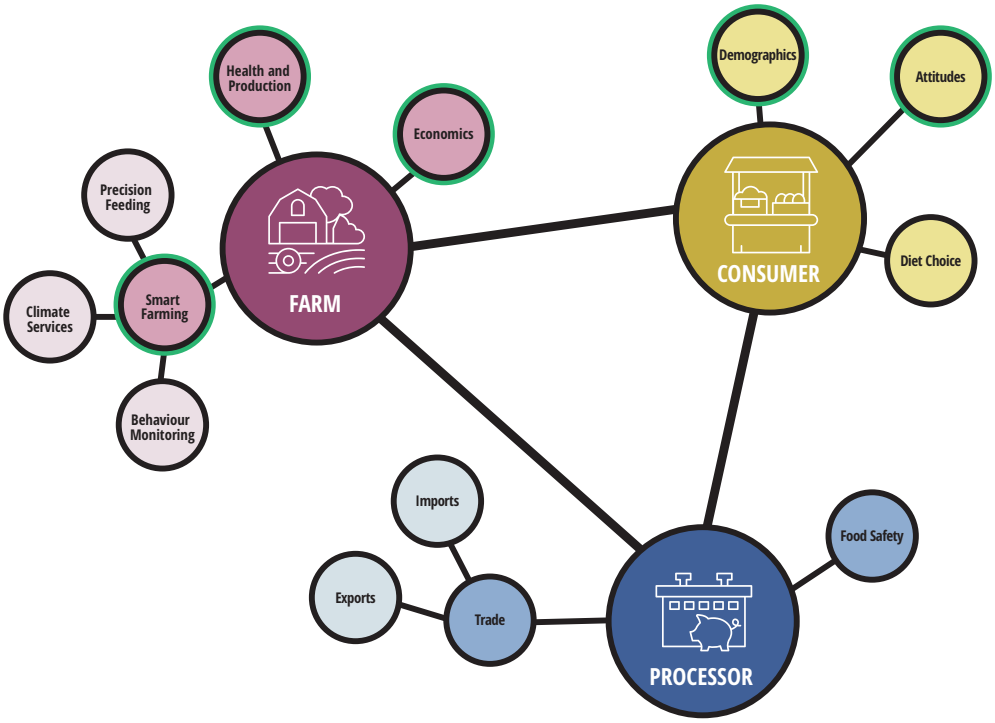
Smart Agri-Systems: A resilient future for pig farming

Research at the University of Leeds provides innovative, systems-based solutions to help the UK pig farming industry navigate future challenges to resilience

Projections of a rise in the global human population to 9.6 billion by 2050 have triggered calls to rethink our use of resource-heavy practices that contribute towards global warming, are detrimental to the wider environment, and which lead to a system that perpetuates nutritional inequality across the world. It is increasingly clear that transforming the future of food and farming requires an in-depth understanding of how changes in policy, environmental conditions and consumer demand impact the system and the complex, intricate interactions that operate within it. We need to better understand how resilient the food system is to change.



One such proposed change is a move towards sustainable intensification of agriculture to meet the higher demand for healthy and nutritious food. In recent decades, the consumption of animal products – and pig meat in particular – has seen a global increase. Despite the overall increases in global demand, there are several potential risks for the pig industry; these include changes in climate, environmental emissions and soil health consequences, emerging and endemic infectious diseases and antimicrobial resistance, changes in global trade, and variability in consumer demand across different communities.

The Smart Agri-Systems research initiative, led by Professor Lisa Collins at the University of Leeds, uses industry-focussed, systems-based approaches to provide innovative solutions for a smarter food and farming future. As part of this initiative, Professor Collins is leading a programme of research to examine the resilience of the UK pig industry. From developing and using cutting-edge technology and data analytics for understanding variability at the level of the individual pig, through to investigating consumer decisions, the work being conducted allows a scalable view of the industry which can be used for testing a wide range of future scenarios.

Health and production

The industry is only as healthy as the pigs that are in it. With that in mind, research begins at the level of the individual pig, with current work investigating how and why some animals are more likely to develop health, welfare and disease issues than others. One such project is looking at how the environment in the uterus impacts on the development of aggressive behaviour and fertility issues later in life. Another project is investigating how nutrition can alleviate stress and influence animal health, welfare and productivity.

As part of the £2.1 million Global Food Security programme funded project PigSustain, Professor Collins and her team have joined forces with academics from the Universities of Reading, Lincoln, and the London School of

Hygiene and Tropical Medicine, as well as the Animal and Plant Health Agency and a range of end-users to investigate the impacts of intensification and future changes on the resilience of the UK pig industry. This project bears witness to a major data collection, integration and analytics exercise comprising millions of records. This includes infrastructure, environmental, economics, production and health records collected on-farm, weather data from local stations, abattoir inspection reports, and submitted carcass diagnostics. Understanding historical trends and relationships will provide more reliable forecasts and predictions for future scenarios. It also allows us to see how the system has historically responded to shocks such as a widespread outbreak of infectious disease.

Smart farming

The University of Leeds' Smart Farm is being developed with advanced monitoring and sensing technology, data capture, Internet of Things (IoT) and data analytics for use by a wide range of commercially relevant and cutting-edge agricultural, ecological, Earth and environmental research. The site is also home to the Centre for Innovation Excellence in Livestock (CIEL) pig research facility, with state-of-the-art systems for precision nutrition and optimised management.

The PigSustain project is developing an affordable, robust, on-farm surveillance technology to individually detect and track indoor-housed pigs without the need to physically mark or tag them for identification. The underpinning algorithms are being trained using machine learning to recognise and provide an early alert to farmers for cases of infectious disease and outbreaks of unwanted behaviours.

For outdoor pig production, a NERC-funded collaboration is investigating the use of satellites to remotely sense animal movement in relation to production performance, environmental emissions and soil erosion. This will be used to develop climate-smart solutions for resilient livestock production.

"The Smart Agri-Systems research initiative, led by Professor Lisa Collins at the University of Leeds, uses industry-focussed, systems-based approaches to provide innovative solutions for a smarter food and farming future."

Economics

The economic viability of the pig industry is key to its long-term sustainability and the global competitiveness of the UK pig industry will come under increasing pressure in the coming years. The PigSustain team are investigating the realities of changing on-farm costs, by developing predictive models of how these components interact within the context of global pig production and future trade risks. This includes understanding the range of dynamic factors that impact decision-making processes around entering and exiting the industry.

Demographics and attitudes

Demographic variability and changing consumer attitudes affect meat consumption trends. PigSustain is using data collected as part of the Office for National Statistics' Living Costs and Food Survey in combination with Census data to predict individual-level pork expenditure patterns in light of changing attitudes towards meat consumption.

A whole system approach

Using a systems modelling approach allows the exploration of industry resilience to future shocks and trends. Simulation models are being developed in PigSustain to characterise the whole supply chain, integrating outputs from across the programme of research. A key output of this will be a tool for end-users to assess risks and resilience in the face of future challenges, including proposals for alterations to policy.

Professor Lisa Collins

PigSustain

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The genetic improvement of cowpea: Develop high-yielding varieties

CGIAR Research Program on Grain Legumes and Dryland Cereals is working on genetic improvement of the important crop cowpea to develop high-yielding varieties with resistance to diseases and pests and to increase its production and consumption, as this article from The International Institute of Tropical Agriculture (IITA) explains

An affordable source of protein and minerals and livelihood to millions of people, cowpea is one of the most economically important crops in sub-Saharan Africa. Mostly grown in the dry savannah areas, it has a high tolerance to drought and the ability to improve soil fertility; plus the ability to easily adapt to changing environments.

Given that a significant number of rural households are dependent on cowpea farming for food, nutrition, income and animal feed, the CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) is working on genetic improvement of this important crop in order to develop high-yielding varieties with resistance to diseases and pests and to increase its production and consumption.

A nutrient-rich crop

Being an indigenous crop to sub-Saharan Africa, the protein-rich cowpea grains are consumed both in rural and urban communities in different forms. Both wild relatives and cultivated types are distributed across the region. Consumers prepare various dishes using cowpea grains and leaves. Popular dishes include 'akara' (wet ground grains deep fried in oil in small balls) and 'moi' (wet ground grains mixed with condiments such as pepper, onions, cooking oil, wrapped in leaves and steamed).

Grains are also ground and the flour added to wheat flour dough to fortify bread for feeding school children in some communities. The leaves, also rich in protein, are consumed as vegetables especially in Eastern Africa. Fresh grains are used as a pea in some areas of West Africa, while fresh pods are used as vegetables mostly in Asia.

The haulm that remains after harvesting and threshing is a good source of quality fodder for ruminants. In parts of Nigeria, dual-purpose varieties are grown for both food and fodder.

Soil fertility booster

Being a legume, cowpea plants contributes to soil fertility in the generally poor soils in sub-Saharan Africa. It fixes atmospheric nitrogen in symbiosis with Rhizobacterium in its root nodules, benefiting subsequent crops. Varieties that show a spreading growth habit cover the soil quickly, thereby, helping to reduce soil erosion and in controlling weeds in intercropped systems.

Compared with other crops, cowpea is generally drought tolerant. It is well adapted to the dry savannah regions of sub-Saharan Africa where annual rainfall ranges from 350 to 900 mm. Some extra-early to early maturing varieties of cowpea have been identified and found suitable for reduced cropping season due to the ensuing climate change and reduced or erratic rainfall. These varieties are able to escape the onset of drought.

The seed trade in areas where cowpea is commonly grown is weak. Farmers hardly purchase seeds for planting and seed companies do not produce and sell cowpea seeds. Besides, cowpea being a self-pollinating crop, it encourages farmers to keep seeds from harvests for subsequent plantings. In both rural and urban areas of sub-Saharan Africa, women who process cowpea into 'akara' and 'moi moi' sell these

Researcher inspecting cowpea plants, IITA, Ibadan, Nigeria

Image: © IITA

products in markets to earn regular income that helps them to feed their families and take care of the health and schooling of their children.

Improving productivity and tackling pests

Since cowpea is grown mostly under rain-fed conditions with minimal input by farmers, its grain yield is generally low. Besides, generally, farmers do not adopt farming practices, such as appropriate plant population density, protection against insect pests, use of fertilisers and planting of improved high-yielding varieties that could enhance its productivity.

The productivity of cowpea in farmers' fields in sub-Saharan Africa is very low at less than 500 kg/ha, mainly because of insect pests; it can produce up to 1,500 kg/ha or more in research fields. There is at least a major insect pest at every growth stage in the field and even in storage.

Maruca vitrata, a lepidopteran insect, is the most common pest. None of the hundreds of germplasm lines of cultivated cowpea evaluated showed the desired levels of resistance to this insect pest. The wild cowpea relative Vigna vexillata, which has a good level of resistance, is not compatible with cultivated cowpea. Hence, cowpea has now been genetically engineered with the Bacillus thuringiensis (Bt) gene that confers a high level of resistance to Maruca. This material is the result of an effort of international researchers which is still being tested under contained field conditions.

Another constraint limiting cowpea productivity is parasitic flowering weeds – Striga gesnerioides and Alectra vogelli. Both cause appreciable grain and fodder yield losses in cowpea. In Nigeria, the variety release and registration committee have made it mandatory for any cowpea variety to have resistance to Striga before being released. Sources of genes for resistance to both the parasitic weeds have been identified, and varieties having resistance to Striga are being promoted across the sub-region.

Cowpea breeding programs across sub-Saharan Africa with support from several donors (Bill & Melinda Gates Foundation, Global Crop Diversity Trust, Kirkhouse Trust, USAID) and the CRP-GLDC are putting a lot of emphasis on increasing crop productivity and dissemination of improved varieties to farmers. This holds the key to a promising future for smallholder farmers in the region. ■

IITA is one of the partners of the CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) http://gldc.cgiar.org

CGIAR RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

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Harnessing the plant microbiome for commercial applications

Philippe Rolshausen, Cooperative Extension Specialist based at University of California, Riverside, explains how the plant microbiome can be harnessed for commercial applications

In the second half of the 20th Century, the green revolution increased agricultural production to feed a globally growing population. It was made possible because of the adoption of new practices, transfer of technology and planting of high-yielding crop varieties. On the other hand, this revolution changed the agricultural landscape and came at an environmental cost because of the increased demand for water and a greater need for agrochemical inputs. Fifty years later, we stand at a crossroad of the green revolution because while we are projected to reach a global population of nine billion people by 2050, we cannot afford to ignore the environmental challenges that lie ahead of us.

Public awareness of environmental risks has expanded consumer demand for organic or sustainably grown food products which, in turn, shifted the standard conventional farming practices to more integrated systems. The use of synthetic chemicals is still a cornerstone of those agricultural practices in order to maximise crop productivity and limit losses caused by diseases. While these practices will not disappear for obvious reasons, research has optimised chemical formulations, delivery and efficiency and as a consequence, reduced the chemical inputs in cropping systems and runoffs in the environment. In addition, it facilitated the adoption of natural biological products that contain living microorganisms. Agricultural biological products have now become an integrated part of pest and disease management practices and nutritional programmes in developed markets, where bioproducts are used in combination with synthetic crop chemistries.

The assemblage of microbial organisms associated with humans or plants is known as the microbiome and can be viewed as an extension of the host genome. There are over a billion bacterial cells that inhabit a gramme of soil or gut. The equilibrium established between those living entities (or homeostasis) is critical for host health and that imbalance between the two entities (or dysbiosis) may lead to a state of stress. The microbiome has been a major focal point of scientific and clinical research and has fuelled the expanding market for plants and human probiotics. The agricultural biologicals market is projected to grow at a Compound Annual Growth Rate (CAGR) of 13.8% to reach $14.65 billion by 2023 from $6.75 billion in 2017. In comparison, the U.S. markets for probiotics is estimated at $49.4 billion in 2018 and is projected to grow at a CAGR of 7% in the next five years. The strategy for a probiotic is to introduce "beneficial" microbe(s) that could provide advantageous traits to the host and improve environmental fitness. Yet the inability to predict or manipulate the behaviour of the introduced microbe and to deliver a consistent response to the treatments have impacted scientific credibility. The advent of "Omics" technologies provide the tools for a broader understanding of the microbial ecosystems and their dynamic interaction with the host. It enabled the screening of large microbial populations and identified individual or groups of taxa with functional capabilities.

The rhizosphere (the soil environment that surrounds the roots) is a microbe-rich environment that includes fungi, oomycetes, archaea, viruses and bacteria. Evidence shows that plants have developed a mechanism for recruiting specific microbes to cope with environmental stress. In this capacity, the host-selected microbes have provided a protective role against invasion by opportunistic pathogens, or drought conditions. Capitalising on those endemic functional microbes would increase the success rate for commercial biopesticides that currently rely on the exogenous application of non-native strains to a crop system. There is broad scientific support for biological controls against plant pathogens. However, those have been established in controlled conditions in in vitro or in planta assays, but under field conditions, very few biological control agents can perform at a competitive level. This limitation combined with the challenge of formulating a product that guarantees a long shelf life of microbial activity has hindered market access of the microbial technologies. Yet there have been a handful of com-

"...we stand at a crossroad of the green revolution because while we are projected to reach a global population of nine billion people by 2050, we cannot afford to ignore the environmental challenges that lie ahead of us."

mercial successes for agriculture with fungal- (e.g., Trichoderma) and bacterial-based (e.g., Bacillus, Streptomyces, or Pseudomonas) bioproducts.

The plant rhizosphere also conveys key nutritional functions similar to those of the human gut. Scientists made the analogy that "plants wear their gut on the outside" because roots are exposed to the fluctuation of the environmental conditions, as opposed to the gut that is internal and, thereby, more environmentally sheltered. The energy production strategy between plants and mammals are, however, different. Plants can internally generate their own carbon energy (or autotrophs) through photosynthesis, while mammals seek their energy from other external sources (or heterotrophs). The mammalian gut has evolved to facilitate the uptake of simple sugars, lipids, vitamins and ions. In contrast, nutrient acquisition by roots to support plant growth is almost exclusively limited to mineral ions and water from soil. The microbial profile of human guts and the plant rhizosphere is qualitatively and quantitatively different because of the contrasting conditions under those two environments (oxygen level, pH, food availability). Despite the fact that those two microbiomes have evolved independently, they have in both cases, helped facilitate availability and assimilation of nutrients to their host. One obvious example is the symbiotic relationship between legumes (peas, beans) and rhizobia. Those bacteria help the plant fix atmospheric nitrogen (78% of the air) in exchange for a carbon supply. Another example is the symbiotic relationship between the plant and mycorrhizal fungi, whereby the mycorrhizae receive carbon from the plant in exchange for increased nutrient uptake (principally phosphorus and nitrogen). Both of those symbiotic microbes have been commercialised as biofertilizers and are being used successfully in agricultural production systems, mostly for annual cropping systems. Our research has also shown that citrus trees are often found in association with mycorrhizae and those fungi appear to support tree health under stress conditions. Our group is investigating if this symbiotic relationship can be established early on at the tree propagation phase in nurseries, rather than at a later stage in the field. In this way, this strategy would promote tree growth early on and sustain orchard longevity.

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Agricultural issues: Protecting the United States from harmful invasive plant pests and diseases

The work of the Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) in the United States covers a wide range of agricultural issues, including protecting the U.S. from harmful invasive plant pests and diseases, as this article uncovers

The U.S. Department of Agriculture's (USDA) Animal & Plant Health Inspection Service covers a wide range of agricultural issues, including protecting the United States from potentially harmful invasive plant pests and diseases. The organisation was established in 1972 to consolidate the USDA's animal and plant health bureaus.

Since then, the scope of agricultural issues the agency oversees has grown exponentially and today covers areas such as wildlife damage and disease management, regulation of genetically engineered crops and animal welfare, and protection of public health and safety, as well as natural resources that are vulnerable to invasive pests and pathogens.

Guarding against invasive species and diseases is a 24-hours a day, seven days a week job for the agency. The potential consequences of, for example, the Mediterranean fruit fly or Asian long-horned beetle, going unchecked could be billions of dollars of production and marketing losses annually.

Similarly, if a disease such as foot-and-mouth or highly pathogenic avian influenza were to become established in the U.S., producers could face devastating losses due to the imposition of trade restrictions by foreign partners.

APHIS has aggressive emergency protocols in place to tackle pests and disease and it works with partners and affected states to quickly manage and eradicate outbreaks as soon as they are detected.

To promote the health of U.S. agriculture in the international arena, APHIS also develops and promotes science-based standards with trading partners to ensure America's agricultural exports, which are worth more than $50 billion a year, are protected from unjustified restrictions.

Under the Plant Pest and Disease Management and Disaster Prevention Programme, the APHIS distributes funding to individual states to expand or enhance pest surveys, identification, inspection, mitigation and risk analysis, as well as public education and outreach.

Since 2009, the USDA has provided around $293.5 million and supported more than 2,340 projects under the Plant Protection Act.

"To promote the health of U.S. agriculture in the international arena, APHIS also develops and promotes science-based standards with trading partners to ensure America's agricultural exports, which are worth more than $50 billion a year, are protected from unjustified restrictions."

Collectively, these projects allow the USDA and its partners to quickly detect and respond to invasive pests and diseases while maintaining the infrastructure necessary to ensure that disease-free, certified planting materials are available to speciality crop producers.

In the 2019 financial year, the USDA is providing $66 million to 407 projects in 49 states, as well as Guam, Puerto Rico and the Northern Mariana Islands.

Image: © Duy Do | Dreamstime.com

The largest single allocation will see $16 million go to California to support projects covering a range of plant health and pest mitigation activities.

This includes $5 million to survey for harmful exotic fruit fly populations in the state, along with $3.5 million to support the activities of detector dog teams in searching for harmful, exotic plant pests in packages at mail and express parcel delivery facilities.

Another $2.2 million will support the National Clean Plant Network (NCPN) foundation plant stocks for citrus, grapes, fruit trees, sweet potato and roses. APHIS provides funding through the network to university and government facilities that develop, maintain and provide clean foundation stock for selected speciality crops. The programme is designed to help protect the environment and ensure the global competitiveness of speciality crop producers. In 2019, APHIS will allocate $6 million to support NCPN projects nationally.

Elsewhere, $1.7 million has been allocated to California's Emergency Plant Health Response Teams for responding to, delimiting the infestation area, and managing outbreaks of exotic plant pests.

"California is a critical partner in protecting U.S. agriculture", says USDA Under Secretary Greg Ibach.

"With this funding, California will be able to better protect its own resources and, in doing so, contribute to USDA's mission of keeping our nation's agriculture economy healthy and strong." ■

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Creating urban tree biodiversity within a uniform street tree landscape

Dr Nina Bassuk, Professor at the Urban Horticulture Institute, School of Integrative Plant Science, explains creating urban tree biodiversity within a uniform street tree landscape

Street tree landscapes typically consist of uniform rows of a single species, generally selected for their high branch clearance from the ground, attractive appearance and high tolerance to urban stresses. However, the desire for uniformity, which can be seen in countries all over the world, has created a conflict between the cultural preference for visual uniformity and the practical need for species diversity.

Most cities exhibit a low species diversity when it comes to urban trees. This may be caused by historical convention combined with the assumption that only a few species would adhere to cultural and design norms. However, the over-planting of a limited number of species called monocultures, have brought about the decline of formerly common and numerous types of tree. When a few trees dominate, their diseases and insect pests can proliferate causing tree decline.

Elms, chestnuts, and ash trees have been decimated by the proliferation of insects (emerald ash borer) and diseases (Dutch elm disease, Chestnut Blight). It is clear that design objectives must be balanced against the practical need for species diversity in street tree plantings.

Current strategies

Faced with the difficulty of balancing aesthetic and ecological concerns, current designers all too often short-change or even abandon one or the other objective-genetic diversity or visual uniformity. Where they may have once planted an entire neighbourhood with the same species, those favouring uniformity over practicality might now plant a single species for one or two blocks of a given street. Although this sort of compromise may feel like a bow to diversity, it isn't a true solution to the problem. Planting trees in somewhat smaller 'same species' blocks will not necessarily prevent the kinds of devastation associated with monocultures on a block by block basis, particularly if the species selected have already been heavily planted in the community.

For those favouring an ecologically sensible approach, the alternative to monocultures is sometimes to plant wonderfully diverse selections of trees that share no common characteristics whatsoever. The results of such efforts can be aesthetically disappointing and in a number of cases have led to public outcry.

Unfortunately, this type of plant selection has served to fuel the idea that the only way to achieve uniformity in design is through the exclusive use of one species.

The case for visual uniformity

So, what makes uniform plantings so appealing in the first place? What makes them so difficult to give up? The advantages to uniformity are primarily aesthetic and have a long-standing tradition over many centuries internationally. A street lined with rows of more or less identical trees brings to most observers a sense of order and tranquillity, even the domination of nature. In the most heterogeneous of neighbourhoods, a uniform row of trees can have a cohesive influence, tying together diverse elements and creating a sense of neighbourhood identity. Street trees can also soften the potentially jarring transitions from residential to commercial areas.

Moreover, marching rows of identical trees have been used as a symbol of power by military commanders as they marched their armies down those uniformly designed streets.

The case for species diversity

Unfortunately, the appeal of same species plantings is ultimately outweighed by its disadvantages. Even if aesthetics were the only consideration, the fact that unhealthy or dying trees are unattractive makes the need to diversify unavoidably.

Another factor that makes monocultures impractical is the tremendous diversity inherent in the urban environment. The challenges and stresses for trees can change dramatically within very small distances, often making it impossible for a single species to thrive uniformly throughout a given area. Variables, such as light, reflected tem-

Three species on a street creating a uniform appearance while increasing genetic diversity

American Elms in a monoculture before Dutch elm disease (DED)

After Dutch elm disease (DED) killed all the Elms

perature, drainage, soil compaction, limited rooting space, soil pH, availability of water, exposure to salt, and restrictions to crown development can vary tremendously even from one tree space to the next. A careful assessment of site conditions prior to plant selection rarely points to the selection of a single species. Even those who are aware of this fact often make the mistake of selecting one species that will purportedly survive under any and all difficult conditions. Such widely adaptable species dominate the aforementioned list of overplanted trees that have suffered decline, become unmanageable, or both.

A solution

To avoid similar problems in the future, it is clear that uniform plantings of a limited number of species must be avoided. But, is it possible to gain the practical advantages of diversity without giving up the aesthetic desire for uniformity? Fortunately, the answer is yes. Through the careful selection and grouping of plants, communities of trees can be created which, despite their genetic diversity can satisfy our desire for visual uniformity.

By breaking down the visual characteristics that distinguish one species from another into basic categories, we have selected a set of five criteria for putting genetically diverse species into aesthetically compatible groups. The first criteria concerns height to first branch. The distance from the ground to the first branches of the tree canopy creates the visual and physical envelope that we view or walk under. By keeping this space equal between trees, the walking or viewing experience appears alike between trees. The second and third criteria are tree size and shape. Nothing will create a uniform appearance less than a large tree planted next to a small tree or a narrow tree planted next to a broad spreading tree.

> "Unfortunately, the appeal of same species plantings is ultimately outweighed by its disadvantages. Even if aesthetics were the only consideration, the fact that unhealthy or dying trees are unattractive makes the need to diversify unavoidably."

The other two criteria of less importance are branching density and foliage texture. They are given secondary consideration because they generally are not as obvious to the casual observer and can even become difficult to distinguish as the distance from the observer increases. By using these criteria, it is possible to have greater biodiversity in our cities while acknowledging the desire for visual uniformity.

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Fighting climate change and embracing renewables

Fighting climate change is no longer an expensive hobby for the rich. Rather, embracing renewables will make everybody richer, says the Danish Minister for Energy, Utilities and Climate, Lars Christian Lilleholt

In 2015, the vast majority of countries adopted the Paris Agreement on climate change. In essence, we promised to limit greenhouse gas emissions to a level, which will hinder temperature increases of no more than 2 degrees above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius this century.

Critics keep ridiculing the Paris objectives as unachievable and disastrous for the global economy while pointing at ever-rising greenhouse gas emissions globally. Nonetheless, the Danish Government remains optimistic. A united Parliament last year adopted a target of zero-net emissions by 2050. We are not dreaming: our optimism is based on 30 years of active and successful energy and climate policies.

Denmark has reduced greenhouse gas emissions by around 27% from 1990 till 2017, and we expect to have decreased our emissions by approximately 45% by 2030. Still, the Danish economy is flourishing – partly because our policies have nurtured globally leading green energy industries.

Intermittent wind and solar power already cover more than 40% of Danish electricity consumption – notably without sacrificing energy security or affordability: the Danish electricity system is one of the most reliable in Europe – not least due to strong interconnections with our neighbouring countries. The World Energy Council has repeatedly ranked Danish energy security number one in the world. On top of that, Danish electricity prices excluding taxes remain among the lowest in the European Union (EU).

This is good news and not only for Denmark: renewable electricity production stands to conquer the rest of the world due to simple economics. Prices of renewable electricity have tumbled to a level where they can compete with new fossil-based electricity in large parts of the world and the cost-trend of renewables continues steeply downwards. Increasingly, renewables can also compete with existing fossil capacity with capital costs already written-off. A recent bidding round in Denmark for new renewable electricity capacity reduced subsidies needed to less than one-third of a euro-cent pr. kWh. Renewables are sound economics, which will both help save the global climate and make most countries richer and cleaner.

> "Electric cars are now in a rather mature state with costs dropping and range increasing. Hence, the time has come for states to help scale up markets. The Danish Government has decided that no new traditional petrol and diesel cars will be registered in Denmark from 2030."

Yet, there is no time for complacency: five major research institutes have just confirmed 2018 as the fourth warmest year on earth since 1880. 18 of the 19 hottest years since 1880 have taken place since 2001. After stabilising for a few years, global greenhouse gas emissions have started growing again.

Granted that renewables can minimise energy sector emissions, we still have to tackle two difficult sectors with large and increasing greenhouse gas emissions: transport and agriculture. For both sectors, low-emission alternatives still seem either costly or even non-proven.

The cost of renewables has only got down through many years of dedicated and often costly energy and climate policies undertaken by a relatively small number of countries. We must try to copy the most successful policy interventions to ensure similar cost

Lars Christian Lilleholt

reductions for low-emission alternatives in transport and food production.

A few general lessons may be distilled: ground-breaking inventions in most cases come from targeted research programmes financed by governments. When new technologies have matured it has been key to create sufficient markets to attract a number of producers. If governments foster competition, intense learning and cost-cutting will usually follow.

Electric cars are now in a rather mature state with costs dropping and range increasing. Hence, the time has come for states to help scale up markets. The Danish Government has decided that no new traditional petrol and diesel cars will be registered in Denmark from 2030. Already by 2025, new urban buses and from 2030 all urban buses must be zero-emission. Upfront, these targets definitely seem costly. But we are confident that the robust demand for zero-emission cars and buses will bring down costs significantly. The Danish market is way too small to guarantee success, but by joining similar efforts by other climate ambitious states we will succeed. Accordingly, Denmark is advocating similar targets to be adopted by the EU. This would definitely accelerate technology development and cost-cutting – while helping both the global climate and European air-quality.

At present, agriculture causes up to 25% of global greenhouse gas emissions and bringing that down poses major challenges. The main emission-driver is meat consumption, which tends to go up along with higher global incomes and population. Copying rich-world meat consumption for all could put a heavy strain on global land resources. So far – few low-emission alternatives seem at hand – except for the vegetarian diets now being abandoned by consumers in emerging economies.

> "Intermittent wind and solar power already cover more than 40% of Danish electricity consumption – notably without sacrificing energy security or affordability: The Danish electricity system is one of the most reliable in Europe – not least due to strong interconnections with our neighbouring countries."

But we have to face up to the task. Basic research in low-emission food technologies have been wanting and commercial R&D all but absent. The Danish Government is now trying to rectify this with a new, dedicated food-climate-change research programme. Others must follow suit. If so, human ingenuity eventually will provide good solutions.

In conclusion, present greenhouse gas emission trends are definitely of concern. 30 years ago, CO_2 emissions from energy were the climate problem. But sustained efforts over many years have now delivered low-cost renewables, which will eliminate emissions from the energy sector. Affordable zero-emission technologies are forthcoming for a major part of transport emissions. Emissions from food-production remain a major challenge but definitely not an insurmountable one. ■

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Electricity from renewable sources must be stored efficiently

Anke Hagen, Dr.rer.nat, Dr.tec., Professor at DTU Energy explains why it is important that electricity from renewable sources is stored efficiently and why such capacity is needed in the long-term

The installation of wind turbines and photovoltaics are advancing rapidly in Europe today, realising more and more the large potential for electricity production without the emission of pollutants. This increase in production capacity is needed in the long-term to substitute electricity production from fossil sources, which is on the political agenda worldwide. On one hand, the production profile from wind and solar is fluctuating by nature. The consumption profile, on the other hand, follows a predictable pattern. The result is often a mismatch between electricity production and consumption, which must be balanced. Therefore, efficient, cost competitive, large-scale storage and distribution solutions are needed.

Electrolysis technologies

One attractive concept is electrolysis, which uses electricity to produce a storable and distributable gas. Among the electrolysis technologies currently available, solid oxide electrolysis (SOEC) stands out with some particularly attractive features, including:

- The electrolysis process has an exceptionally high efficiency rate approaching 100% and;
- The co-electrolysis of steam, together with CO_2 is possible, which yields a synthesis gas mixture, which, in turn, can be converted into a large variety of gaseous or liquid products.

The concept of electrolysis has gained an increasing amount of attention and is known by the term power-to-x (x being gas, liquids, fuels or chemicals). The interesting benefit, not only from an economic point of view, is that electricity from renewable sources is, therefore, introduced into other sectors such as in the transport and chemical industries, as well in large-scale energy storage.

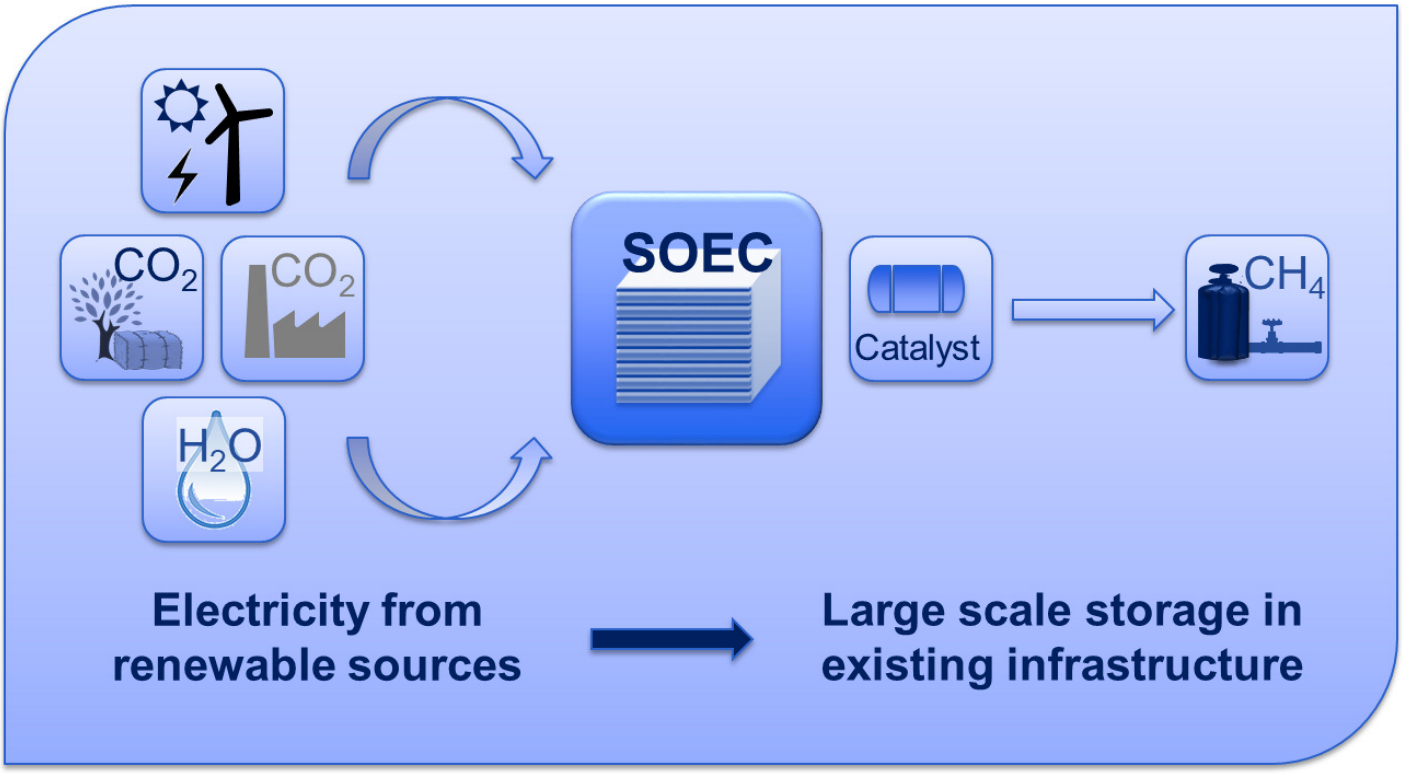
SOEC is the youngest of the electrolysis technologies, its costs are too high currently and must be reduced. This can be realised through the improvement of the performance of SOEC units and by an increase in the lifetime of the technology. These are two of the main goals of the European project, ECo (Efficient Co-Electrolyser for Efficient Renewable Energy Storage, grant number: 699892). The concept of the ECo project aims to combine electricity and existing gas infrastructure through high-temperature electrolysis to store and distribute green electricity efficiently, and at a large-scale.

The project considers fluctuating electricity input, steam, and CO_2 from industrial sources or biogas entering the SOEC. A better understanding has been gained about how SOECs behave under such conditions initially and during long-term operation. Improved SOECs were developed, which allow the operation to take place at a lower temperature of 100 degrees, compared to a state-of-the-art approach without a loss of performance. This achievement can be directly translated into an actual cost reduction because cheaper materials can be used for the system components and SOEC degradation is expected to slow down. The most recent SOEC version from the ECo project integrates the expertise of three European partners into the same SOEC and is, therefore, a resounding success due to the close European collaboration involved.

Anke Hagen, Dr.rer.nat, Dr.tec., Professor

Image: © Joachim Rode

The SOEC process involves a mixture of hydrogen and carbon monoxide – known as synthesis gas. This synthesis gas can be converted into methane through established catalytic converters. If the SOEC is operated at elevated pressures, as also investigated in the



ECo project, methane can even be formed directly in the SOEC unit, which decreases the system costs even further.

Combining green electricity, SOEC and e-gas production

Methane is a synthetic natural gas or e-gas if formed by using renewable sources. The benefit of producing methane is, that even today, a huge infrastructure exists that can both store and distribute energy with only small losses taking place over large distances, which is much smaller in contrast to long-distance power lines. In fact, today's European natural gas infrastructure is capable of storing energy corresponding to 50% of the electricity produced from renewable sources. The use of this infrastructure saves the need for costly investments where the storage and distribution of green electricity are concerned.

Apart from technology research, the ECo project also investigates environmental opportunities for combining green electricity, SOEC and e-gas production. It is clear that any new technology must provide benefits in the long-term. For this analysis, specific and realistic application cases were both identified and analysed. One of the input media is CO_2. The cement industry and biogas were considered as sources for CO_2 – also in a potential future fossil-free energy system. Interestingly, various benefits can be achieved using the co-SOEC approach. It allows, for example, savings of fossil fuel input in a cement plant. Furthermore, integrating co-SOEC in a biomass gasification plant, an increase in the production of synthetic natural gas is achieved.

Certainly, the electricity input is one of the major factors for the SOEC. As such, the electricity mix at a specific location has a large impact on the potential reduction of CO_2 emissions through the SOEC concept as pursued in the ECo project. This potential is already present today in specific places, such as in countries with a high share of electricity production from renewable sources and it will increase even more in the future, with more green electricity installed.

For more information, please visit: http://www.eco-soec-project.eu

This is a project sponsored by the European Commission

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A view on the revised Energy Efficiency Directive

The revised Energy Efficiency Directive is placed under the spotlight here by Miroslav Poche MEP from the Group of the Progressive Alliance of Socialists and Democrats in the European Parliament

The adoption of the revised Energy Efficiency Directive (EED) is an important step to embrace the clean energy transition and the already adopted 2030 climate legislation to meet the Paris Agreement commitments. The adoption of the Directive is, however, only the beginning of the journey. Many implementation questions will remain to be solved when a new European Parliament and a new European Commission come in July and November 2019, respectively.

The next Commission will face two major challenges when it comes to energy policy. First, the Commission will have to actively enforce proper implementation of the EED and, of course, other key files of the Clean Energy for All Europeans package. Second, the Commission will have to take active steps to realise this ambitious goal.

The transposition into national law will be the first test of the Member States' seriousness about the energy transition and turning their commitments under the Paris Agreement into concrete actions. Unfortunately, the implementation process of the 2012 Directive showed that the promises were not always followed by the action, which resulted in 27 Member States being hit by infringement procedures due to failure to notify the Commission regarding the national measures to transpose the Directive into national law were launched.[1]

This, of course, raises the question of how to ensure that the Member States deliver on their targets. The Governance Regulation is supposed to be the answer to this problem, a vital instrument for achieving the overall objectives of the Energy Union and the EU targets. However, this can only be achieved if there is understanding, cooperation and action at all levels, such as consumers, SMEs, industries, corporations, local authorities or national governments. Collective and fair action by all is the only way to achieve ambitious action on climate change. What we now need is proper implementation and enforcement as we need the Member States to fulfil their targets and promises.

Over the coming years, the next Commission is very likely to propose new policies to assure that Europe is on track towards reaching its 2030 energy and climate targets and potentially, this ambition will be raised. I strongly believe that the Commission should further focus on strengthening the European emissions trading scheme (ETS). The results of the ETS reforms have not met our expectations despite the boost from recent reforms. Low carbon prices and the fact that parallel policies, such as energy efficiency, RES support, nuclear support, coal phaseouts reduce the prospects for a sufficient carbon price, only prove that the current ETS lacks efficiency.

The EU ETS price is clearly insufficient in the short-term as it does not provide a strong and credible enough signal for decarbonisation in the medium to long-term. One solution to this might be to introduce a carbon floor price on emissions. This mechanism would protect investors against sudden ETS price drops, encourage businesses to make more low-carbon investments and speed up the transition to a low-carbon economy. For inspiration, since April 2013, British electricity generation has already been subject to a minimum carbon price and the Dutch government is planning to introduce a similar price floor, beginning at €18 in 2020 and rising to €43 by 2030.

In relation to my work on the revision of the EED, I was also entrusted to become a rapporteur for the proposal on a decision of the European Parliament and the

Miroslav Poche MEP

Image: © Diana Cernakova

Council on the adjustment of European energy efficiency targets. The proposal is, in general, a technical proposal designed to recalculate the value of European commitments in the field of energy savings. The final agreement with the Council states that a reduction in energy consumption by 32.5% should be achieved by 2030 at the level of primary and/or final energy consumption which means that the consumption of the European twenty-eight should not exceed 1273 Mtoe in primary energy and 956 Mtoe in final energy in 2030. The expected UK consumption projection will have to be subtracted from this number. After having done so, the numbers are now converted to 1128 Mtoe at primary and 846 Mtoe for final energy consumption for 27 EU countries. The proposals that I suggested were of a technical nature. It was important to clarify that both primary and final consumption have their own target numbers. We also had to shorten the suggested provision regarding the entry into force of the legislation. However, I must highlight that there has been a very constructive approach from all the shadow rapporteurs, as well as from the Council, and it has been obvious that nobody wishes to create new problems in the very complex Brexit-related environment we have to face. The plenary has adopted the text in February. Speaking of Brexit itself, I wish this EED file never came into force. ■

1 http://europa.eu/rapid/press-release_IP-15-4668_en.htm

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Health, environment and economy: Sustainable food production at FoodParks

Håkan Sandin, Horticulturist at Swedish University of Agriculture explains sustainable food production and why the three areas of health, environment and economy are crucial in this vein

The inseparable triple combination of health, environment and economy is the basis for all development work and creates lasting sustainable food production. This also applies when we build a completely new food industry. Our task is not to close our eyes to any difficulties and be scared by the power structures that destroy our health, environment and economy. We have to build and create sustainable, mutualistic and circular solutions that can last for thousands of years.

> "These industrial areas we call FoodParks. Where we can produce very large amounts of food in small areas, e.g. 20,000 tonnes of fish and 40,000 tonnes of vegetables on a couple of hectares."

We must, therefore, challenge the political power structures and the commercial corporate power that both allow the production and sale of harmful food in our world. We have a responsibility to ourselves as the human race and to the world, to develop food supply systems that are based on new science. We have to stop talking about what we always have done, referring to proven experience. Proven experience destroys our health, our environment and our economy.

Bacteria in human bodies

Let me explain again and again. It starts with 40 billion bacteria that all humans have in their stomach and intestinal system. Humans have 1.5 kg of bacteria, if we feed them correctly, good bacteria, an internal organ that we have ignored for so long time.

The human race shook hands with these individuals may be 10 million years ago. The contract states that these bacteria receive protection, warmth and food under one single condition, namely that they keep us healthy.

This contract has worked for millions of years. Something has however gone extremely wrong in recent years. We have a complete explosion of lifestyle diseases that modern health care cannot handle. One of the reasons is that we give the wrong food to these bacteria. This is what the latest research says, which is documented through around two new scientific papers a day and historically through 1000's of papers over the past five years. So what is wrong with the food we feed the bacteria? What kind of food should we feed them?

Human food

If you are asked: What kind of food should humans eat? What is your answer? The answer is in one way very simple. We will, of course, eat what gives us a long and healthy life without any diseases and economic problems. And what if that is so? Then again, we have to ask ourselves what kind of food is it? Is it meat, vegetables, insects, bread or sugar-containing beverages? We have to answer these questions!

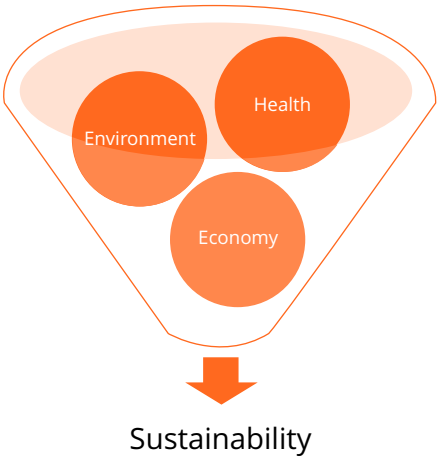

Figure 1: The links between health, environment and economy are very strong

The science tells us that we have abused our contract with the bacteria and made them our enemies. If we eat the wrong food, they eat on our internal organs, create leakage and send out toxic substances in our bodies. We get serious illnesses like severe depression, diabetes, attention deficit hyperactivity disorder (ADHD), osteoarthritis and many other diseases. In many parts of the world, mankind knows this off by heart and by tradition. But our western power structures and influential international companies maintain a production infrastructure that is harmful to our health, our environment and our economy on a big scale and in a small scale. This means that what you eat as an individual makes an impact on the world environment and economy. The

If you eat harmful food

- Nasty bacteria infect the stomach and intestinal system.
- They cause leakage and spread in the body.
- Cytokines are released.
- They cause inflammation.
- The brain is negatively affected.
- Hormones that make us feel good are inhibited.
- We become depressed and ill.

Red colour illustrates a bad situation

If you eat healthy

This negative process can be reversed in a few months through feeding the good bacteria with food that they thrive from, creating a healthy intestinal flora of bacteria.

Green colour represents a good situation

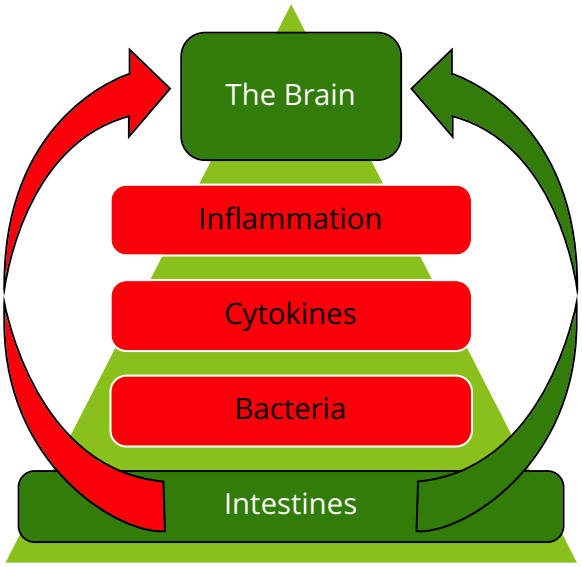

Figure 2: You can live a healthy life, starting to eat the right food now

question is how can we reverse this trend and how can we get the international power structures and the big strong international companies to create sustainable development, based on new science?

Scientifically based competition

Is it possible to make people healthier? In one way, the answer is very simple. We must re-establish the contract with our bacteria, that is, learn to eat what makes our stomach and intestinal bacteria happy.

Also, we have to expose the current order to competition. We must remove the harmful food from the shelves, not by force but through scientifically based competition, simply because they destroy our health, our environment and our economy.

The links between health, environment and economy

How do we link our work together to begin this development? It is important that we start looking at the connections between health, the environment and the economy. Each one of us understand that these relationships are very strong, but we need to describe them from a scientific perspective. As we understand these relationships in a scientific way, we can also begin to build a new future.

In Sweden, we have started this work by creating a completely new industry of fish and vegetables in house, which takes advantage of leftover resources in our society. Fish and vegetables are also the foods that science says are the healthiest for humans. We can build this industry without burdening the environment or seizing more arable land.

These industrial areas we call Foodparks, where we can produce very large amounts of food in small areas, e.g. 20,000 tonnes of fish and 40,000 tonnes of vegetables on a couple of hectares. In these industrial parks, we have full control of everything that we put in, all the flows in the park and everything that leaves the park.

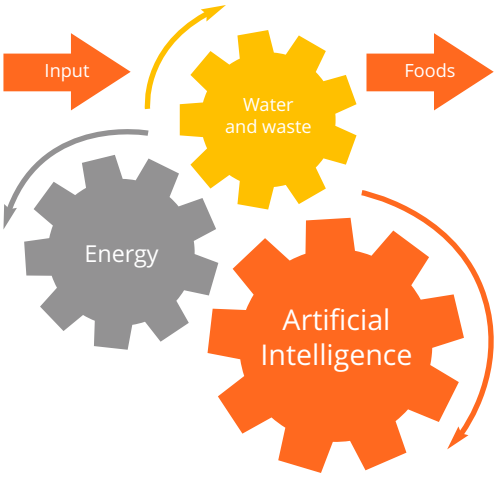

Figure 3: FoodParks produce healthy foods, water and energy. We need a lot of energy, water and artificial intelligence

SSEC SWEDISH SURPLUS ENERGY COLLABORATION

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Multi-utility networks: The Scottish perspective

Lesley Campbell, Commercial Director at GTC Scotland explores multi-utility networks, including broadband, from the Scottish perspective

Scotland is part of the UK but has a devolved government. This means that the house building industry operates in a different environment to the rest of the UK and as such, it is essential that any utility provider understands the different challenges.

GTC is the UK's largest independent provider of utility networks and infrastructure to the new-build market. It has a wealth of experience across all six utilities, serving over 1.5 million homes and working with all the leading housebuilders across England, Scotland and Wales.

GTC is providing ultrafast fibre broadband to homes in the new town of Tornagrain

In 2016, GTC opened a Scottish office to ensure it was well placed to understand the different needs and demands of the Scottish construction industry, and the requirement for detailed knowledge and understanding of the building regulations and policies determined by the Scottish Government.

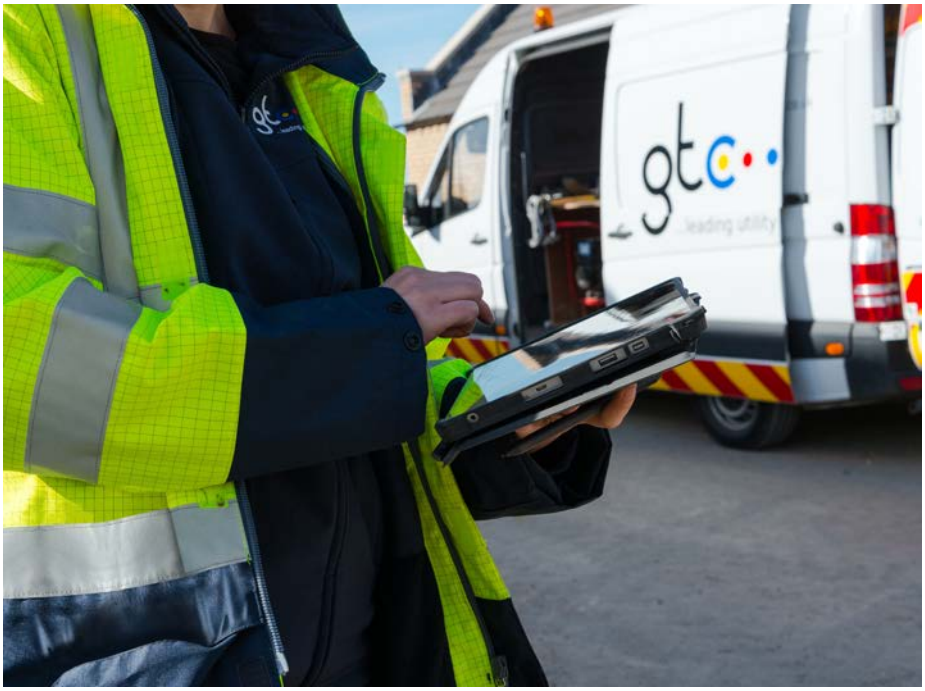
Taking a multi-utility approach

GTC Scotland has developed innovative ways of working to deliver multi-utility networks.

Scottish housebuilders have long recognised the benefits of adopting a multi-utility approach to the procurement and installation of connections for new homes. Sourcing all the utilities needed for sites from a single network provider saves time in the procurement phase by avoiding the need to negotiate with multiple companies to achieve the best deal. The alternative, piecemeal, approach can have implications for the construction phase with schedule clashes, repeated groundworks, and ducting either not laid or crushed by later installations, being among the common problems. In contrast, synchronising the installation of utilities enables the programme to be directly aligned to the developer's construction schedule. Where a developer needs only deal with one project manager, who co-ordinates and schedules everything, there are clear efficiency and cost-saving gains.

Having an overview of all the trenching and ducting onsite also offers opportunities to identify better methods of installation. GTC Scotland, for example, undertakes all the trenching for water, gas and electricity at one time with all the installation work carried out by its own in-house teams of engineers. The company has also been pioneering a new method of installing fibre networks with much of the construction work now being completed by GTC directly. This removes the need for the housebuilder to lay the duct and chamber network and, therefore, significantly reduces their cost of installation.

GTC Scotland has taken this multi-utility approach one step further with the introduction of full turnkey plot connections teams. Experienced and highly knowledgeable, the teams undertake all the utility connections to



One project manager to co-ordinate and schedule all the utility installations

new homes in just one visit for faster and more efficient electricity, gas and water connections. GTC's UltraStream 360 Fibre-to-the-Home broadband networks will be added to the services connected by these multi-utility plot teams in early 2019.

Agile response

Recognising housebuilders' need for flexibility and certainty regarding new service connections, GTC Scotland has introduced a 5-day Call Off Initiative for service connections. GTC now only accepts requests for these service connections a maximum of five days in advance but in return, guarantees to complete orders within those five days. This approach gives housebuilders confidence over lead-times, allowing the maximum flexibility for orders to be placed as they are needed.

In a further development, GTC will soon be undertaking the final connections to Scottish Power and SSE Networks (both low voltage and high voltage) with no need for third-party involvement. This, again, streamlines the connections process, keeping as much as possible under the control of the GTC team. In a similar way, the primary site connections to the Scottish Water Mains Network will follow. This will put GTC in full control of delivering the utility infrastructure to new sites, removing any need to wait for the incumbent utility company to make the critical connection of the site network to their grid.

Meeting the demand for ultrafast fibre broadband

The provision of fibre broadband to new homes is the utility that is undergoing the most rapid change. Consumer demand is growing exponentially, with homebuyers looking for ever-increasing capacity and speed and the opportunity to choose the broadband package that is right for them. GTC's ultrafast fibre broadband networks enable Scottish housebuilders to meet these expectations. GTC's Fibre-to-the-Home (FTTH) networks deliver 360Mbps and are future-ready, with fibre all the way into each property, capable of speeds up to 1 Gbps. The networks are open access, offering a choice of ISPs so that the homeowner can choose the speed and package that meets their needs and fits their budget and the services – data, voice, TV, and SKY TV – that they require. GTC Scotland is already installing fibre to thousands of new homes across Scotland including 4,000 homes in the new town of Tornagrain and has a further five projects in progress. Importantly, homeowners will find the fibre connection, along with their other utilities, ready from the day they move in.

New homes for Scotland

The demand for new homes in Scotland shows no sign of reducing. With so much pressure to deliver new housing, housebuilders and developers need to have confidence in their utility supply chain. GTC, with its expertise and understanding of the Scottish housebuilding environment, is already delivering connections to thousands of new homes.

gtc ...leading utility networks

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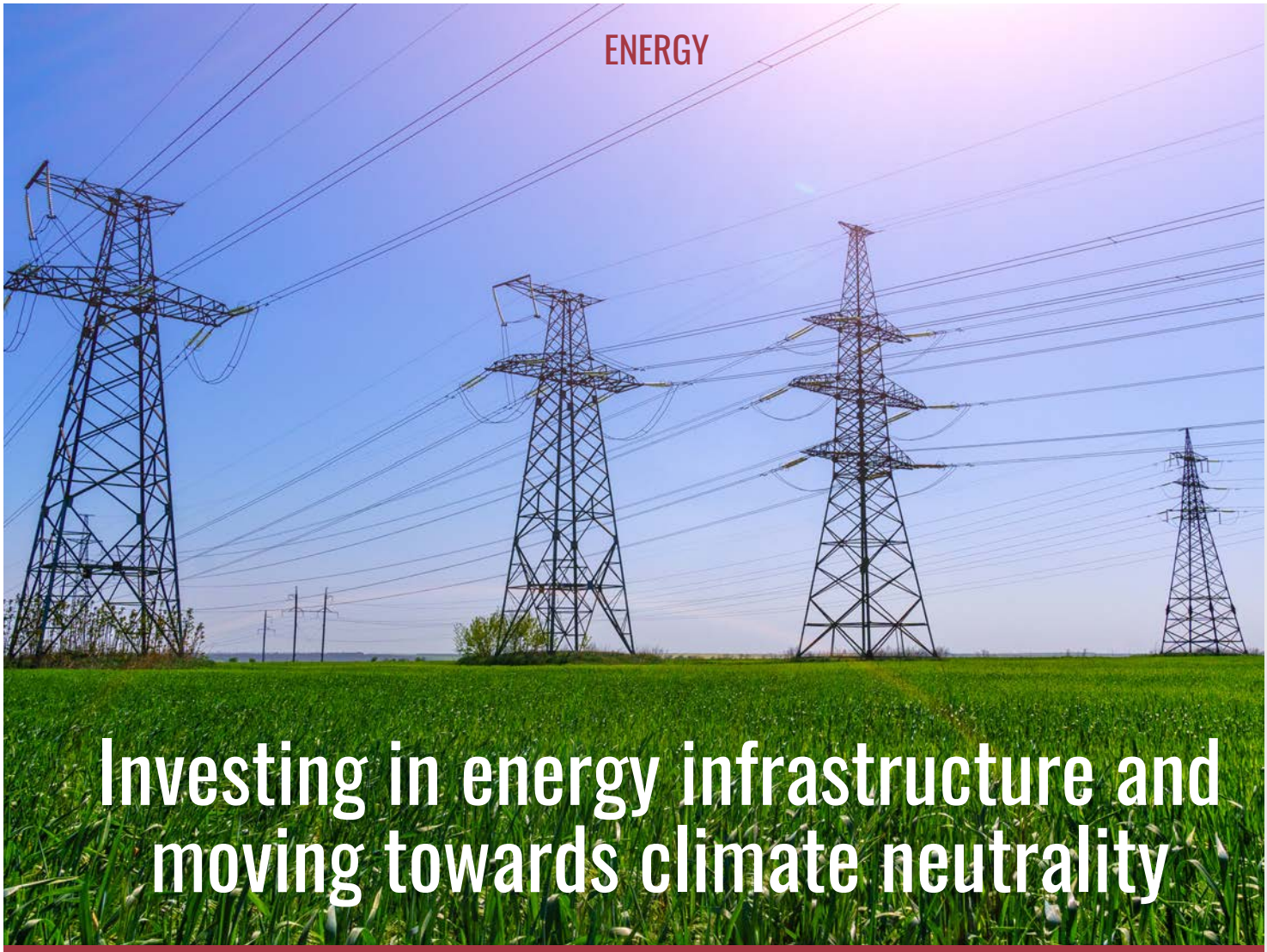

Investing in energy infrastructure and moving towards climate neutrality

Two key priorities of Maroš Šefčovič, Vice-President, Energy Union at European Commission are detailed here, including investing in energy infrastructure and moving towards climate neutrality

The responsibilities of Maroš Šefčovič, Vice-President, Energy Union at European Commission include establishing a European Energy Union and helping to mobilise further investment in renewable energy installations, power grids and other energy infrastructure. Coordinating the European Commission's endeavours to make sure the European Union (EU) reaches its climate and energy targets in the future is another. (1)

In January 2019, we find out that the EU is investing an additional €800 million in priority energy infrastructure with major cross-border benefits. The funding comes from the European support programme for trans-European infrastructure, Connecting Europe Facility (CEF) that includes €504 million allocated to electricity and smart grids, €9.3 million for studies on CO_2 transport infrastructure, and €286 for the gas sector.

Projects that enhance the EU's security of energy supply through the promotion of secure, safe, and efficient network operation, and contribute to environmental protection and sustainable development are given priority. One of these is the Baltic electricity synchronisation project in the electricity sector which has been awarded a €323 million grant. The creation of a connected, modern energy grid is a fundamental part of the Energy Union and one of the political priorities of the Juncker Commission.

Commission Vice-President in charge of the Energy Union, Maroš Šefčovič affirms: "CEF is one of those instruments that prove the EU's added value. Today's approved list showcases that Energy Union is an efficient tool to modernise and green our economies, to make them future proof in line with climate and environmental goals." (2)

The European Commission's long-term vision for a competitive, prosperous, modern, and climate neutral economy by 2050 is entitled, A Clean Planet for all. In essence, this points the way to Europe leading the way

Maroš Šefčovič, Vice-President, Energy Union

Image: © European Union , 2019. Source: EC - Audiovisual Service. Photo: Lukasz Kobus

when it comes to climate neutrality. This includes investing in realistic technological solutions, empowering citizens and aligning action in key areas like industrial policy or research.

While there are many steps ahead, let's leave the last word to Vice-President, Šefčovič who comments on this forward-looking aspect of policy that delivers on one of his key priorities concerning climate mentioned at the start of this article.

"We cannot safely live on a planet with the climate that is out of control. But that does not mean that to reduce emissions, we should sacrifice the livelihoods of Europeans. Over the last years, we have shown how to reduce emissions, while creating prosperity, high-quality local jobs, and improving people's quality of life. Europe will inevitably continue to transform. Our strategy now shows that by 2050, it is realistic to make Europe both climate neutral and prosperous, while leaving no European and no region behind." [3] ■

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Waste thermal energy recovery and conversion

Professor Savvas Tassou, Brunel University London, discusses how waste thermal energy recovery and conversion to electrical energy can contribute to the decarbonisation of energy intensive industries

The potential of waste heat recovery and its conversion to useful energy is universally recognised. However, there are technical, economic and management challenges that need to be addressed for this potential to be realised. This article presents some of these challenges and research undertaken by the I-ThERM project to address both high and low-temperature waste heat recovery and conversion challenges. The work is funded by the H2020 programme of the European Union (EU) and UKRI's (UK Research and Innovation) Programme.

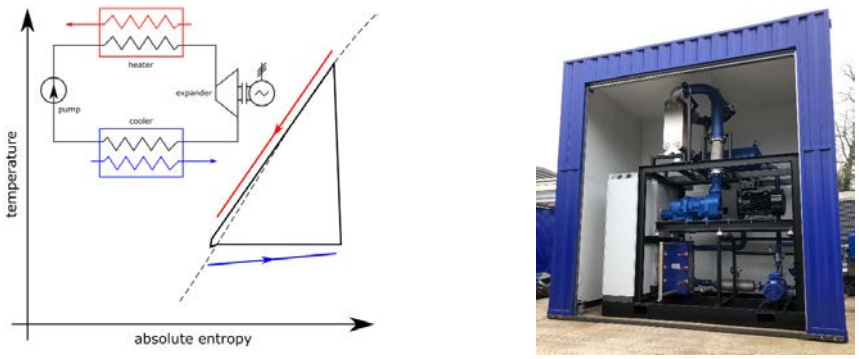

Figure 1. Schematic diagram of the TFC cycle and demonstration system under development

Industry in the EU28 is responsible for approximately 25% of final energy use with almost three-quarters of this energy consumed by heating and cooling processes. Gas and electricity are the most dominant forms of energy in industry with gas being combusted in boilers and furnaces to provide direct heating to processes or indirect heating through the production of steam or hot water for space and process heating.

During the last fifteen years, the EU's industrial energy consumption fell by 17% and the energy intensity (energy consumed per unit of production) by 25%. This is due to the implementation of low-cost energy efficiency measures with the potential for returns on investment of less than two years. Despite the progress achieved to-date, significantly more research effort is required for the development and implementation of new technologies and processes to meet the EU's Greenhouse Gas Emission (GHG) reduction targets to 2050.

Combustion-based heat production processes in industry generate significant quantities of waste heat which can range from 30% to 50% of the energy input to the process. Depending on the process this heat is at different temperatures which can be classified as low, medium or high. This heat can be recovered and used directly within the process or industrial site, exported to neighbouring sites, upgraded to higher temperatures, or converted to other forms of energy such as high value electricity.

The potential of heat recovery in providing substantial energy savings in industry is now well recognised but to realise this potential there are a number of barriers to be overcome. These include: i) insufficient information on performance to provide confidence in the technology before it is implemented, ii) high initial and maintenance costs, iii) lack of infrastructure and space for the installation; iv) production constraints and risk of disruptions and v) lack of financial support and other governmental incentives.

Objectives of the H2020 funded I-ThERM project

To address some of the challenges and barriers to the application of heat recovery technologies, the I-ThERM (Industrial thermal energy recovery, conversion and management) project, aims to investigate, design, build and demonstrate innovative plug and play waste heat recovery and conversion solutions with high replicability and energy recovery potential in the temperature range 70ºC-1000ºC. The project involves 13 partners from across Europe, three large industry partners, seven small and medium companies (SMEs) and three Research and Technology Development (RTD) organisations, and is coordinated by Brunel University London. It is funded under the EC's Horizon 2020 (H2020) programme EE-18-2015 'New technologies for utilization of heat recovery in large industrial systems, considering the whole energy cycle from heat production to transformation, delivery and end-use'.

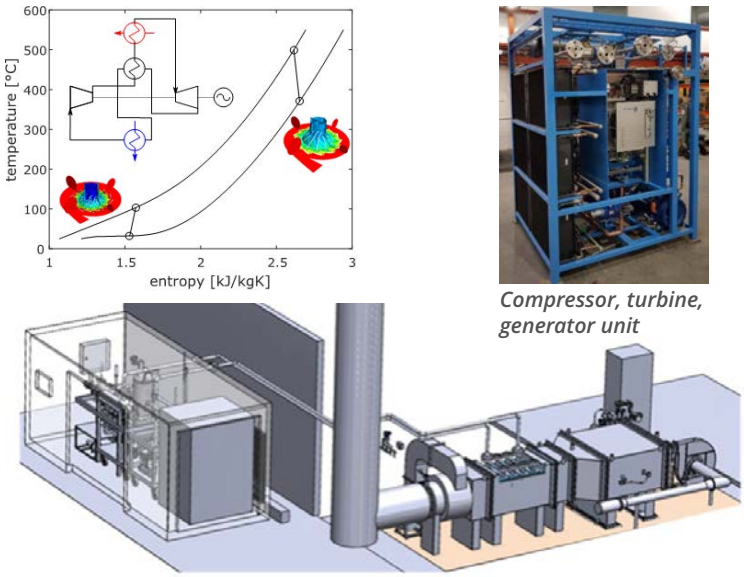

Figure 2. sCO_2 cycle and test and demonstration facility

The main objectives of the I-ThERM project are:

1. Development and demonstration of heat recovery equipment and systems in easily customisable plug and play forms based on the heat pipe technology. Two specific technologies will be developed. The Flat Heat Pipe System (FHPS) to recover heat from high-temperature radiant heat sources and the Heat Pipe Condensing Economiser (HPCE) to recover sensible and latent heat from corrosive exhausts.
2. Development and demonstration of two innovative waste heat to electrical power conversion technologies, the Trilateral Flash Cycle (TFC) technology for low-temperature (70ºC-120ºC) applications and the supercritical Carbon Dioxide Technology sCO_2 system for high-temperature (350ºC-800ºC) applications.

Progress to date

The project started in October 2015 and demonstration and evaluation of the technologies is expected to be completed by March 2020. The two heat recovery technologies have been designed and prototypes of the flat heat pipe technology have been constructed and successfully tested at the wire roll mill at Arcelor Mittal in Spain. The current focus with the heat pipe condensing economiser is on the development of coatings to protect the heat pipes against corrosion from the condensation of acidic components in the exhaust gases. Alongside this, attention is also placed on heat transfer enhancement and condensate drainage from the pipes.

The trilateral flash cycle heat to power conversion system

A significant proportion of the waste heat available from industrial processes is at low to medium temperatures. Many of these processes and industrial sites do not have the need for additional heat and so there is considerable interest to convert this heat to high-value electricity. Organic Rankine Cycles (ORCs) which are reasonably established as heat to power conversion devices have relatively low efficiencies at low-temperature applications. The TFC system being developed in the I-ThERM project aims to fill this gap. Figure 1 shows a schematic diagram of the cycle and a picture of the demonstration unit under development. The system will be installed and demonstrated at the Tata Steel manufacturing site at Port Talbot in the UK by Spirax Sarco UK.

The supercritical CO_2 heat to power conversion system

Currently, there are no packaged plug and play systems available in the market for high-temperature waste heat to power conversion. The I-ThERM project aims to develop and demonstrate such a system for the first time in the EU using the Brayton cycle and supercritical CO_2 as the working fluid. Figure 2 shows a schematic diagram of the basic cycle and the test and demonstration facility for the system. The sCO_2 system has the potential for direct heat recovery, high-temperature and pressure operation, high efficiency and very compact size. The high temperatures and pressures also present challenges in heat exchanger design, material selection, and development of the compressor-turbine-generator unit. These challenges are being addressed in the project.

Concluding remarks

The technologies being developed in the I-ThERM project are designed to address both technical and economic challenges for both low and high-temperature waste heat recovery and conversion to electrical power. Evaluation of the technologies will be performed through installation and monitoring at industrial sites for demonstration purposes. This will be followed by further development and commercial exploitation.

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2019: A key year for the legislation in the European battery industry

Upcoming legislation will turn 2019 into a key year for the European Battery Industry, argues Rene Schroeder, Executive-Director of the Association of European Automotive and Industrial Manufacturers (EUROBAT)

EUROBAT is the Association of European Automotive and Industrial Manufacturers. Its 50-plus members comprise more than 90% of the automotive and industrial battery industry in Europe. Its members operate more than 30 plants and R&I centres while generating an annual turnover of more than €6.5 billion.

With batteries high on the European political agenda and important changes of the EU institutions (European Parliament elections and a new Commission) ahead, 2019 will be an important year for the battery industry from a regulatory and policymaking perspective.

In February, EUROBAT published its "2019-2024 Election Manifesto", highlighting three core areas where new policymakers can help achieving the ambitious decarbonisation goals, while at the same time boosting Europe's economic and technical performance. These are: including all battery technologies in the equation, emphasising on Europe taking the lead in sustainable battery design and production and establishing a clear regulatory framework with no overlaps.

Europe: Sustainable battery design and production

For the first one, the policymakers have to support all battery technologies and manufacturing to facilitate the decarbonisation process of our mobility and energy systems in Europe. Batteries are and will remain crucial in the fight to combat the adverse effects of climate change and there is a clear need for a positive environment and regulatory framework that enables all electrification technologies to play a role. No single battery technology can meet all the challenges of end-user and policymakers' demands.

Specifically for the transport sector, we have to make sure that we can promote electric vehicles, as well as all forms of hybrid solutions, while further fine-tuning efficiency of the internal combustion engine (ICE). Also in the energy sector where batteries store renewable energy and discharge it when needed at every level of the gird – achieving stability and flexibility – is important but there is still some work on the regulatory front. Some barriers still exist and must be addressed in the next term in order to achieve full harmonisation of grid charges and taxation for storage across the EU.

Establishing a clear regulatory framework

As a second key regulatory area, EUROBAT highlights the need to create the best conditions for battery technologies to grow, generating jobs and skills in Europe. Indeed, Europe must take a lead in designing and building the most environmentally sustainable energy solutions and supporting the development of its battery industry. To do so, policymakers, citizens, associations and industry must work together to remove legislative and market barriers. They must instead promote the development of a favourable environment in which the European battery industry can flourish, delivering growth, room for innovation and increased employment.

The European Commission launched in 2018 the Battery Action Plan, which succeeded in breaking through silos and which we fully support, should however, include all four battery technologies, not just one. One of the industry's main concern, however, is the EU chemicals and substance policy, based on the ban or restriction-of-use of hazardous substances. This

approach poses a constant threat to investments in Europe as investors lack certainty as to the long-term possibility of using fundamental substances in the production of batteries and could place EU manufactures at a competitive disadvantage compared with companies based outside the EU who will not have to comply with this regulation.

Legislation that supports sustainable European battery value chains

Finally, the third recommendation to newly elected Members of the European Parliament and officials is to adopt legislation that supports sustainable European Battery Value chains. Indeed, our industry needs a coherent and supportive regulatory framework for sustainable batteries in line with the principles of the circular economy and wider EU decarbonisation targets. Today, there are still too many overlaps between existing regulations such as: Battery Directive, End-of-Live (ELV) Vehicles Directive and REACH. Policy decisions on the regulatory framework for batteries must also take into consideration jobs, growth and innovation. In 2019, the European Commission will continue the preparation of the legislative proposal on the EU Battery Directive. We believe it must be revised and focused on the environmental sustainability of batteries, not on the hazardous properties of substances.

While EUROBAT welcomes the work of the European Commission on the sustainability of batteries in the framework of the European Battery Alliance, the current Eco-design legislative proposal will only be efficient if well designed and in connection with other existing policy instruments, such as the Battery Directive. We believe that any instrument(s) – such as the Eco-design framework – addressing the sustainability of batteries must include indicators for CO_2 equivalent content, recyclability and socio-economic considerations (CSR, ethically responsible producers and labour requirements). This instrument, or a variety of instruments, will have to be developed coherently with the existing policy framework on batteries, including for instance the Battery Directive.

If we can address the above challenges and take advantage of the opportunities, we believe these could safeguard the EU battery industry and allow it to play its role in combatting the global and pressing problem of climate change. ■

EUROBAT

ASSOCIATION OF EUROPEAN AUTOMOTIVE AND INDUSTRIAL BATTERY MANUFACTURERS

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Safer batteries by using calorimeters

Dr Carlos Ziebert, head of IAM-AWP's Calorimeter Centre, KIT, outlines how research and testing in calorimeters paves the way for safer batteries

Established in 2011, the Calorimeter Centre at the Karlsruhe Institute of Technology's (KIT) Institute for Applied Materials – Applied Materials Physics, operates Europe's largest battery calorimeter laboratory. It provides six Accelerating Rate Calorimeters (ARCs) of different sizes – from coin to large pouch or prismatic automotive format – which allow the evaluation of thermodynamic, thermal and safety data for lithium-ion cells on material, cell and pack level under quasiadiabatic and isoperibolic environments for both normal and abuse conditions (thermal, electrical, mechanical).

Safety comes first – this is the mission of the centre's head, Dr Carlos Ziebert. A holistic safety assessment is a prerequisite for upscaling and market acceptance of battery technologies, because the thermal runaway can cause ignition or even explosion of the cell that leads to negative public attention or even rejection. With increasing energy density, the safety of Li-ion batteries is becoming more and more important. Thus, calorimetry is a fundamental technique in order to obtain quantitative data on the thermal and safety behaviour – you need to know how many watts a cell will produce under every condition. This information can then be used to adapt the battery management, thermal management and safety systems. In the ARCs the temperature, heat and internal pressure evolution can be studied, while operating cells under conditions of normal use, abuse or accidents. The battery calorimeters provide thermal stability data on materials level, eg of anodes, cathodes or electrolytes or their combinations and safety tests on cell and pack level by applying:

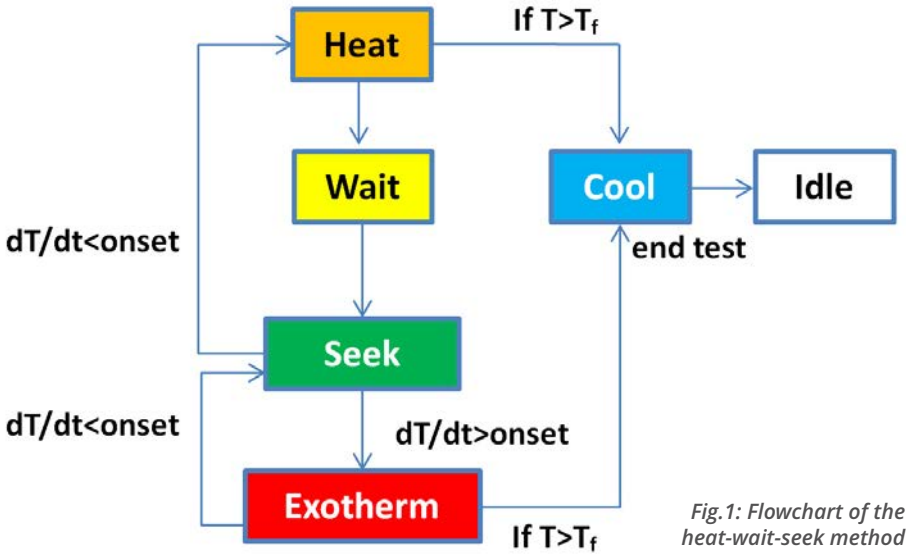

Fig.1: Flowchart of the heat-wait-seek method

a) Electrical abuse: External/ internal short circuit test, overcharge test, overdischarge test

In the ARC, the temperature increase by applying an external short circuit or during an internal short circuit, which might be caused eg by a production fault, can be measured. The cell can also be overcharged or overdischarged, leading to different failure modes.

b) Mechanical abuse: Nail test

In the ARCs, a mechanical system allows to push a nail into the cell. This provides not only a pass/fail type test to qualify cells, but also quantitative data.

c) Thermal abuse: Heat-Wait-Seek test, ramp heating test, thermal propagation test

The Heat-Wait-Seek (HWS) test starts in the Heat Mode by heating up the cell in small temperature steps (typically 5K), as shown in the schematic flowchart in Fig.1.

At the end of each step, the Wait Mode is activated to reach thermal equilibrium. Then the system enters Seek Mode, which seeks the temperature rate and ends with two possible modes: Exotherm Mode or Heat Mode. If the measured temperature rate is larger than the onset sensitivity (typically 0.02K/min), which means that self-heating of the cell is detected, the system goes into Exotherm Mode.

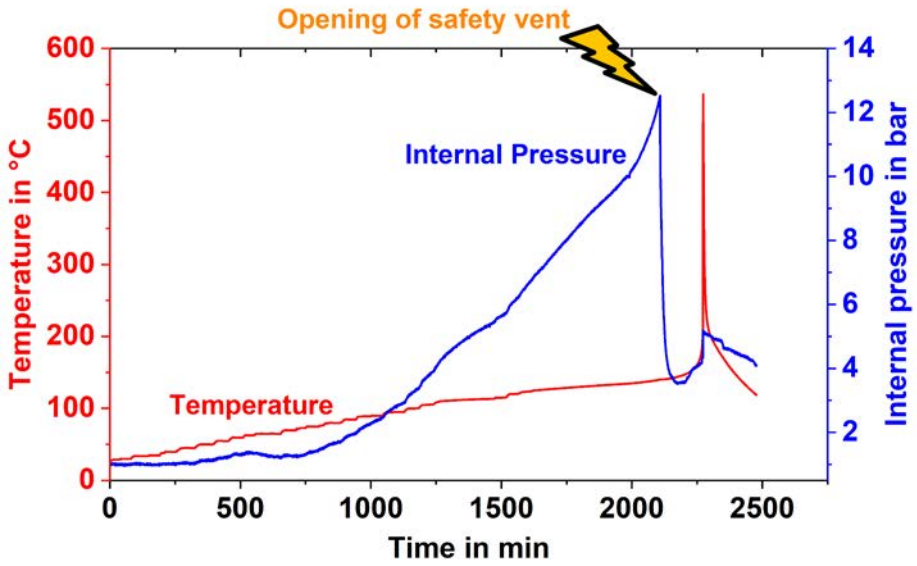

Fig.2: Temperature and internal pressure variation during thermal abuse of an 18650 cell

In this quasiadiabatic mode, the heaters in the calorimeter chamber follow immediately any change of the cell temperature, preventing the heat transfer to the chamber. Thus, it is heating up more and more until a thermal runaway occurs or the chemicals are completely consumed by the exothermic reactions.

On the other hand, if the temperature rate is smaller, the system goes back into Heat Mode. If the temperature exceeds the end temperature value, the ARC enters the Cool Mode, switches off the heaters and starts to cool down by introducing pressurised air to the chamber. For the Ramp Heating test, which mimics a Hot Box test, the cells are heated up at a constant rate instead of a stepwise heating of the cells as in the HWS test.

In addition, new methods for the measurement of external and internal cell pressures for early prediction of thermal runaway of LIB have been established on 18650 cells.

The external pressure was measured using a gas-tight cylinder inside the calorimeter chamber, in order to detect the venting of the cells. For internal pressure measurements, a pressure line connected to a pressure transducer was directly inserted into the cell and the pressure was recorded during a HWS test, as can be seen in Fig.2. This plot clearly shows that, at first, a pressure increase occurs much earlier than a self-heating and, at second, that the cell goes into thermal runaway even if the safety vent opens and releases gases leading to pressure drop. Thus, the measurement of the internal pressure could be used for the early prediction of processes leading to thermal runaway. This method has been adapted from cylindrical cells to pouch cells and prismatic automotive cells.

Moreover, the calorimeters allow studying the thermal runaway propagation in order to develop and qualify suitable countermeasures, such as heat protection barriers.

As result of the battery calorimeter tests quantitative and system relevant data for temperature, heat and pressure development of the cells as well of the decomposition products are provided as: i) a fast feedback for the cell developers, ii) essential data for modeling and simulation and iii) required data for the design and adaptation of battery management.

Thus we hope that the Calorimeter Center in close cooperation with the EERA (European Energy Research Alliance) Joint Programme on Energy Storage will help to establish a European cell production with a world-leading technology, as it is aimed with the European Battery Alliance and the Battery 2030+ initiative.

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Hydrogen: An energy powerhouse with unlimited potential

Morry Markowitz, President of the Fuel Cell and Hydrogen Energy Association argues that hydrogen is an energy powerhouse with unlimited potential for a cleaner and self-sustaining world in the future

Hydrogen is not only the lightest and most abundant element in the universe, but it also is an energy powerhouse with the potential to move the world towards a cleaner, a more self-sustaining and efficient path forward.

In the U.S., millions of metric tons of hydrogen are produced annually, predominantly from natural gas in a process known as steam methane reforming. For decades, it has then been safely stored, transported, and used – primarily in the fertilizer, agriculture, food, chemical, and petrochemical industries. Today, hydrogen is being used in a new way: working in fuel cells to provide clean, reliable power for a range of applications.

For mobility, fuel cells are being deployed in a portfolio of zero-emission vehicles – cars, forklifts, buses, medium- and heavy-duty trucks, and even trains. Fuelling these vehicles requires investment in infrastructure and a vision towards creating a sustainable supply of hydrogen. More than ten years ago, California mandated that 33% of the hydrogen sold at fuelling stations must be renewable, a goal which industry has consistently exceeded. There are now 39 hydrogen fuelling stations in the state, and new ones are slated to begin operation in the Northeast U.S. Other countries, including Japan, Germany, and China, collectively have more than 100 stations open, with the goal of constructing many more in the coming years.

Outside of the fuel cell cars utilising these stations, other transportation sectors are quickly increasing the demand for hydrogen. While some markets such as medium and heavy-duty trucking are just beginning to utilise fuel cell technology, others are more established. FCHEA member Plug Power's customers, collectively with more than 25,000 fuel cells in material handling vehicles, have surpassed an impressive 16 million hydrogen fills.

To help meet this growing need, the public and private sector are devoting resources into research, development, and large-scale deployment of both conventional and renewable hydrogen generation. The U.S. Department of Energy launched its H2@Scale initiative to bring together the National Laboratories, industry, utilities and other stakeholders to advance wide-scale hydrogen production, storage, and utilisation for both the stationary and transportation sectors. Industrial gas companies are investing heavily in both new and expanded facilities in the U.S., including a $150 million world-scale liquid hydrogen production plant by Air Liquide in the Western U.S.; two new liquid hydrogen production plants in Texas and California by Air Products; a new hydrogen production facility in Delaware from the Linde Group; and a $40 million expansion to a United Hydrogen plant in Tennessee.

On the renewable side, solar and wind electrolysis – generating hydrogen by 'splitting' water – is becoming more common, as is the use of biogas to produce hydrogen from organic waste. Most recently, FCHEA members Toyota and FuelCell Energy announced the installation of a multi-megawatt fuel cell power plant at the Port of Long Beach in California that will generate not only electricity but 100% renewable hydrogen fuel onsite via biogas from dairy cattle waste. Toyota will purchase the hydrogen for its fuel cell-powered cars and heavy-duty trucks that are deployed at the port.

Our industry and the customers who use fuel cells in everyday operations rely on the availability of a safe, cost-effective, and increasingly renewable supply of hydrogen, and there have been significant technological advancements in renewable generation, compression and storage of hydrogen. It has been an amazing ride that is only just beginning – we can't wait to see where it goes. ■

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The implementation of a green waste valorisation technology to produce value-added products from sewage sludge

The HORIZON 2020 ToSynFuel project, coordinated by Fraunhofer UMSICHT, will demonstrate new integrated waste valorisation technologies into industrially relevant environments, says Dr-Ing Robert Daschner from Institute Branch Sulzbach-Rosenberg

At the end of 2015, the European Commission adopted an ambitious Circular Economy Package to stimulate Europe's transition towards a circular economy, which will boost global competitiveness, foster sustainable economic growth and generate new jobs.

The actions to be implemented will contribute to "closing the loop" of product lifecycles through greater recycling and re-use of resources, and bring benefits for both the environment and the economy. The plans will extract the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing greenhouse gas emissions and environmental impact. The full lifecycle is covered: from production and consumption to waste management and the market for secondary raw materials. This transition will be supported financially by European Structural and Investment Funds, €650 million from Horizon 2020 (the EU funding programme for research and innovation), €5.5 billion from structural funds for waste management, and investments in the circular economy at a national level.

The circular economy has the potential to preserve precious and scarce resources, reducing environmental impacts of resource use and injecting new value into waste products. Key actions to be carried out under the current Commission's mandate include also a revised regulation on fertilisers, to facilitate the recognition of organic and waste-based fertilisers in the single market and support the role of bio-nutrients.

The legislative proposals on waste, adopted together with this action plan, include long-term targets to reduce landfilling and increase preparation for reuse and recycling of key waste streams.

Use of sewage sludge as a resource rather than waste to dispose

Recycled nutrients from organic waste or by-products (bio-based materials such as food waste, used water and animal by-products such as manure) can be returned to the soil as fertilisers, reducing the need for mineral-based fertilisers and creating organic fertilisers for EU farmers and gardeners.

The circulation of these fertilisers is hampered by differing rules and quality standards across EU countries.

Today the majority of fertilisers used are manufactured from imported resources or through energy-intensive processes. The revised Fertilisers Regulation adopted by the Commission in 2016 foresees changes to allow the recycling of nutrients through the production of waste-based and organic fertiliser products.

For example, in order to meet the future global needs of phosphorus, it is likely that phosphate recovery and recycling from sludge liquid effluents will become more economically competitive, leading to increased uptake. In various EU countries new sewage sludge directives are already in place, forcing phosphate recovery.

The organic fraction of municipal solid waste (OFMSW) and sewage sludge represent a large amount of the biodegradable waste generated in the EU. The most recent estimates, reported to the Commission by the Member States, suggest that about 100 million tonnes of biowaste from municipal solid waste and sewage sludge dry matter are produced in the EU every year. Sewage sludge evolves from the treatment of waste water to produce a 'sludge cake'. It is a highly abundant waste with a yearly production potential of approximately 90 kg per inhabitant per year (wet basis). Germany currently produces 1.8 million tonnes per year of sewage sludge on a dry basis. Similar to anaerobic digestion residues, there are increasing legislative demands imposed on the disposal of sewage sludge by landfill, land spreading and incineration.

Groundbreaking ceremony of the project demonstrator located beside a sewage sludge drying plant

In Italy and according to Eurostat data, landfill remains the major disposal route for sewage sludge, followed by land spreading. In countries such as Germany or Netherlands, incineration is applied to a higher degree. Considering Europe consists of 28 countries, the most commonly used disposal method in 2012 was land spreading, followed by incineration and then composting and landfill.

Ultimately, the choice of the most appropriate management and treatment process for sewage sludge is, of course, deeply related to the local conditions. It is known that landfill disposal of sludge affects the leachate production and the CO_2 emissions directly to the air. Therefore, the main methods of sewage sludge management in the EU remains agricultural use and incineration.

ToSynFuel project to convert sewage sludge in value-added products

ToSynFuel is a Horizon 2020-funded project coordinated by the Fraunhofer Institute for Environmental, Safety, and Energy Technology (Fraunhofer UMSICHT) in Germany. It has developed a waste conversion technology called Thermo-Catalytic Reforming (TCR®), which has the potential to have a significant impact on addressing sustainable energy, economic, social and environmental needs.

The project consortium comprises of key industrial stakeholders with the knowledge and expertise to develop and operate a pre-commercial demonstrator, which is the basis for a first-of-its-kind industrial unit.

The technology converts residual biomass into three main products: biochar (containing phosphorus and potassium), hydrogen-rich synthesis gas, and liquid bio-oil that can be refined in to high-grade bio-fuels.

For this particular project, the researchers are focusing on sewage sludge, but the waste conversion technologies are extremely versatile. Within the ToSynFuel project, sewage sludge will be tested as the feedstock, but the technology combination of TCR® with pressure swing adsorption (PSA) and hydro-deoxygenation (HDO) can convert a broad range of residual biomass like digestate from anaerobic digestion plant, biowaste and oil pomace.

The technology integration will be shown within ToSynFuel through a demonstrator located beside a sewage sludge drying plant. Such plant locally dries and produces sewage sludge feedstock, currently about 10,000 tons per year. Sludge driers at this scale are common in German infrastructure, complying with the new EU legislation concerning the sludge processing. Sewage sludge has shown great potential for being utilised as a feedstock for TCR® conversion due to its availability, low cost and high energy content, and the fuel properties obtained from the bio-oil. Processing 2 million tonnes per year of sewage sludge into TCR® products would be sufficient to produce up to 200,000 tonnes per year of liquid transport fuels as well as up to 1,000,000 tonnes of biochar with about 70,000 tonnes of phosphorous. This will represent a significant contribution to the circular economy.

Biochar from sewage sludge can be gasified in a simple gasification system, the so called updraft gasifier to increase the energy yield. The obtained ash is in powder form and the contained phosphorous can create nutrient rich soil that can be readily adsorbed by plants.

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Profile in OAG January 2019 issue

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How billions of helpers are producing methane from CO_2, water and renewable energy

Around 700 billion microorganisms are producing methane from CO_2, water and renewable energy in the STORE&GO research facility, as Dr Frank Graf from DVGW Research Centre at Engler-Bunte-Institute of Karlsruhe Institute of Technology (KIT) describes

A key element for the sustainable transition of the European energy system is the efficient storage of renewable energy, especially of volatile solar and wind power. The power-to-gas technology can store renewable energy and – by adding CO_2 from natural sources – convert it to emission-free methane. In Zuchwil, Switzerland, a research facility has now started to operate within the STORE&GO project where microorganisms are the protagonists of the process.

Image: © Regio Energie Solothurn

Representatives of Swiss authorities and of the STORE&GO project are opening the Solothurn power-to-gas plant

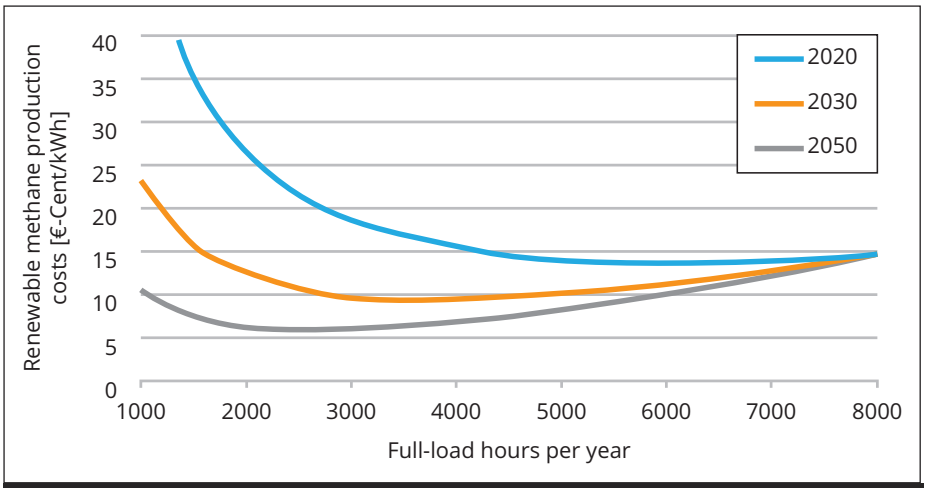
On January 28, 2019, everything on the Aarmatt areal of the Swiss energy company Regio Energie Solothurn revolved around their latest employees: around 700 billion microorganisms, known as Archaea. They are now producing methane from carbon dioxide and hydrogen in the STORE&GO PtG demonstration facility in a process called biological methanation. At the demo site, hydrogen is produced by electrolysis, which is powered by nearby renewable energy sources. The gas from the electrolyser is fed to a bioreactor containing Archaea microorganisms along with CO_2 from a nearby wastewater treatment plant. The microorganisms then transform the hydrogen and CO_2 into methane (CH_4). This renewable gas can be injected into the communal gas network of Regio Energie Solothurn and offers a unique opportunity to store energy and recycle carbon dioxide (CO_2).

The biological methanation plant complements the existing hybrid plant of the Regio Energie Solothurn and is being developed in collaboration with the partners Electrochaea, the University of Applied Sciences Rapperswil (HSR), the Ecole Polytechnique fédérale Lausanne (EPFL), the Swiss Federal Laboratories for Materials Testing and Research (EMPA) and the Swiss Association for Gas and Water (SVGW).

How to improve social acceptance of innovative technologies?

Over the past two decades, renewable energy has not only been of scientific interest. Society in Europe has also understood its importance and been generally open to the development of technologies and infrastructure. However, a low level of acceptance or even a strong local opposition may arise, when it comes to turning innovative projects, like the Solothurn PtG plant, into reality. Identifying factors that have an impact on social acceptance is thus crucial for the persistent success of the further energy transition and projects like STORE&GO.

Image: © Energieinstitut at university Linz



Production costs of renewable methane (lower heating value) from a PtG plant with 100 MW electrical input. The average production costs rise when running the plant also in times of high electricity prices

Therefore, the project partners conducted an extensive survey of 500 households in each of the countries Germany, Austria, Italy and Switzerland. The results show that power-to-gas in combination with photovoltaics has the highest acceptance from a number of options regarding new energy infrastructure by the participants. If a mayor, chancellor or the EU recommends a technology path, the acceptance of the households even further improves, as the study shows. All studies mentioned here will be published on the STORE&GO website over the coming months.

Another key factor for any new technology to gain acceptance and prevail is its potential and overall applicability. To generate a gas with a power-to-gas plant, for instance, it is essential to have reliable CO_2 sources. STORE&GO research identified large-scale greenhouse gas emitters in various industries all over Europe, such as waste and wastewater treatment, metal production and processing, as well as paper and wood production.

On the one hand, many of these sectors are unlikely to fully decarbonise their processes in the future and might, therefore, be a potential source of CO_2. On the other hand, about one-third of these emitters have at least ten wind turbines within a vicinity of 10 km. It is exactly at these spots, where power-to-gas plants could combine the availability of both, CO_2 and renewable energy, and serve as a coupling element between industry and the energy sector. The European production potential might this way, increase to about 1000 TWh renewable methane per year, covering about one-fifth of the current European gas demand.

Future business case and techno-economic optimisation for Power-to-Gas

As the STORE&GO pilot plants and research show, power-to-gas has a great potential to couple the two energy systems of electric power and gas. The technology combines the advantages of electrons and molecules and acts as an enabler of the European energy transition. However, it is essential to further reduce production costs of synthetic methane generated through power-to-gas processes. Only if investment costs, plant efficiency and electricity costs are optimised, then will renewable gases will be ready for the market in the near future and could compete with other energy sources.

To understand which factors affect most the feasibility of power-to-gas installations, STORE&GO researchers carried out a detailed techno-economic analysis. This revealed that the type of methanation technology hardly makes a difference with regard to the costs of the generated gas, thus, opening up a range of choices when it comes to plant design. The studies further show that production costs of renewable methane could be as low as about 6 ct per kWh in 2050 if electricity is purchased mainly during periods of low prices in the future.

According to the project results, the regulatory framework is a key driver. But how can the rules for electricity and gas networks be harmonised in the future? Or how can PtG plants be liberated from end-user fees, for instance? Another much-discussed topic over the last decade has been the question of how to establish an overall pricing system on greenhouse gas emission to benefit any low-carbon technology. These issues need to be addressed in the future. Legal experts of the STORE&GO project have already examined the regulatory framework of power-to-gas and have come up with suggestions on how to tackle those topics (see Deliverable D7.3 on storeandgo.info).

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Science and technology innovation including energy: A crucial driver for economic growth

Science and technology innovation is a crucial driver for economic national progress and growth in Taiwan. As an example of National Sci-Tech Programmes in the country, we take a look at the National Energy Program and the call for the country to achieve 100% renewable by 2030

In the knowledge-based economy of today, science and technology (S&T) innovation have become a crucial driver for economic national progress and growth. In light of this, the Ministry of Science and Technology (MOST) in Taiwan was created in March 2014 and the organisational structure was geared to facilitating stronger links between research in the academic and industrial development. Prior to this, the equivalent organisation was known as the National Science Council (NSC) of the Executive Yuan, which dates back to February 1959.

In addition, we know that MOST will carry on the NSC's tradition of innovative programmes and measures – and bringing academic research a step closer to the needs of industry. MOST believe it can boost Taiwan's industrial and academic competitiveness at the international level, by employing an entrepreneurial and innovative spirit, as well as encouraging creativity in S&T.[1]

One of the National Sci-Tech Programmes in Taiwan that the MOST website draws our attention to is the National Energy Program (NEP-I)[2]. By way of an introduction, we know that Phase I of the NEP-I was set up by a Resolution from the Energy Policy & Technology Development Working Group of the Executive Yuan. In addition, 15 energy technology-related development programmes were drafted during November 2007.

The website of NEP-I draws our attention to the four focus areas for future energy programmes, as well as the 2011 disaster at the Fukushima nuclear power plant and also, the global financial crisis.

"NEP-1 established four directions for future energy programmes: energy efficiency, energy usage & energy sustainability, renewable energy development & utilisation, and formulation & evaluation of energy technology development strategies.

"In March 2011, the unfortunate disaster at the Fukushima nuclear power plant saw a major change in dealing with energy and energy projects.

"In addition, the global financial crisis of the European Union, the U.S. subprime mortgage calamity, etc., along with the constant political threat of terrorists and an increasing demand for energy and material resources in Asia as well as the burst of the bubble from the overinvestment of photovoltaic and LED industries, have forced a new paradigm shift with regards to energy and energy resources allocation."[3]

We know that when it comes to energy policy in Taiwan, there are a number of goals, such as improving energy efficiency and reducing dependence on imported energy. Another is to improve the international competitiveness of alternative energy industries. Helping build a smart grid system and developing a smart grid technology industry in Taiwan is also a priority.

While there are a number of other goals for energy policy, let's just focus on one here that concerns developing smart offshore wind power and ocean energy technology industries. In the view of NEP-I, they want to strengthen the development of offshore wind and ocean power and, "realise a domestic power production of 2.1 billion kWH and carbon reductions of 1.3 million tons by 2020."

The vision of the Offshore Wind Power and Ocean Energy Master Program is, "increasing national energy independence, reducing emissions and damage and establishing Taiwan's offshore wind power industry

chain." This vision combines university, research and industry resources, plus it integrates concepts for pioneering applications and builds industry consensus to propose development targets for offshore wind power industry, break new ground in the development of offshore wind power and ocean energy technologies, and coordinate solutions from academic and research institutions.[4]

Achieving 100% renewable energy by 2030

Perhaps this vision will help with the recent recommendation that Taiwan should introduce more policies to accelerate its energy transition, with the suggested goal of achieving 100% renewable energy by 2030. An internationally renowned energy and climate advisor advised this back in August 2018. Hans-Josef Fell, Founder and President of the Berlin-based Energy Watch Group says, "transiting to 100% renewable is not a faraway target. It is the main strategy in many nations."

We know that President Tsai Ing-wen has promised to decommission the country's nuclear power plants, which currently generate 9.3% of electricity. By 2025, the plan is to achieve an energy mix that is 50% liquefied natural gas, 30% coal and 20% renewable energy, which today accounts for 4.9%. Fell draws our attention to the example of Germany who has done remarkably well in the move towards renewable energy. "Now renewable energy is cheap and goes faster. If this doubling goes on, we will have 100% renewable energy by 2030 in Germany. It's possible. I believe it will come", he says. Fell underlines the need to diversify sources of renewable energy to balance fluctuating power supply, based on wind and solar power.[5]

> "Transiting to 100% renewable is not a faraway target. It is the main strategy in many nations."

In closing, it's worth relating the energy areas discussed in this article as an excellent example of science and technology (S&T) innovation becoming a crucial driver for economic national progress and growth which is a key policy aim of the Ministry of Science and Technology (MOST) in Taiwan. ■

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A focus on green energy Taiwan

Dr. Gwo-shyh Song, Associate Professor at the Institute of Oceanography, National Taiwan University and Senior Consultant with Global Aqua Survey Ltd provides an in-depth look at green energy in the country

Taiwan, an island-type country with a population density ranked second in the world, must be provided with approximately 42GW electricity autonomously each year. In 2017, power distribution for coal-fired power generation was 39.2%, gas power generation 43.4%, nuclear power generation 9.3%, hydroelectric power generation 8.1% (plus a few percentages on renewable energy). Recently, a rise in the awareness of environmental protection, under the anti-nuclear policy of the Taiwan Government ruling by the Democratic Progress Party, and peoples' awareness of anti-air pollution resulting from thermal power generation, wind power seems to be the major antidote to this impasse in energy distribution. Due to land wind turbines, in addition to its poor efficiency, its development has also been limited by land use and the turbine's low-frequency noise. Hence, since 2012, the government had promoted the so-called offshore wind power scheme for thousands of turbines. Coupled with the mature development of offshore wind farm in Europe, such as the significant reduction of costs due to the maturation of development technology, Taiwan has now become the most important area in the world to develop offshore wind power generation.

The wind field in Taiwan Strait is blessed in the world, for instance; the average density of wind fields near the coastal zone of Changhua is 7m/s or equal to 750W per square metre of power generation. According to C-Offshore reporting, Taiwan Strait ranks among the highest wind farms in the world. The development of offshore

wind power in the Strait area has the following characteristics:

1. Wind speed greater than 10m/s, a good rate of more than 60% in 7.5 months during the autumn and winter season; even a proper rate of more than 20% in 4.5 months during the spring and summer season. More importantly, the direction of the wind is stable.

2. Water depth of less than 50 metres can be developed in a wide area of up to 5,600 square kilometres.

3. More than 80% of wind farm positions have a moderate offshore distance to reduce the impact on the inshore environment.

4. With the exception of some inshore wind fields, most of the wind farm geological conditions of the excellent seabed are covered by more than a hundred metre thick layers of a medium or coarse grain of sands without the occurrence of active faults.

5. The government is encouraging a push to reduce fisheries disruption.

Promoting green energy is the main mechanism to solve the environmental impact in the development of modern world inspections, and while it is expensive, Taiwan cannot stay out of it. However, the development of offshore wind power based on national economic considerations must also take into account the following shocks:

1. Impact and myths of the environment

Is it time to use nuclear energy but it this causing much disturbance in Taiwan because it is a relatively cheap and stable base power in energy distribution? Many people are opposed to nuclear power because of Taiwan's location in earthquake zones – combined with the incidence of Japan's Fukushima tsunami nuclear power plant disaster and nuclear waste which has not been resolved – so this makes the residents who live around power plants feel unsafe. The government has, therefore, decided to gradually reduce the power supply ratio of nuclear energy, with the intention to denuclearisation the country in 2025.

The supply ratio of thermal power generation must be increased in a short period of time without the use of nuclear power. Although the cost of thermal generating electricity is cheaper – especially coal-fired power generation, releasing pollution particles also called particulate matter (PM) 2.5 – makes almost all major metro-cities with bad air quality such that people choose against the additional development of so-called coal-fired power plants during the 2018 referendum.

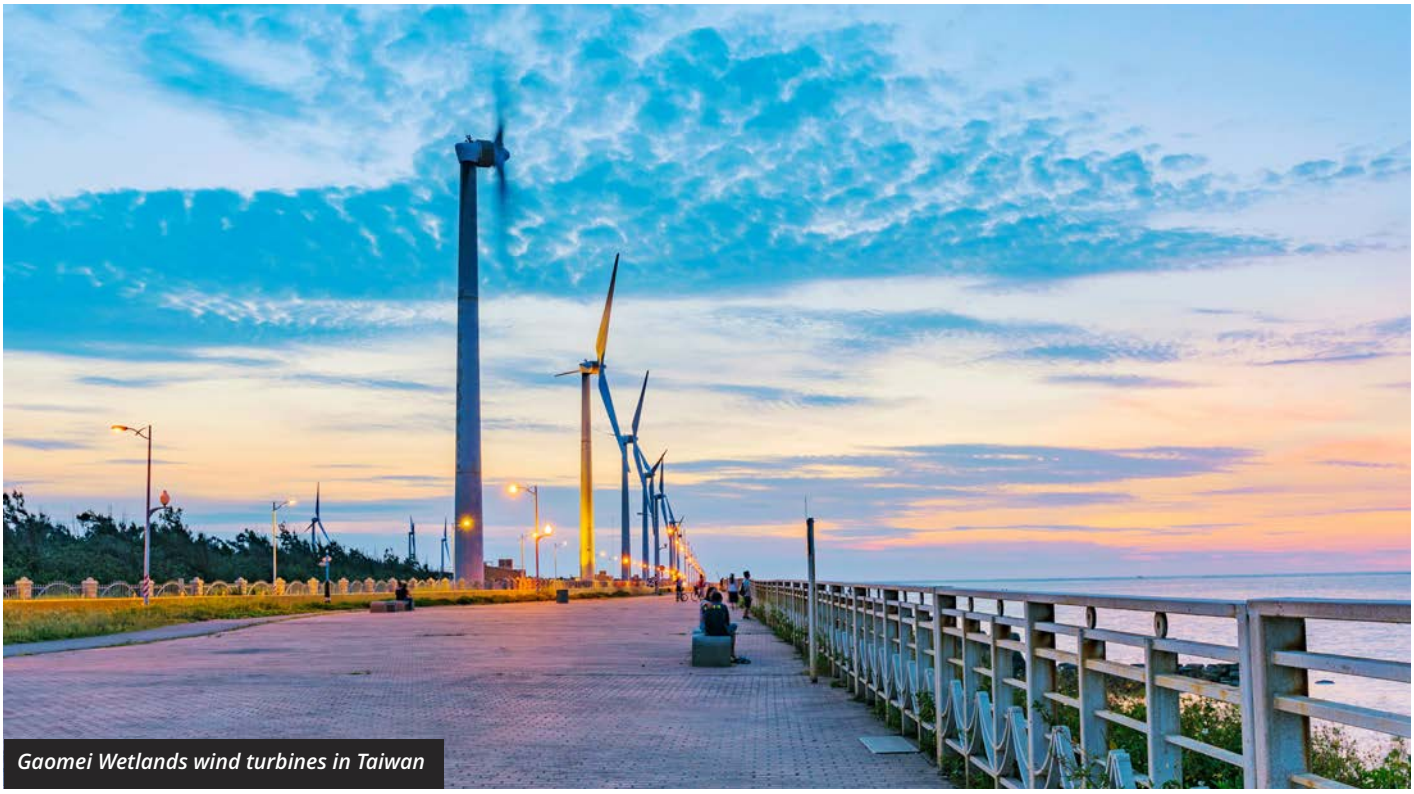
As for the construction of hydroelectric power or reservoirs, it has caused the destruction of the natural environment or results in reservoir siltation and river ecological damage, and even coastal erosion phenomenon. The establishment of terrestrial wind turbines in recent years because of the low-frequency noise has been generated but its development has been limited.

So, it seems that offshore wind power is the antidote to environmental killers compared with other types of power resource. The impact on the migration of migratory birds and the restrictions on fishing activities were the most discussed when I was on the Environmental Impact Assessment Committee; however, it had also been suggested that the agglomeration effect of the foundation of the turbines based on the seabed may have a positive effect on the increase in catches.

2. Power generation efficiency and cost

Regardless of whether wind power can be used as base power, the demand for existing electricity in Taiwan was 42GW in 2018. If the average generating capacity per turbine is 8 MW, then half of the wind field area of 5,600 square kilometres for offshore wind power generation is used and spacing between the turbines is 1 km. 22.4GW power of electricity can be generated in ten years which is more than half of the amount of power required in Taiwan.

Wind turbines can generate power at a wind speed of 3m/s. It indicates that there will be 97% of the time period in the Strait Wind Power can be generated. With larger wind energy based on higher wind speed, we can predict that it can generate 60% of the total electricity that is produced by offshore wind turbines during the autumn and winter; or at least 20% of the total wind-generated electricity in the summer season. It indicates that in 2030, with the total wind-generated power at 22.4GW, there is 13.44GW which can be generated or accounts for about one-third of the electricity demand during winter, and 4.5GW can be generated or accounts for 11% of electricity demand in the summer. This amount of power generation can replace the electricity generated by nuclear power in Taiwan or reduce the amount of air pollution emitted by coal-fired power generated by 30% in



Gaomei Wetlands wind turbines in Taiwan

the summer when the air is more heavily polluted.

To encourage skilled developers to assist in the initial development of offshore wind electricity, Taiwan has provided approximately the purchase price of NTD 6 dollars per degree (exchange ratio between NTD and USD is 31:1). This electricity price is much higher than the average cost of generating electricity for the Taiwan Power Company (TPC) itself, NTD 2.2. As a result, many groups of people have questioned the offshore wind power policy which will greatly raise the cost of power generation and, therefore, cause prices to rise and will impact on the overall economic development of Taiwan.

But will the development of offshore wind power really end up like this? Before we can come to this conclusion, we must first observe the following two phenomena:

a). This initial pricing was only applicable to the development of demonstration wind farms, a price that would slowly decline with the status of development. The 5.5GW wind farm granted to date, of which 3.3GW has been used in terms of the average purchase price that has to be supplied before 2025 has fallen to NTD 5.4- NTD 5.8 per degree. The remaining 2.2GW wind farms granted with the open bidding has dropped to a reasonable price of NTD 2.2 - NTD 2.5 per degree. It comes to the average purchase price of 5.5GW for wind farms, dropping to around NTD 4.5 per degree.

b). The ratio of power energy types in the Taiwan Power Company has a different energy cost structure. With the removal of environmental costs, coal-fired power generation cost is NTD 1.6, gas power is NTD 2.7, nuclear power is NTD 1.2, hydroelectric power is NTD 2.7, and terrestrial wind power is NTD 0.8 degree (above of them is non-procurement costs).

Hence, when considering the different costs at various times and in terms of the different energy structure of power supply, the costs of power generation in Taiwan will be increased by between 12%-15%, based on the use of offshore wind power calculations. Finally, it will be reflected in the pricing of electricity.

So, let's make a preliminary budget estimate. Nuclear power generation in Taiwan was around 4GW in 2018 as part of the government's strategy: offshore wind power is used to replace nuclear power generation. The remainder of wind power should replace high-pollution coal-fired power generation. According to the time schedule of offshore wind power development, 5.5GW of wind power can be supplied by 2025, and 10.8GW (EIA obtained by existing developers) by 2030. Let's assume the generating costs of offshore wind power are NTD 4.5 per degree for the first 5.5GW, and NTD 2.3 per degree for the remainder of 5.3GW, then electricity generation costs will be in between NTD 2.47 and NTD 2.53 per degree. Compared with

the costs of NTD 2.2 in 2018, an increase of between 12%-15% in the pricing of electricity is predicted.

In summary, under the condition that 10.8GW wind power can supply 5.4GW electricity by assuming there is 50% proper rate in a year – wind power can totally replace the nuclear power used or one-third of high-polluted coal-fired power in Taiwan between 2025 and 2030. However, electricity prices will rise by at least 10% which will impact individuals in the country.

3. Benefits for local industry

The purchase price for high-priced wind power proposed by the government in Taiwan totals USD 160 million worth of investment for 3.3GW of power by foreigner developers, who were asked to come up with a so-called home-grown industry chain mentoring programme. This means that requiring local industries to participate in the construction process is necessary. Projects include work on the fan tower, turbine and its components, the underwater foundation, basic power facilities, the electric cable and the laying, underwater construction, hydrographic and geological site surveys, as well as the manufacture of ship and tools which all must be done locally.

The plan aims to utilise hundreds of millions of investment to increase the country's economic growth by providing employment opportunities for thousands of people in Taiwan. Besides that, its final goal is to ensure the localisation of wind power industrial technology.

Because the development of offshore wind power concerns the cost of generating electricity in Taiwan, the increase in NTD 0.3 per degree was predicted on the total at 42GW of the power supply. It means that the country will spend more around NTD 110 billion (USD 3.3 billion) per year; therefore, the plan has been criticised by many since the 20 years' wind power supply plan will cost the people of the country around NTD 2,200 billion of extra money (USD 70 billion). The rise of local industries and the roots of technology have become the major antidote to this controversy.

So far, developers from all over the world are DONG Energy (or Orsted) from Denmark, Yushen from Singapore, Northpower from Canada, Macquarie Capital from Austria, Copenhagen Infrastructure Partners (CIP) from Denmark, WPD from Germany; and includes some local businesses, such as Swancor Holding Co, China Steel Corp and Asia Cement Corp. This is because the development of green energy has already reached a global consensus.

In addition, this is the best time for Taiwan to develop offshore wind power. Since the development of wind power in European counties for many years, the accumulation of this huge breadth of experience is such that Taiwan could fall into the trap of not taking the right approach. Together with strong support from the Taiwan Government, it then brought the wind power developers from all over the world successively.

Based on the protection of the Earth's environment, although the cost of offshore wind power construction is relatively high at this stage, in recent years, with mature technology in place, experts predict that the costs per degree of offshore wind power in Asia will be less than NTD 2 dollars. Of the top 20, Taiwan Strait has been blessing by the 16 best wind fields in the world; therefore, the promotion of offshore wind power in the face of non-nuclear homes and a reduction of air pollution, I believe that Taiwan is on the right track.

Whether this precious energy, located in Taiwan Strait, can give Taiwan a bright future in the next few years as a model for the world's environmental leader, let's wait and see.

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Transforming construction with the Core Innovation Hub

The Construction Innovation Hub support collaboration across the digital, manufacturing and construction sectors to develop and commercialise technologies that will help transform the sector. Sam Stacey, challenge director for Transforming Construction at UKRI, outlines how it will work

The UK construction industry is facing a once-in-a-generation opportunity for transformation – but it cannot currently deliver the infrastructure and homes the UK needs in the way it currently operates. The industry is very labour intensive, with processes dependent on each stage being completed before the next starts, high levels of material waste, variable quality and gaps between designed and actual asset performance.

In the past, construction has been held back by industry fragmentation and lack of applicable technology. We will change that through a partnership between government and industry.

In July 2018, the government published the Construction Sector Deal as part of the Industrial Strategy. The Sector Deal describes how government procurement will drive change in the design and assembly of buildings, how the skills challenges faced by the industry will be addressed and how £170 million provided as part of the Industrial Strategy Challenge Fund (ISCF) will bring to market the solutions needed for transforming construction. This will bring together a critical mass of clients, construction firms and materials suppliers to start the transition to a new approach that embraces digital, and offsite manufacturing technologies.

To seize this opportunity, the sector will have to change – it will have to go through the industrial and information revolutions. The challenge is great – but if we achieve our aims, the UK will be a world leader in construction, opening the doors to new market opportunities in an expanding sector expected to be worth $15 trillion by 2025.

At the heart of the Sector Deal is the Core Innovation Hub (CIH). The CIH ties together and enables all other elements of the Sector Deal – collaborative R&D, building strong supply chains in the UK and the government's £20 billion per annum construction procurement to deliver better performing buildings. The CIH consists of is a partnership between three centres of established excellence: the Manufacturing Technology Centre (MTC), the Building Research Establishment (BRE) and Cambridge University's Centre for Digital Built Britain (CDBB).

The CIH will bring technologies used successfully in other industries to the construction of buildings and infrastructure. Digital technologies will be used to design buildings based on components – in the same way cars are built now. Manufacturing processes will be developed to produce these to high standards – enabling rapid production of buildings to lower costs, while also delivering better performing schools, hospitals and homes to the benefit of businesses, public services and people. Buildings will be produced with less waste, to use less energy and be recycled at the end of their lives.

Data will become an increasingly valuable commodity – with material traceability, so we will know what has been installed where and to what standard – making buildings safer.

Safety on site will also improve, with fewer workers put into dangerous environments. This, in turn, will make the sector attractive to a more diverse workforce.

Factories established as part of new growing UK supply chains can be located where the social return to the

country is greatest, bringing regeneration and skilled jobs to manufacturing heartlands.

"In the past, construction has been held back by industry fragmentation and lack of applicable technology. We will change that through a partnership between government and industry."

Digital techniques such as augmented and virtual reality will be brought into construction for the first time. The latest generation of robots will assist construction workers on site and in factories. Machines that work autonomously, such as self-driving excavators and robotic cranes, will be introduced to construction sites. Smart sensors and digital systems will be incorporated in buildings and infrastructure, so they can manage and maintain themselves – and the data they gather will enable us to make our towns and cities better places to work and travel in.

All this will mean that we will be able to build much faster, cheaper and more sustainably than we do today. Not only, for example, will we be able to produce nine schools for the price of five today, but the learning experience for the pupils in those schools will be better.

The Construction Industry Sector Deal represents an opportunity to make the UK construction industry a world-leader. We must seize this, and make it a reality.

Sam Stacey is Challenge Director – Transforming Construction at UKRI. He is leading the Transforming Construction challenge, a £170m research and innovation investment, matched by £250m from industry, to create new construction processes and techniques for building manufacture in the UK. ■

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Supporting the green transition: A unique building project in Denmark

Peder Vejsig Pedersen, Senior Advisor at European Green Cities outlines a unique building project, Copenhagen International School (CIS) as an example of supporting the green transition

Due to BIPV oriented funding in Denmark from the EUDP and ForskVE RTD programmes (see: www.activehouseroofsandfacades.com), it has been possible for Cenergia (now a part of Kuben Management to make an agreement with Copenhagen International School) to realise an Active House labelling for them, and to include an online Active House radar with assistance from the company, Leapcraft.

Copenhagen International School (CIS) is a unique building project, for which it has been a pleasure for me and my former colleagues, Miriam Sanchez and Vickie Aagesen to work on. This cooperation also included Karin Kappel from Solar City Denmark, who have carried out amazing work in promoting best practice BIPV architecture since 2004, and Gate21, engaged as a collaborator in relation to the ForskVE realisation. For Kuben Management, I hope that winning the Active House award will support the idea of working with the Active House standard in practice because it has many benefits and it is not costly to work with. In relation to ForskVE, it has been possible to include several Active House labelled projects in the Danish sustainable building database which can now be viewed in English at www.bæredygtigebygninger.dk .

The idea of working with performance documentation has always been a part of the Active House approach and with the demands for this in the EU Building Directive, it has become increasingly relevant, and something that will be supported by the development towards more digitalisation in buildings.

Peder Vejsig Pedersen receiving the Active House Award 2018 for the CIS building in Copenhagen, at the Active House Symposium in Lecco, Italy

> "My advice for the future is to really focus on new and unique projects, which support the green transition, and to work with engaged builders, such as what we witnessed with the CIS building."

CIS is a good example of a school building with an emphasis on a healthy indoor climate, which had a strong focus in the design process, also based on special demands from the builder, f.ex. when it comes to using decentralised ventilation systems. This is in a scenario where bad indoor climate issues are not uncommon in Danish schools. It is our hope that the qualities documented in the online Active House radar will help to ensure a continuous focus on the indoor climate.

I agree that homebuyers can use Active House documentation to help them secure quality but also due to the reasonably low costs to use it. Good advice would be to try to cooperate with other sustainable building quality systems. In the Nordic countries, f.ex. have the Nordic Swan Label which one of the leading contractors (NCC), uses for all their housing projects.

My advice for the future is to really focus on new and unique projects, which support the green transition, and to work with engaged builders, such as what we witnessed with the CIS building. CIS is a really good example of what a determined builder can do in practice. Here, the driving force was one of the board members of the school who at the same time was a designer and secured full-scale BIPV Mock-Ups on the actual building site to identify the best possible BIPV design (in cooperation with the experienced BIPV manufacturer, Solar Lab). This actually led to the withdrawal of the architect (C.F. Møller), for a short period, due to risks they saw in connection to the use of completely new technology for almost all facades. In the end, they came back and was deeply engaged in securing the qualities in practice of many of the technical and architectural solutions.

Active House labelling: www.activehouse.info

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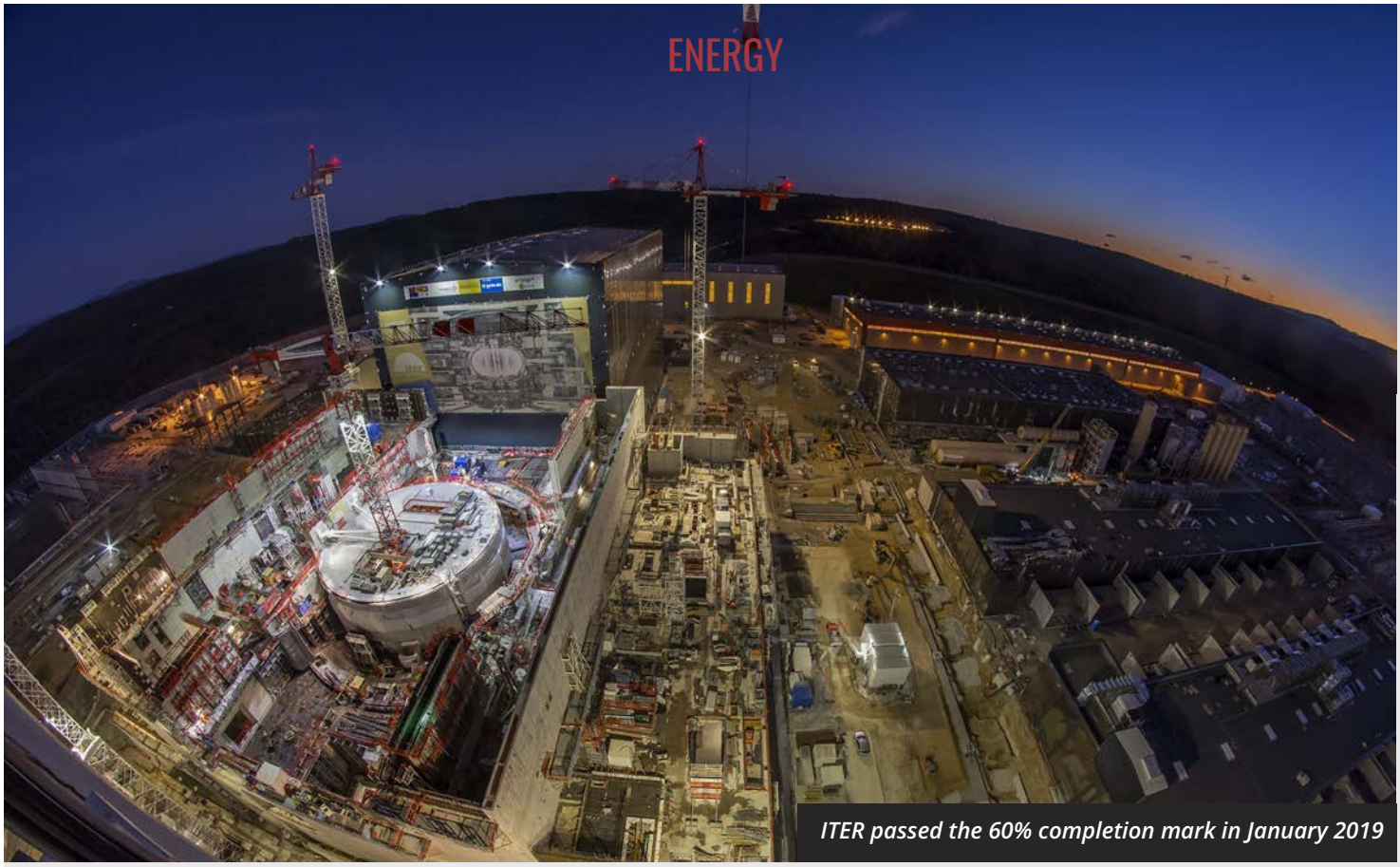

ITER passed the 60% completion mark in January 2019

Image: © ITER Organization

Fusion: Clean, safe and virtually unlimited source of energy for future generations

Laban Coblentz, Head of Communication at ITER takes us on a journey of discovery when it comes to fusion as a clean, safe, virtually unlimited source of energy for thousands of future generations

Cradled in the rolling hills of Haute-Provence in southern France, a slumbering giant is emerging from the earth. Global awareness is also rising: the ITER Tokamak, a collaboration of 35 countries to build the first industrial-scale fusion reactor – literally "a star on earth" – is among the most ambitious scientific endeavours of our time, with high stakes for our future.

While hundreds of tokamaks have been built over the past six decades, none are like this. Still, observers tend to limit their observations of ITER's uniqueness to superlatives. The 150 million °C operating temperature of the plasma. The frigid chill of the superconducting magnets, operating at near absolute zero (-269 °C). The weight of the Tokamak Complex – 400,000 tonnes, heavier than the Empire State Building – resting on 493 carefully positioned seismic pads. The strength of the Central Solenoid structure at the machine's heart, able to withstand twice the thrust of a space shuttle launch. Or the heat flux ITER's toughest surfaces must withstand 20 megawatts per square metre, twice the torrid load a space shuttle endures on re-entering the Earth's atmosphere, but for a sustained period.

These comparisons can be mindboggling. But they do not fully portray ITER's "firsts," nor do they hint at ITER's ongoing, real-time return on investment for its partners. Within this first-of-a-kind machine is a mini-universe of first-of-a-kind components, systems, and technologies.

Consider the ITER magnet system, designed to forge an invisible magnetic chamber inside the metal tokamak, confining the ultra-hot plasma away from the physical walls. To build this first-of-a-kind structure at

Image: © Fusion for Energy

A specialised tool created by Douce Hydro to test the performance of ITER's "pre-compression rings"

ITER's scale required, among other materials, 100,000 kilometres of niobium-tin strand, nearly 500 tonnes. At the outset, worldwide production capacity of niobium-tin stood at 15 tonnes per year. Nine suppliers in six of the seven ITER Members ramped up global output to nearly 150 tonnes per year – each working to precisely the same materials specifications, testing protocols, and quality assurance standards. A global industry was born. For any superconductor application, such as medical scanning equipment, a call for tender could now be placed with equal confidence in Carteret, New Jersey, Xi'an, China, or the Jastec facilities in Japan.

Consider the first-of-a-kind tools demanded by ITER's assembly process. Taekyung Heavy Industries of Korea has manufactured the twin titans in this ITER toolbox: two 22-metre-tall Sub-Sector Assembly Tools, each capable of delicately folding together a 440-tonne vacuum vessel sector, two 310-tonne toroidal field magnets, and segments of the thermal shield into a composite whole, with precision measured in millimetres. To verify the performance of ITER's magnet-protecting "pre-compression rings" – more than a billion glass fibres held together with epoxy resin – a futuristic testing device developed by Douce Hydro of France (pictured above) will exert a force of 36,000 tonnes with a positional accuracy of 0.1 millimetre.

Each such tool – and there are dozens more – demands innovation. And there is more. Across every aspect of the project, in laboratories and fabrication centres on three continents, fit-for-purpose R&D is being used to develop specialised steel alloys, gyrotrons, pellet injectors, power electronics, cryogenic pumps, tritium breeding systems, and hundreds of other first-of-a-kind innovations.

When CEOs talk about the benefit of participating in this project, they rarely focus on a contract's monetary value. They speak of being stretched, of the creativity and innovation ITER demands, of the newly developed industrial capacities that result, of new spin-off technologies with implications and markets well beyond plasma physics or tokamak engineering – and of the increased competitiveness they acquire by being part of this unprecedented project.

The multinational nature of the ITER project is in itself driving first-of-a-kind solutions to logistics, shipping and storage, schedule management, 4D software and data management, multi-sector cooperation, and other challenges of international project management. Given the array of complex cross-border threats facing modern society, from climate change to pandemics, several wise observers have commented that the lessons learned in this area may prove to be among our most enduring and meaningful contributions: learning how to work together, in the most tangible terms, to solve a global problem.

Ultimately, ITER will enable scientists to study a controlled "burning" or self-heating plasma, the gateway to offering fusion as a clean, safe, virtually unlimited source of energy for thousands of future generations. But until that time, even now, the returns on investment are rolling in. ■

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Plasma-Jet-Driven Magneto-Inertial Fusion – A progress report

Y. C. Francis Thio and F. Douglas Witherspoon, HyperJet Fusion Corporation,
provide an update on the progress on Plasma-Jet-Driven Magneto-Inertial Fusion

In this article, we continue our reporting on the progress made on the fusion approach, plasma-jet driven magneto-inertial fusion (PJMIF), which we began in the last of these series of articles [1]. A review of the progress made in the development of the plasma gun needed by PJMIF is given in [2]. Under the ARPA-E ALPHA program launched in 2015 [3], a plasma gun called the ALPHA2gun was developed. The plasma gun development has experienced three development cycles. The first cycle was undertaken with a series of gas valves culminating in Revision 9 (Rev9) using the ALPHA2gun [4].

The second cycle of development introduced Revision 10 (Rev10) of the gas valve, which had substantially improved performance characteristics over the first 9 versions in terms of precision gas mass metering, the speed of opening and closing, reliability, and repeatability. The third cycle of the development of the plasma gun (HJ1) is near completion [5]. Final tuning of the gun is in progress.

In 2016-2018, multiple-gun operations to launch and merge up to seven jets to form a conical section of the plasma liner was performed using the second-generation gun (Alpha2Gun) equipped with the Rev10 gas valve at the Los Alamos PLX-α facility. High-speed framing end-on CCD images of the six Jets merging were acquired, samples of which are shown in Figure 1(a). The images show clearly the formation of primary shocks when the jets first merge. The shocked region of the jet spreads laterally, and soon the shock processes the entire jet. The shocked plasma flows proceed to merge and produce secondary shocks which process the plasma in a similar way as the primary shocks, thus resulting in a cascade of shocks.

This phenomenology was expected theoretically. Computer simulations of the jet merging dynamics agree well with the experimental results as shown in Figure 1(b). Reasonable agreement between the computer simulations and the experimental results is obtained when 10% random mass variations and 1 μs random timing variations in the arrivals of the jets are introduced into the computer simulations.

The shock cascade raises an important physics issue. The shocks heat up the plasma liner, increasing its internal pressure, which resists the self-compression of the liner, thus reducing its efficacy in compressing the target plasma when it is used to implode a target plasma. A dimensionless quantity that may be used to gauge the severity of this effect is the Mach number, which is the ratio of the plasma liner flow speed to its internal sound speed. The heating of the plasma liner raises its internal sound speed, thus lowering the Mach number of the flow.

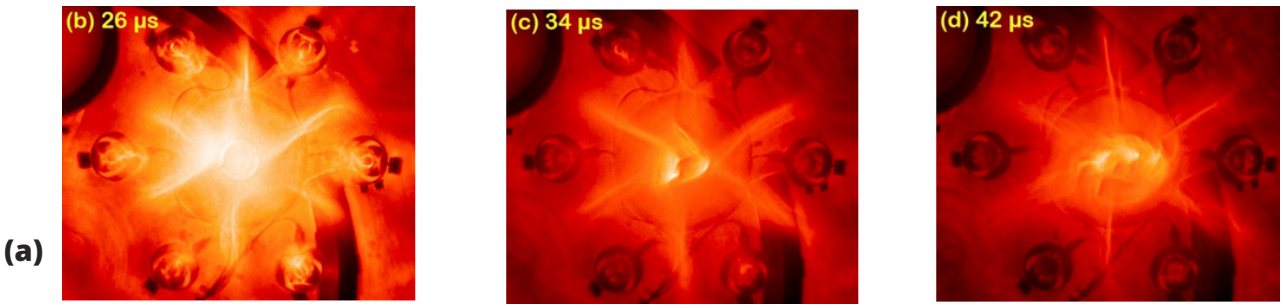


Fig. 1. Merging of six jets to form a conical section of a plasma liner: (a) High-speed framing end-on CCD images (false colour) of six jets merging at 26 μs, 3
National Laboratory. Reproduced from [6], with permission from AIP Publishing.

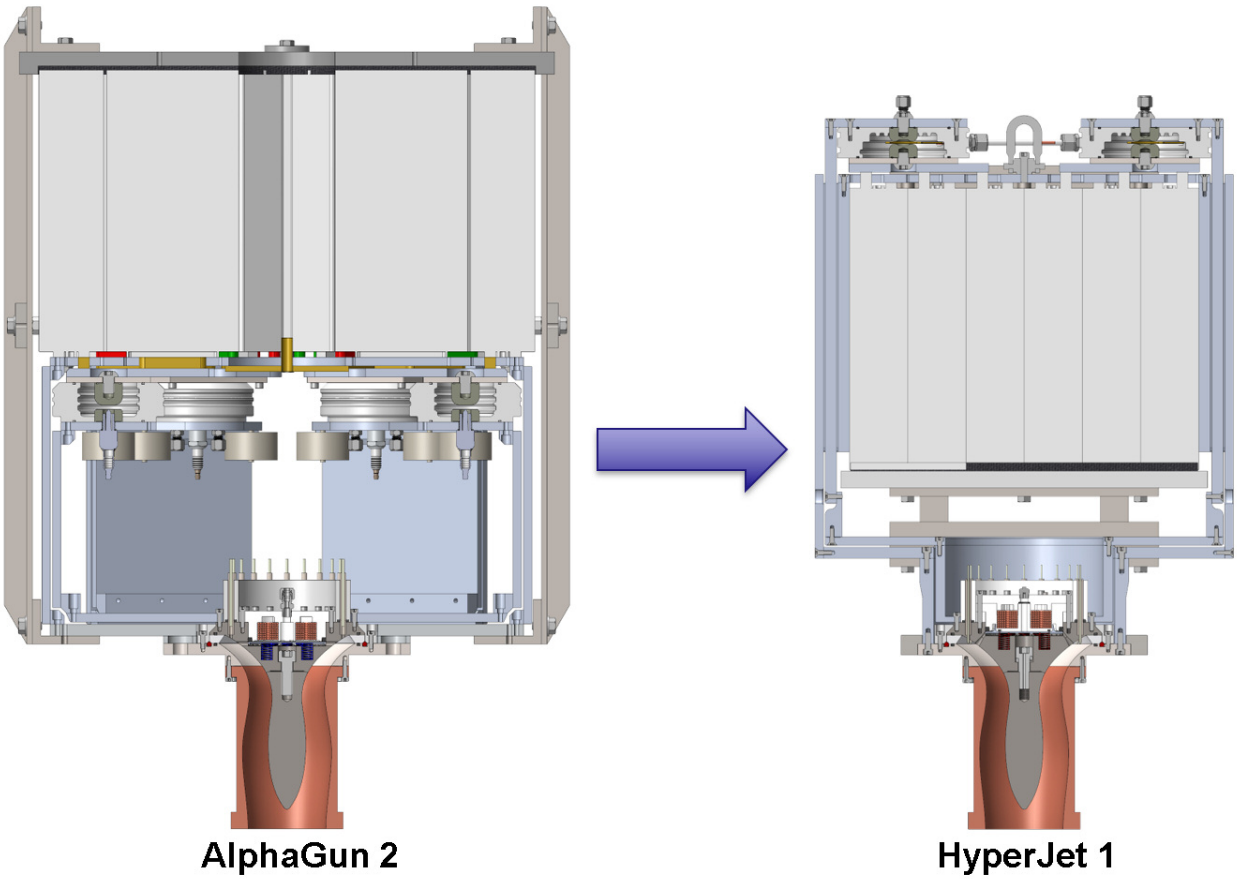
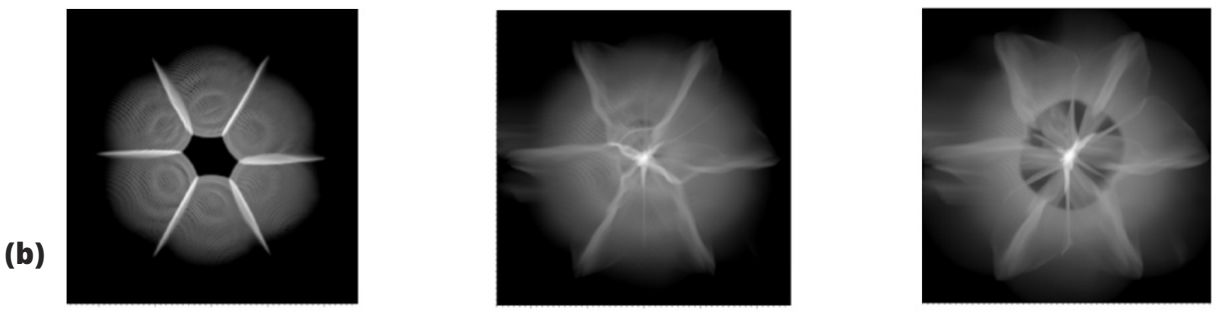


Fig. 2. The footprint and volume of the capacitor module are significantly reduced from Alpha2gun to HJ1.

The heating of the liner by the shocks is mainly experienced by the ions in the liner, while the electrons remain cool. If the electrons can cool the ions at a sufficiently high rate, it is possible that the plasma liner may recover its high Mach number at some point after merging. By studying how the Mach number of the liner evolves in time, we can better assess the effect of the shock cascades caused by the jet merging on the imploding efficacy of the plasma liner. This is an important piece of physics we wish to extract from our multiple jet merging experiments.

We found indeed that the rate of cooling of the ions by the electrons was sufficiently fast for the ions to recover its Mach number from a temporary depression during the traverse of the plasma liner towards the centre before it was expected to engage with the target in an actual liner-on-target implosion in a typical PJMIF scenario [7, 8].

Over the last 12 months, HyperJet Fusion has been engaged in the development of a third-generation plasma gun (HJ1), introducing the following new features [5]:



4 μs, 42 μs after launching of the jets. (b) Computer simulations of the six-jet merging experiments using the code, FronTier, of Brookhaven

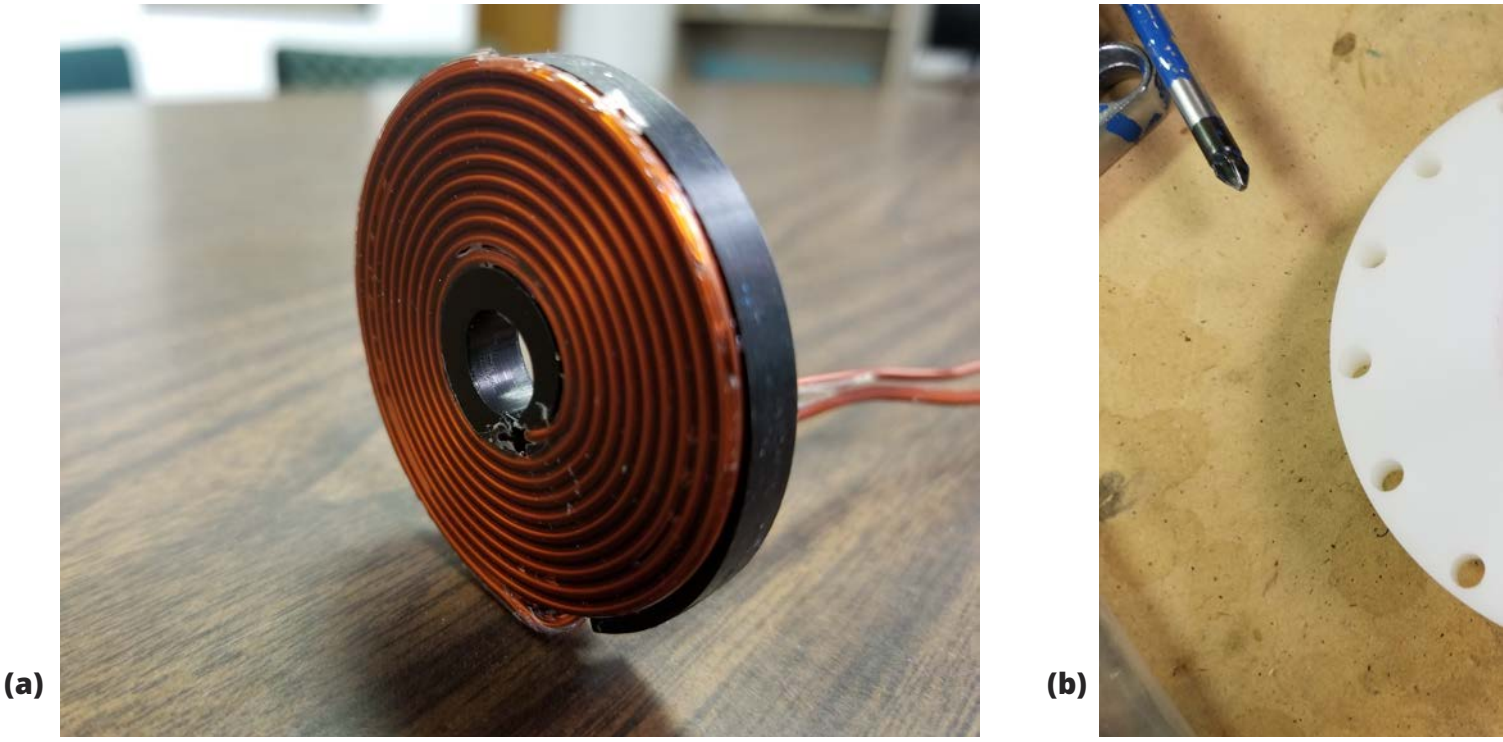


Fig. 3. The new HJ1 gas valve and pre-ionizing technique: (a) the gas valve drive coil is planar, axisymmetric, precision wound and highly reproducible. (b) The

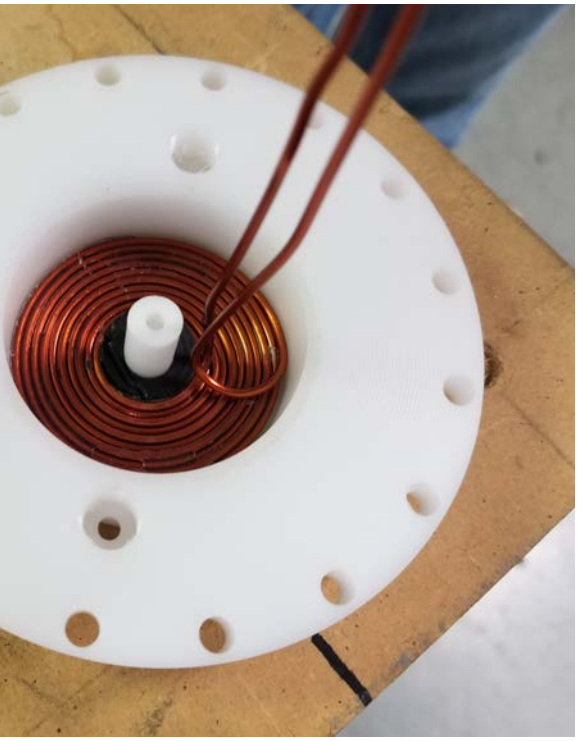
The footprint and volume of the capacitor module driving the gun is considerably reduced going from Alpha2gun to HJ1 as shown in Figure 2. This is necessary in order to field all 36 guns on the PLX tank. The space between the transmission plates in the manifold is completely filled with a solid insulator, thus, providing robust and reliable electrical insulation without any voids, preventing any spurious arcing breakdowns in the transmission manifold. The tighter configuration also results in lowering the internal inductance of the transmission manifold. We expect that, as a result of the lower parasitic inductance, HJ1 should have higher electric-to-kinetic efficiency.

The gun makes use of a gas valve to dispense working gas into the gun. The gas valve is opened by an electromagnetic propulsion subsystem consisting of a drive coil and an aluminium flyer plate (a coilgun). To open the gas valve, a large pulse of electrical current is passed through the drive coil, which induces a large eddy current in the flyer plate. The drive current in the coil and the induced eddy current in the flyer plate repels each other giving rise to the propulsive force that opens the valve.

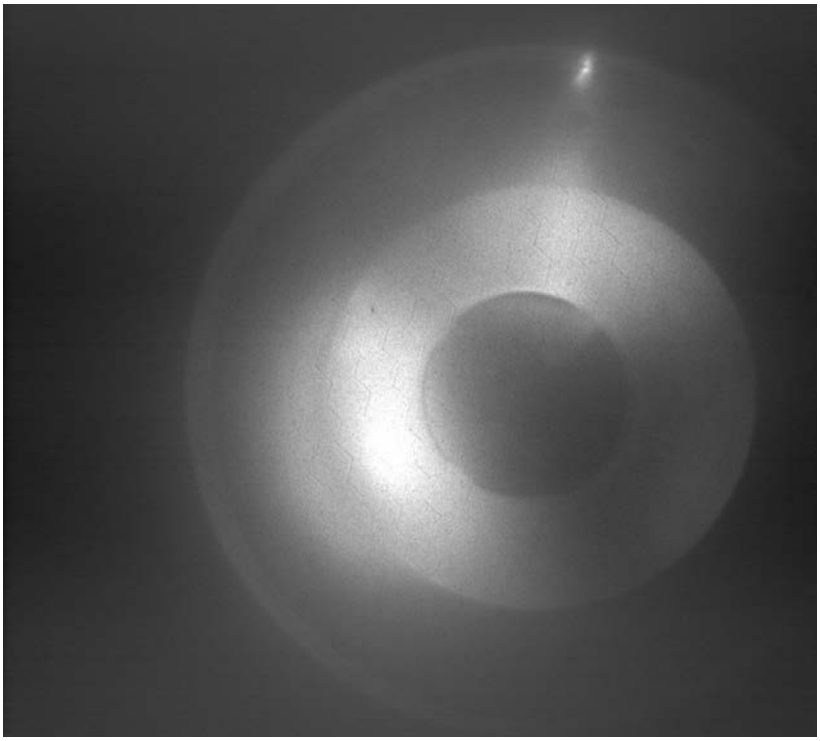
The self-inductance in the drive coil in HJ1 is about 20 times smaller than in Alpha2gun, leading to a 10-fold increase in the electric-to-kinetic efficiency. Consequently, the capacitor bank of about 1 kilo-joule per gas valve that was required to drive the gas valves in Alpha2gun is reduced to only 100 joules, which can be supplied by a capacitor module that can be packed with each individual gun.

The drive coil in HJ1 is a single-plane, axisymmetric coil that can be wound and placed in the gas valve body with a high degree of geometry precision with respect to the flyer plate (Figure 3). The initial gap between the top of the drive coil and the flyer plate is tightly controlled, leading to very little variations in the mutual inductance between the drive coil and the flyer plate from valve to valve. The mutual inductance is the electrical parameter that determines the repulsive force between the drive coil and the flyer plate. Small adjustments to the circuit parameters for the individual coil of each gun will be sufficient to compensate for any electrical and mechanical variations from valve to valve. A dedicated gas-valve test stand to fine tune, calibrate and qualify each gas valve for all the 36 guns have been developed. Improvement in gun-to-gun repeatability of the gas valve is expected.

To prepare the initial neutral gas slab to accept the main current pulse, the



(c)



e drive coil is snugly fitted into the valve body, leaving very little wiggle room. (c) A self-switching glow-like discharge for pre-ionizing the initial gas slab.

gas slab needs to be pre-ionized. In HJ1, we introduce for the first time a new pre-ionization technique for plasma guns based on a self-switching glow-like discharge (Figure 3(c)) [5]. Eliminating the switch simplifies considerably the logistics of implementing the 36-gun plasma liner experiment. Furthermore, the new pre-ionization system is two-fold more efficient energy-wise than that used in Alpha2gun, allowing a smaller capacitor to drive the pre-ionization, small enough for the capacitor to be packed as part of the gun. However, the technique appears to have the tendency to trigger the main current discharge prematurely. We are in the process of troubleshooting the problem.

A new closing switch for the main discharge has been developed that uses a much more efficient triggering mechanism based on the field-distortion configuration. The field-distortion trigger uses only 15 J of energy per gun compared with 250 J of energy per gun in the Alpha2gun. This also eases the logistics burden of fielding the 36-gun plasma liner experiment [5]. Production of the 36 guns is underway.

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Enhancing industrial technology and addressing energy and global environmental problems in Japan

The aims of the New Energy and Industrial Technology Development Organization are detailed here when it comes to enhancing industrial technology and addressing energy and global environmental problems in Japan

The New Energy and Industrial Technology Development Organization (NEDO) was established after the two oil crises of the 1970s when the requirement for energy diversification in Japan increased. In essence, NEDO is a governmental organisation that since 1980, promotes the introduction and development of new energy technologies. It's interesting to note that research and development (R&D) when it comes to industrial technology was later added to the remit of NEDO. In addition, NEDO is one of the largest public R&D management organisations in the country.

The mission of NEDO is two-fold – raising the level of industrial technology – and addressing energy and global environmental concerns.

On the first aspect, we know that NEDO undertakes projects to explore future technology seeds as well as mid- to long-term projects for industrial development. NEDO also supports research related to instances of a practical application.

On the second aspect, NEDO actively looks at the development of new energy, such as wind power, biomass and waste, as well as photovoltaic, wind power, geothermal power, thermal utilisation and fuel cells. Energy conservation technologies form another part of the organisation's remit. Promoting a greater utilisation of new energy and improving energy conservation are important aspects of NEDO'S work.

Promoting the demonstration of new energy, energy conservation, and environmental technologies abroad based on knowledge obtained from domestic projects are ways in which NEDO contributes to the resolution of global environmental problems and a stable energy supply. [1]

Contributing to society by accelerating innovation

Hiroaki Ishizuka, Chairman of NEDO believes that they are contributing to society by accelerating innovation and achieving results in a timely manner. In a recent message, he keenly observes that NEDO's Technology Strategy Center was established back in April 2014, more of which he explains in his own words.

> "Technology development strategies utilising Japan's competitive advantages will also be formulated by anticipating innovation trends faster and more accurately than in other countries. NEDO will then plan and carry out industry-academia-government collaborative projects."

"It is designed to formulate technology development strategies with a mid and long-term perspective, and plan and propose new projects which incorporate its strategies. In addition, a new project manager system has also been introduced not only to improve management capabilities but also to enhance NEDO's role as an intermediary to facilitate the commercialisation of innovative technology seeds."

He also highlights that NEDO's Fourth Five-Year Plan began in April 2018, which considers today's trends in the fields of industrial technology, innovation, energy,

and the environment. He explains how the Plan will be carried out.

"NEDO will carry out the plan with a focus on its three pillars of achieving results for practical use through technology development management, fostering technology-based start-ups, and providing a new direction for mid- and long-term technology development.

"First, as a specific effort to achieve results for practical use through technology development management, NEDO is striving to further strengthen its management capability to promote challenging research and development activities based on technology strategies.

"Second, NEDO will develop and implement various support measures to foster human resources and technology-based start-ups, including assistance in formulating project plans, thereby creating innovative new industries."

Hiroaki goes on to explain that with the ambition of facilitating open innovation from R&D projects, NEDO will set up a system that provides consistent support from the seed phase right up to practical applications. "NEDO's aim is to serve as a public-private support hub for venture businesses through cooperation and the exchange of information with other public support organisations", he adds.

Third, Hiroaki reveals that a new direction will be taken when it comes to mid- and long-term technology development, something that will lead to cultivation and the practical use of innovation in the years ahead. He develops this third point in his own words.

"Technology development strategies utilising Japan's competitive advantages will also be formulated by anticipating innovation trends faster and more accurately than in other countries. NEDO will then plan and carry out industry-academia-government collaborative projects."

Having looked at what NEDO aims to do now and in the future, we leave the last words to Hiroaki who believes that technological innovation currently being developed during the Fourth Industrial Revolution will help to establish new energy and industrial systems. Let's not forget that NEDO will continue to play a crucial part in Japan's industrial and economic and policies, with its two-fold mission of enhancing industrial technology and addressing energy and global environmental problems.

"Society 5.0 [3] is also expected to be realised. To this end, NEDO will continue to make every effort in accordance with its Five-Year Plan so as to contribute to society by providing opportunities to produce innovation through industry-academia-government collaboration and achieving results in a timely manner." ■

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Research focus: Exploring novel energy-harvesting materials

Yuzuru Miyazaki, Full Professor at the Department of Applied Physics, Graduate School of Engineering, at Tohoku University in Japan enlightens us on his fascinating research on exploring novel energy-harvesting materials in this special question and answer interview

In this interview with Yuzuru Miyazaki, Full Professor at the Department of Applied Physics, Graduate School of Engineering, at Tohoku University in Japan, we learn about exploring novel energy-harvesting materials, such as thermoelectric materials, cathode materials for secondary batteries and photovoltaic materials, amongst a number of other exciting areas of research in the field.

The focus of this compelling interview includes Yuzuru Miyazaki's research, his work on high-quality structure analyses using neutron and X-ray diffraction, and the challenges around thin-film thermionic multilayers and organic thermoelectric materials, amongst other areas.

Can you introduce your work when it comes to exploring novel energy-harvesting materials, such as thermoelectric materials, cathode materials for secondary batteries and photovoltaic materials?

I studied basic materials science during my bachelor course. Just before my graduation, a scientific fever of cuprate superconductors occurred. I was, therefore, deeply motivated by this positive impact and began to study pursue novel cuprates during my Master and PhD courses at Tohoku University. Fortunately, I was able to find several cuprates which possess interesting structural units. Some of them actually exhibited superconductivity. From this successful experience, I decided to explore novel functional materials which exhibit special properties, in particular, generating electricity based on a knowledge of solid state chemistry. At that time, the 21st Century was approaching and the energy crisis was one of the critical issues in academic research.

Thermoelectric (TE) materials can generate electricity from the temperature difference by means of the Seebeck effect. TE materials themselves do not generate noises or vibrations and do not emit toxic gases and, therefore, they can be regarded as clean energy sources. However, apart from bismuth telluride-based and lead telluride-based materials, both comprise quite rare and toxic elements, indeed, there are quite a few compounds that can be used as potential TE materials utilising the waste heat of our surroundings. In our research, we focused on oxide materials as they are stable at high temperatures and the constituents are abundant.

My experience on oxides (cuprates) was also quite helpful when it came to studying oxide TE materials. We discovered several cobalt oxide-based TE materials, which are quite stable even at a high temperature up to 1000 K. The crystal structure of them is quite similar to that used as a cathode of the lithium-ion battery. So, we have also begun to explore cathode materials for secondary batteries in layered cobalt oxides that do not contain lithium. We are also studying photovoltaic materials in relation to layered oxide materials.

What is the current focus or themes around your research?

Our main focus when it comes to our research is the waste heat recovery from automobile engines. Currently, the waste heat of around 46 peta calories is emitted annually from automobiles in Japan. The temperature range here is 600-1000 K. If we can recover electricity from such waste heat by the efficiency of ~10%, a number of large thermal power plants can be scrapped and CO_2 emissions can, therefore, be greatly reduced.

Higher manganese silicide, HMS ($MnSi_{\sim 1.7}$) is one of the potential TE materials, to be used at around 800 K. HMS consists of naturally abundant elements and is chemically stable up to 1000 K. Typical samples exhibit the dimensionless figure-of-merit, zT~ 0.3 around 800 K, which needs much improvement. As the zT value roughly corresponds to the thermal-to-electric conversion efficiency, zT~ 0.6 at 800 K is at the very least, necessary. To practically generate electricity, tens or hundreds of p- and n-type TE materi-

als (legs) should be joined electrically in series and thermally, in parallel. We call such a device a pi-type TE module. Electrons (holes) are major conducting carriers for n- (p-) type TE materials. As the HMS is a p-type material, a corresponding potential n-type TE material is necessary. The first choice should be another silicide, Mg_2Si-based material. Currently, we are financially supported by the NEDO/TherMAT project, Japan.

Tell us about your work when it comes to high-quality structure analyses using neutron and X-ray diffraction, combined with first-principles calculations?

Generally, the functions of materials are highly dependent on their electronic structure. The electronic structure is derived from the crystal structure of materials. Hence, a deep knowledge of the precise arrangement of atoms is critical to understand their properties. Such an arrangement can be determined from diffraction experiments of X-ray, neutron and/or synchrotron X-rays. We generally use the first-principles calculation to elucidate electronic structures and, hence, the precise arrangement of atoms in a material is crucial to predict its properties. Unfortunately, many researchers today do not care about having a deep understanding of the crystal structures.

How many novel materials have been discovered based on your guiding principles?

It depends on how we define the difference. If we define the difference as the distinctly different crystal structures, the number should be around 20. Some examples are strontium cuprate oxycarbonate $Sr_2CuO_2CO_3$ and its relatives $Sr_2(Y,Ca)Cu_2O_x(CO_3)$ and $Sr_2(Y,Ce)_2Cu_2O_x(CO_3)$, and so on. The latter two cuprates are based on $Sr_2CuO_2CO_3$ but another structural unit of either (Y,Ca)Cu or $(Y,Ce)_2Cu$ is inserted. If we expand the definition to include the same crystal structure but different components, the number could be more than 40. They are like P2-type Ca_xCoO_2, Sr_xCoO_2 and Ba_xCoO_2, all derived from the solid-state ion-exchange from the layered cobaltate Na_xCoO_2.

What challenges are there concerning challenges on thin-film thermionic multilayers and organic thermoelectric materials?

We have quit these studies but instead, we have started to fabricate new types of TE modules, tilted-multilayer TE modules, which can exclude the problem of electrodes. The electric current flows parallel to the temperature gradient in conventional pi-type TE modules and, hence, electrodes are necessary in between every p- and n-legs.

However, the new type TE module utilises the off-diagonal Seebeck effect, which generates electricity perpendicular to the temperature gradient. In such a module, multilayers of TE materials and metals are simply tilted to an angle of 30-50 degrees to the temperature gradient and electrodes are only necessary at the uppermost and the opposite sides of the multilayer. Currently, we are financially supported by The Japan Society for the Promotion of Science (JSPS) project in our country.

What are your research priorities for the future?

We should expand other fields of energy-relating materials. One possibility could be to explore potential cathode materials for calcium-ion batteries to make use of our accumulated experience. We have discovered several unopened layered materials suitable for the diffusion of calcium-ions and hope that they will exhibit superb electrochemical performance.

Is there anything you would like to add?

In five years' time, our university will construct an ultimate synchrotron radiation facility, named SLiT-J. This facility will herald a new era when it comes to investigating the static and dynamic crystal structures of matter with a high degree of accuracy. We are, therefore, very keen to commit to SLiT-J, so that we can bring much insight when it comes to producing superb energy harnessing materials.

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Disabled access: What can be done to power UK railways forward?

Hilary Stephenson, Managing Director of Sigma explains what can be done to power UK railways forward when it comes to the issue of disabled access

The UK is highly dependent on its railway network. Whether for commuting or leisure purposes, five million passengers make train journeys every day. Having equal access to this network is a basic right, so it is crucial that everyone, regardless of individual requirements, can easily use it.

However, currently, disabled travellers cannot access 40% of UK train stations. This is primarily due to non-inclusive interior design and insufficient provision of assistance from members of staff.

Despite recent efforts to address this situation – for example, Network Rail's new accessibility app and the launch of 'TOC', an initiative to enhance accessible train services, the railway is still far from disabled-friendly.

Findings from our recent research support this. They identified a severe lack of accessibility awareness across the sector as a whole. According to the results, over a quarter of transport hubs are still unable to fully accommodate wheelchair users or those with autism.

This highlights that more must be done to improve the situation. This can be achieved in a variety of ways, from training staff to understand the needs of disabled passengers to ensuring that both physical and digital offerings are user friendly and inclusive. With this in mind, let's explore ways the UK's railway network can be made accessible to all.

Physical obstacles

To ensure every passenger experiences a seamless train journey, all aspects of the country's railway infrastructure needs to be designed with the UK's 11 million disabled individuals in mind.

Despite investment into train stations across the UK – such as at Teesside, which recently received a £15 million accessibility fund – there are still many stations that are yet to address their inaccessible spaces.

As it stands, disabled passengers say the majority of stations and trains are so poorly designed it makes them feel like 'an afterthought'. Recently, one individual stated that even stations that have installed ramps have built them so steep it is almost impossible to use them without assistance.

> "...employees should be clearly visible at all points of a person's trip to provide assistance. This could vary from guiding a traveller through a busy station to helping someone on or off of a train."

Key to rectifying this situation is to design inclusively with disabled passengers at the centre of the planning process. It is important to scrutinise all aspects of the railway's physical accessibility – from station carparks to cafes, to train toilets. Asking questions such as: "Would someone who is blind, deaf, in a wheelchair or has cognitive impairments easily be able to get from A to B?"

If at any point the answer to these questions comes back as 'no', then it is clear something needs to be done to resolve these shortcomings. There are countless modifications that can help the railway sector become instantly more accommodating to disabled travellers, some of which are outlined below:

Car parks – there needs to be ample disabled parking close to station entrances. These spaces must also be large enough to allow passengers to comfortably get in and out of their vehicles.

Waiting areas – stations must have waiting areas with sufficient seating reserved for those with disabilities. Plus, there should be separate, quieter rooms or areas where passengers can escape from the typically loud train station environment.

> "As it stands, disabled passengers say the majority of stations and trains are so poorly designed it makes them feel like 'an afterthought'."

Signs and information – all information should be provided both orally and visually. Hence, signs should use bold contrasting colours, be well lit and have obvious braille translations. Induction loops should also be installed.

Toilets – these should be on every platform and at least one toilet block including a disabled cubicle should be open at all times. These need to be created with the user in mind, for example, with lowered seating and wider doorways.

Wheel-friendly access – every platform should have a lift, which projects an audible tone when the doors open and close. Platforms should also be equipped with multiple ramps to enable step-free access on and off trains. Additionally, train doorways and corridors need to be wide enough to fit a standard wheelchair.

Something to also consider when carrying out such improvements is to run the plans past a focus group of people with differing abilities. To maximise the effectiveness of this process, it should be carried out at various points of the planning process. This will help to ensure that the changes being made are fit for purpose.

Online disability design guidelines are available to check what changes need to be made to any given station. This resource should be used.

Personal touches

While making the rail network physically accessible is a major priority, well-designed bricks and mortar can only go so far. This is why it is equally important to ensure people are on hand to assist passengers throughout their journey.

For example, employees should be clearly visible at all points of a person's trip to provide assistance. This

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could vary from guiding a traveller through a busy station to helping someone on or off of a train.

Additionally, to give the highest level of service, staff must be trained to properly understand the various requirements of a wide range of passengers. Enrolling employees onto courses, such as those provided by the National Disability Authority (NDA), is a great way to achieve this. The NDA's e-learning module is a quick option for employers, but there are also dedicated trainers across the country that are available to meet staff and demonstrate how to effectively cater for disabled customers.

> "While making the rail network physically accessible is a major priority, well-designed bricks and mortar can only go so far. This is why it is equally important to ensure people are on hand to assist passengers throughout their journey."

Digital transformation

Not only does the railway network need to be physically accessible; its online presence also needs to reflect this strategy.

Fundamentally, this needs to be more than just a box-ticking exercise to meet the accessibility standards outlined by the Web Content Accessibility Guidelines. Hence, designers cannot just copy and paste accessible features over the top of previously excluding design. This will never be as effective as tailored coding and will reinforce the view that accessibility is an afterthought.

Instead, research must be conducted into people's various needs and motivations, tailoring a website's design accordingly. For example, if a blind person was to try and book train tickets online, they would need an oral description of all of the options available to them, including any time-sensitive discount codes and deals.

Here are a few simple features that should be included to ensure full web accessibility:

- Text size – make sure this is adjustable.
- Visual effects – make these optional by allowing users to turn them on and off where required.
- Links – make clickable links larger than surrounding text.
- Video accessibility – ensure videos are closed-captioned or there is a sign language version available.

Staying on track

While it is easy to take a look at the above pointers and vow to put them into practice, it is not going to be a quick fix. It is, therefore, important to maintain momentum and address these problems indefinitely.

People with ranging abilities will – like anyone – always need to use the railway system. It is, therefore, critically important to recognise that it is non-inclusive design that disables passengers and prevents them from accessing services – not those individuals' varying requirements. By striving to create a rail network with everyone in mind, its physical and digital presence will become more accessible to all. ■

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How ticketing innovation can delight customers and improve transport performance

Simon Pont, CEO at ECR Retail Systems explains how ticketing innovation can delight customers and improve transport performance

Transport operators are facing challenging times as they strive to improve profitability, deliver a positive customer experience and address legislative challenges. Beyond filling seats, operators need to drive ancillary revenues through new service offerings, and given this, the customer experience becomes a point of difference.

Personalisation is key, and the effective use of data allows transport operators to form a holistic customer view across the entire sales lifecycle. Progressive rail passengers have high expectations of easy and efficient purchasing, both before and during their journey. Quality and choice of food and beverage, on board entertainment, Wi-Fi, travel updates and automated refunds, are fast becoming part of the expected customer experience.

An increasing number of transport companies are using customer data to enable more effective decision-making. This enhanced level of business intelligence can facilitate new opportunities and improve business growth. Forward-thinking rail companies appreciate that implementing the latest on board technologies will improve passenger satisfaction, as well as growing new revenue streams for operators. Secure and convenient on board payment services are becoming commonplace, and access to sophisticated customer insights means new opportunities for expanding retail sales.

The importance of smart transport ticketing

For rail and mass transit operators, smart ticketing fits into this trend by enabling an improved customer experience. Customers want "frictionless travel", and a "frictionless experience", whereas current ticketing systems can discourage people from taking public transport.

The equipment and infrastructure needed to manage and deliver paper-based tickets, such as ticket printers, is expensive to implement and maintain. In addition, this old way of delivering paper tickets is subject to fraud and lost revenue. It can be challenging and costly to effectively view and manage the usage of paper tickets in a dynamic real-time environment. The legacy of paper-based ticking approach restricts innovation and prevents the ability to deliver valuable additional services, such as travel delay updates or destination attraction ticketing, which are just two areas that customers have come to expect.

Innovative mobile-based ticketing systems offer numerous advantages, especially for smaller transport operators, and can be relatively easy to implement. A tried and tested ticketing system, used with one of our larger

transport operators, promises to simplify the purchase process, improve the customer experience and reduce cost. The data held by these state-of-the-art ticketing systems can help create a more personalised passenger experience, who can save and re-use their itineraries. Transport operators can use this data to optimise travel schedules, reduce unprofitable routes and to appropriately cross-sell to their customers.

Smart ticketing is about improving the passenger and business travel experience, by using innovative technology to make journeys easier, quicker and cheaper. It's about helping operators to be more intelligent and allowing them to be transformative.

The growth of the next generation of mobile point of sale: mPOS (mobile point-of-sale technology)

There is no aspect of modern travel, whether for passengers or transport operators, that is not affected by technology, and many operators are embracing the opportunity. Advanced ticketing systems is one such area. It promises to enable operators to develop incremental revenue by matching the increasing demand from customers for an overall better travelling experience by marketing and selling additional, and more personalised value-add services.

With the wide choice that customers now have of paying for and carrying tickets, there are opportunities across the customer journey, to market and sell ancillary goods and services. Rail companies can track the points at which they can offer personalised goods and services such as refreshments, seat upgrades, as well as insurance and destination attraction tickets.

Smarter transport ticketing can improve the efficiency of a person's journey, as well as the overall experience. The technology is scalable and adaptable to all business sizes, and having ITSO accreditation, which we at ECR uniquely possess, will enable local authority operators to conform to ITSO standards.

> "Innovative mobile-based ticketing systems offer numerous advantages, especially for smaller transport operators, and can be relatively easy to implement. A tried and tested ticketing system, used with one of our larger transport operators, promises to simplify the purchase process, improve the customer experience and reduce cost."

Capturing relevant information, such as passenger needs and preferences across the entire customer journey is important to support marketing and sales campaigns, and will help deliver better customer service, which will improve customer loyalty and revenues. The effective use of big data analytics, linked to smart ticketing mobile apps, for example, can be used to predict customer-specific purchase behaviour, allowing businesses to offer customers greater personalisation and encourage them to spend more.

At ECR, we have worked with a client that needed a system to handle mobile transactions, including ticketing, and which was intuitive enough for staff to use with minimal training and which enabled fast transaction speeds. The company can now log retail transactions on the system, where all sales, stock, tender and operator information is then sent back to the head office, which enables greater strategic insight into customer trends and preferences.

Summary

As the UK government is now accelerating the abolition of paper tickets across the UK rail network, ITSO accredited, smart ticketing will become the standard, and rail and mass transit operators need to up-to-date systems to ensure that passengers can effectively use mobile technology and smartcards to travel across most of the network by the end of 2019.

Across all transport operators, using technologies such as innovative MPOS systems to drive ticketing, linked to smart back-office analytics capabilities improves the passenger and staff experience, and builds customer loyalty, while at the same time increasing profitability. This is a clear win-win for both passengers and transport operators, so embracing change and new technology is key.

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A focus on European Commission policy: Aviation in Europe

Violeta Bulc is European Commissioner for Transport and this article focuses on an aspect of her role that concerns aviation in Europe, as Jonathan Miles, Editor of Open Access Government discovers

Violeta Bulc, European Commissioner for Transport has a number of responsibilities, including facilitating travel in Europe by ensuring that connections between different transport modes, such as railway and air transport are at an optimal level. Another concerns developing a common European Union (EU) standards for transport security and safety to improve the international environment for transport.[1]

This article will give a flavour of one aspect of Commissioner's Bulc's remit, air transport. In early March 2019, we find out that the European Commission publishes a report about the required actions to strengthen the social agenda in air transport further. The opportunities and challenges faced by aircrews (pilots and cabin crew) in Europe were outlined in this new report. Legal certainty for aircrews is, therefore, provided and looking at the wider picture, we know that promoting high social standards is a top priority within the European Union's Aviation Strategy.

Violeta Bulc, Commissioner for Transport says: "The European Parliament, Member States, the aviation industry and social partners have called on the Commission to tackle the challenges aircrews in Europe face today. I am glad that we are delivering on this by putting forward a report that identifies concrete actions to maintain and promote high social standards in the aviation sector."

By way of background, we know that the EU aviation sector directly employs 2 million people, and overall supports 9.4 million jobs, thus benefiting the EU economy by €110 billion every year and in addition, is a central part of the EU's policy ambition to facilitate both jobs and growth.[2] In a statement from the European Commission in January this year, we find out that 2018 was a good year for transport in the EU and, of course, part of that is to do with aviation as some extracts from the statement below explain.

"New EU rules to better support the mental fitness of aircrew were introduced. This comes as a follow-up to the GermanWings Flight 9525 crash. The rules include a support programme, alcohol testing and psychological assessments for aircrews.

> "All transport modes should contribute to the decarbonisation of our mobility system. The goal is to reach net-zero emissions by 2050. This requires a system approach with low and zero emission vehicles, strong increase in rail network capacity, and a much more efficient organisation of the transport system, based on digitalisation; incentives for behavioural changes; alternative fuels and smart infrastructure; and global commitments. All this driven by innovation and investments."

"In aviation: decreased emissions/km by 40% vs. 1992; new A330neo with leap engine uses 25% less fuel. With new technologies, we gained an additional 36 seconds, and cut kerosene consumption by 5kg per flight."[3]

In an additional positive development, in March 2019, we learn that the European Commission and the State of Qatar initialled an aviation agreement which is the first time that this has happened between an EU member and a country from the Gulf region. In essence, the agreement upgrades the rules and standards for flights between Qatar and the EU. In this vein, a new global benchmark is committed when it comes to fair, strong, competition mechanisms, and including provisions not normally included as part of bilateral air transport agreements, such as environmental or social matters.

Violeta Bulc, European Commissioner for Transport

Expressing delight at the news of an agreement that goes far beyond traffic rights, Commissioner for Transport Violeta Bulc comments: "We delivered! Qatar was the first partner with whom we launched negotiations following our adoption of the Aviation Strategy for Europe – now it is also the first one to cross the finish line! More than that – the agreement sets out ambitious standards for fair competition, transparency or social issues. It will provide a level playing field and raise the bar globally for air transport agreements. This is a major upgrade compared to the existing framework, and our joint contribution to making aviation more sustainable!"

Not forgetting the wider perspective, it's important to say that this agreement fits in with the EU's concerted efforts to ensure open, fair competition and high standards for global aviation, in keeping with the Aviation Strategy for Europe.[4]

Finally, let's think about the European Commission's ambition for a climate neutral Europe by 2050. We know that near the end of 2018, they adopted 2050 – A Clean Planet for all. The strategy shows how Europe can lead the way to climate neutrality in a number of ways, for example, by investing in realistic technological solutions and empowering citizens. Let's then leave the last word to Commissioner for Transport, Violeta Bulc who shares her exciting thoughts on the role of transport as part of this wider climate picture painted here.

"All transport modes should contribute to the decarbonisation of our mobility system. The goal is to reach net-zero emissions by 2050. This requires a system approach with low and zero emission vehicles, strong increase in rail network capacity, and a much more efficient organisation of the transport system, based on digitalisation; incentives for behavioural changes; alternative fuels and smart infrastructure; and global commitments. All this driven by innovation and investments."[5] ■

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flexJET project: Converting flexible waste biomass into sustainable aviation fuel

The Horizon 2020 flexJET project, coordinated by the University of Birmingham, will validate a new integrated process to produce sustainable aviation fuel from waste biomass, Dr Miloud Ouadi explains here

On 28 November 2018, the European Commission presented its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050, showing that decarbonisation is possible, including the role of the aviation sector where no viable alternative to hydrocarbon fuels exists to date.

The strategy shows how Europe can lead the way to climate neutrality by investing into realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research – while ensuring social fairness for a just transition.

From an aviation perspective, the European Union (EU) has invested approximately €5 billion over the last 10 years to support these commitments through various programmes, e.g. Horizon 2020, and a basket of measures, e.g. the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

In 2016, aviation was accountable for 3.6% of the total EU28 greenhouse gas (GHG) emissions and for 13.4% of the emissions from transport, making aviation the second largest source of transport GHG emissions after road traffic. Greenhouse gas emissions from aviation in the EU have more than doubled since 1990 when it accounted for 1.4% of total emissions due to growth in air transport. As emissions from non-transport sources decline, the emissions from aviation become increasingly significant. European aviation represented 20% of global aviation's CO_2 emissions in 2015.

The Commission's vision for a climate-neutral future covers nearly all EU policies and is in line with the Paris Agreement objective to pursue efforts to keep the global temperature increase to 1.5°C. While this covers all man-made emissions, including aviation, measures to reduce these emissions are covered by the Nationally Determined Contributions under the Paris Agreement as well as global measures developed through the relevant international organisations, such as the International Civil Aviation Organisation (ICAO).

The Renewable Energy Directive (RED) targets do not apply to aviation fuel. However, in 2015, the RED was amended to recognise the possibility of a so-called 'voluntary aviation opt-in' to implement in national legislation, which was taken up by the Netherlands and the UK.

Innovative process for aviation biofuel production

The last decade has seen considerable progress in developing Sustainable Aviation Fuels (SAFs) produced from bio-based feedstocks that have lower carbon intensity, and which consequently could play an important role in mitigating the environmental impact of aviation.

flexJET is a four-year project part funded by the European Commission through the Horizon 2020 research initiative. 13 partners from five different European countries are coordinated by the University of Birmingham in UK. As part of Horizon 2020's new research and innovation programme, it is assisting in the long-term goal of bringing innovative biofuels from sustainable raw materials to the market.

The innovative flexJET project is diversifying the feedstock for sustainable aviation fuel beyond vegetable oils and fats to biocrude oil produced from a wide range of organic waste, diverting it from landfilling or incineration. The process offers better economics and improved overall sustainability by processing waste feedstocks near the source and at a scale that matches the waste availability. This is also one of the first technologies to use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximising greenhouse gas savings and further contributing towards the Paris Agreement GHG reduction goals.

"The main aim of the project is to deliver more than 1,000 tonnes of aviation fuel from sustainable biogenic

GFR's contribution in the Sustainable Jet Fuel from Flexible Waste Biomass (FlexJET) project presented to His Royal Highness, Prince of Wales during his visit to Green Fuels at Berkeley, Gloucestershire, UK.

waste feedstocks. This will mark the first pre-commercial plant for subsequent future deployment", says Dr Miloud Ouadi from the University of Birmingham.

The project consortium comprises key industrial stakeholders with the knowledge and expertise to develop and implement a full commercial scale technology. "The key industrial partners consist of stakeholders with expertise from across the whole value chain and include feedstock providers such as BIGA, engineering providers such as Green Fuels Research, Susteen Technologies, HyGear Technology and Services, and Fraunhofer Umsicht, and industrial partner for the downstream SAF supply chain and access to the aviation market such as SkyNRG", says Ouadi. Academia is also heavily involved, with collaborators including the University of Bologna in Italy and the University of Birmingham and the University of Sheffield in the UK. Specific tasks supporting the technology/knowledge transfer and public outreach are being led by LEITAT, ETA-Florence and WRG Europe; project partners with valuable expertise in these fields.

The plant will combine a "Sustainable Aviation through Biofuel Refining" (SABR) process from Green Fuels Research for the refining of biodiesel from organic waste oils with Thermo-Catalytic Reforming (TCR®) technology (an advanced form of pyrolysis) from Susteen Technologies that will produce biocrude oil from waste food and other low-value organic solids. The hydrogen required for the refining steps will be separated from the syngas (an output of the TCR® process) using a decentralised technology from the project partner Hygear.

The size of the commercial plant will be determined by economic data from the project, which will optimise the plant size versus waste collection radius. This means that the commercial-scale facility could be a regional network of local small-scale SABR/TCR® reactors instead of a single large-scale unit. Each plant can be integrated into existing infrastructure.

flexJET project has been presented to HRH the Prince of Wales during his visit to Green Fuels Research laboratories in December 2018. "The Prince was shown the potential impact of SAF in decarbonising aviation and heard how the UK is leading the way in the processing of waste in this game-changing field," says Dr Sergio Lima, Green Fuels Research's Senior Research Scientist.

This project has received funding from the EU's Horizon 2020 Research and Innovation programme under grant agreement No 792216.

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EU financing: € 9,999,732,51
H2020- LCE-2017-RES-IA
Duration: 48 months (2018-2022)
www.flexjetproject.eu

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Europe: Moving toward a sustainable Common Industrial Policy

The policy priorities of Elżbieta Bieńkowska, European Commissioner for Internal Market, Industry, Entrepreneurship and SMEs are explored here, with a special focus on moving towards a sustainable Common Industrial Policy across Europe

In a keynote speech at EU Industry Days 2019 in February, Elżbieta Bieńkowska reveals her thoughts on why moving towards a sustainable Common Industrial Policy is a joint responsibility. In her opening remarks, she highlights that in Europe the economies are changing at a very rapid pace but that the digital revolution offers massive opportunities for firms to be more efficient.

As well as the offer of new products and services, Commissioner Bieńkowska stresses that it presents new opportunities for citizens, such as more and better jobs and most importantly, improvements in the lives of people such as e-health and treatments for illnesses at a much lower cost.

The Single Market: Opportunities and challenges

It is Commissioner Bieńkowska's belief that today, Europe is in a strong position because of the Single Market. While it is the most important asset to help companies to be resilient, we find out that many in Europe do not see the future as a bright one. She explains this point further in her speech.

"There are many who fear that they will become victims of this change, their job replaced by a robot or their company relocated. When we talk about opportunities, they ask whether these are limited to those that meet in Davos. When we talk about digital innovation, they worry about data privacy and data leaks.

Elżbieta Bieńkowska, European Commissioner for Internal Market, Industry, Entrepreneurship and SMEs

Image: © European Union , 2018. Source: EC – Audiovisual Service Photo: Lukasz Kobus

"And think about young students protesting to speed up action against climate change. Some of our global counterparts answer these fears with new tariffs, new subsidies, breaking international rules.

"Renationalisation and protectionism, building walls around their countries and their ailing industries. We are not immune from that sentiment in parts of Europe."

She adds that today, there are now more barriers in the Single Market than ten years ago. In this vein, she paints a picture of fears and frustrations that cannot be ignored and as such, she says it is important to listen more to citizens and address their concerns. It's vital that citizens trust both government and industry, Commissioner Bieńkowska's stresses. In her speech, she outlines more of these frustrations in her own words.

"When our citizens complain about certain large corporations evading taxes, they are right. When our citizens get angry about car manufacturers installing cheat devices, I agree. When they say that globalisation is littering our oceans and is polluting our air, they deserve action.

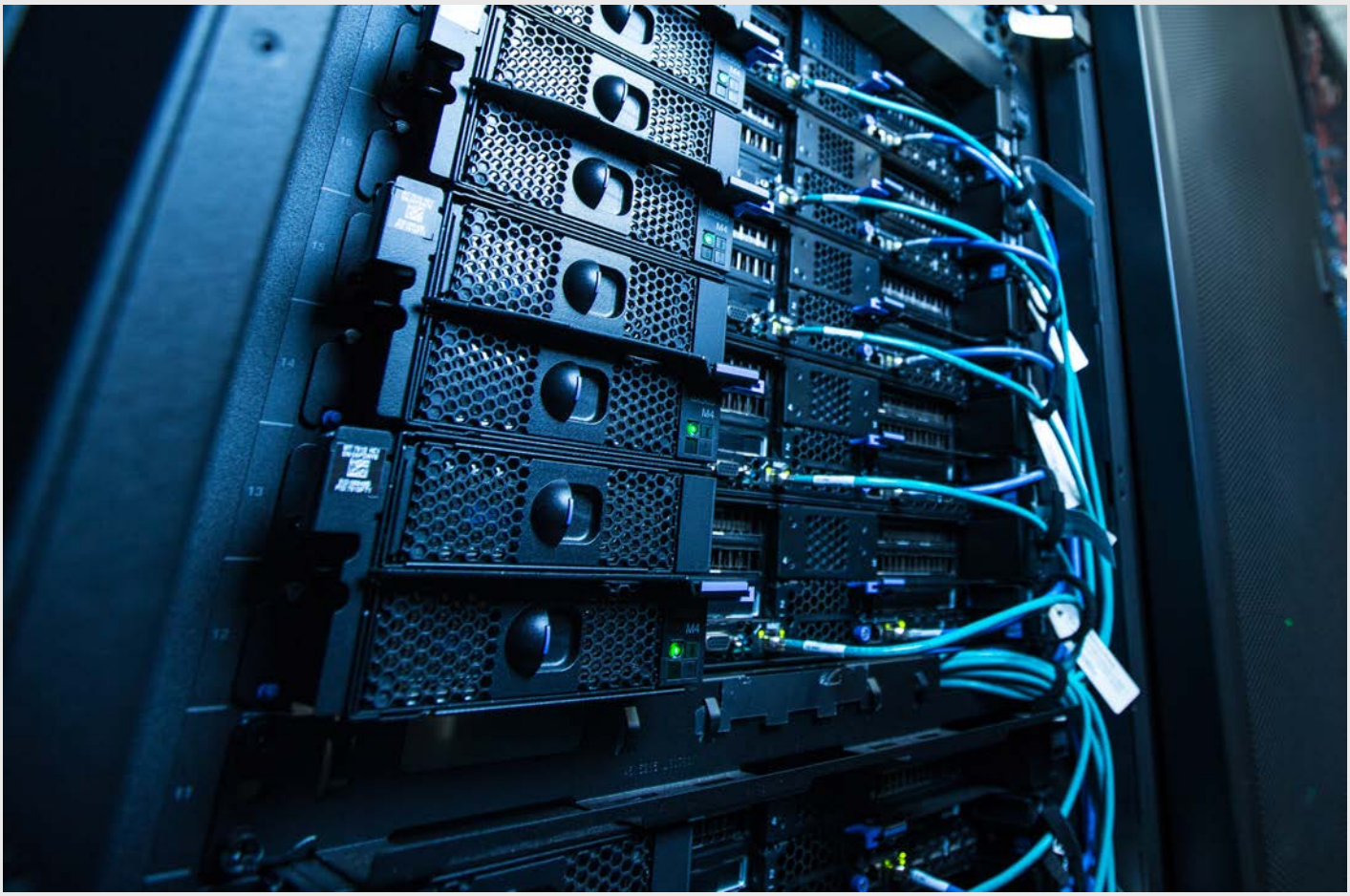
"We need a balance between encouraging digital transformation, innovation and globalisation on the one side. And ensuring that the benefits are felt by all our citizens, that rules are fair and that business is sustainable on the other."

The response of the European Commission

In terms of how the European Commission is responding to the aforementioned concerns, Commissioner Bieńkowska believes that progress has been made. She goes on to say that for the very first time, the European Commission has adopted an integrated approach to industrial policy, that links together the areas of investment, innovation, skills, decarbonisation and of course, the Single Market.

She adds that in addition to promoting digital transformation, the European Commission is, for example, doing more on standardisation to make European values into global standards. She highlights what has been achieved with Eco-design and REACH, as well as tapping the potential of artificial intelligence (AI) and other areas in her own words.

"On globalisation, we have presented a proposal for a European framework to screen foreign direct investment. We are working to reform the multilateral trading system.



"And we are increasing access to third-country markets. As you know the Japan-EU free trade agreement just entered into force. But perhaps the biggest shift has been towards decarbonisation, circularity and sustainability.

"Look at the Battery Alliance. Europe needs to invest in a competitive and sustainable battery industry. We need large investments in several EU countries. So this Alliance is about joining forces with Member States and industry."

The need for more action

Commissioner Bieńkowska's then underscores the need for further action, commenting that while voluntary approaches sometimes work, more effective enforcement is often a better tool. As such, she says that the European Commission should not shy away from regulating where it is both necessary and proportionate. In this vein, she reveals some really important priorities.

"We must tackle the digital threats and move to a true Security Union. We must be in full control of our telecom and internet networks. We must be prepared against hybrid warfare. We must enforce the GDPR. We must resolve data ownership in areas such as car data and medical data. Tech companies must play their full role."

She then turns her thoughts to focus on globalisation, explaining the importance of preserving the benefits of openness, while mitigating its side effects. While all international partners must abide by the same rules, Commissioner Bieńkowska makes it clear that China is the elephant in the room. We find out that while China is a member of The World Trade Organization (WTO), it is not a part of the Global Procurement Agreement. She then remarks in her own words how this can be addressed in Europe.

"To address this in Europe, I call upon the Council to move forward with the International Procurement Instrument. We have to give Member States the tools to defend themselves.

"Europe welcomes Foreign Direct Investment, but we cannot be naïve. We cannot allow investments to threaten our political system and our security.

"Our EU FDI screening is probably just the first step. All Member States should have the possibility to block FDI on national security interests. We are not yet there."

Commissioner Bieńkowska then adds that globalisation also means working with other countries, such as Australia, Canada and Japan – plus doing more when it comes to the all-important areas of decarbonisation, sustainability and circularity which pose a challenge, as well as an opportunity.

The crux of Commissioner Bieńkowska's message is that while industrial policy can be an engine of convergence, the EU cannot deliver this on its own. Certainly, a Common Industrial Policy means that no region or worker will be left behind. She then explains more about how the European Commission will be helping the regions.

"Regions know best how to help themselves, if we enable them. Each region must have enough leeway and resources to do what they know best.

"We must support them in their transition, to make sure no region perceives the Single Market as making them worse off. To provide their workers with the right skills for the future. Our Smart Specialisation Strategy is just about this."

Commissioner Bieńkowska believes it is important to be strategic, which defined precisely means shifting from state aid control to state aid policy that focusses on strategic value chains.

"We have to protect these value chains with trade defence instruments and FDI screening. We already identified the strategic value chains: High Performance Computing, batteries and microelectronics. During the Industry Days, we will unveil our additional proposals."

In closing, Commissioner Bieńkowska shares her thoughts on her desire for Europe to produce zero-emission cars. In this spirit, she calls for incentives to develop clean production technologies rather than bans.

"I want innovation and technology to be the solution and to pave the way to sustainability. We need artificial intelligence to reduce greenhouse gases by managing traffic flows.

"We need renewable bio-based materials that make our industries globally competitive. Our circular economy strategy is just about this.

Our long-term energy and climate strategy was written in this spirit."

Her last point is all about making industry responsible, in that they should provide economic leadership and innovation. Let's close this glimpse into industrial policy by reflecting on the words of Commissioner Bieńkowska, who stresses that industry must place sustainability at the heart of its strategy and operations, as opposed to just being an add-on label. She comments it is about business taking legitimate commercial decisions in a manner that respects the environment, human rights, society, and most importantly, European values. It's vital that the industry pays its fair share of taxes and by doing so, this ensures sustainable growth and profits, as well as new market opportunities.

"The Common Industrial Policy will deliver on convergence. And European industry will take the global leadership and shape this industrial revolution to the benefit of our societies." ■

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Resourcing modern industries by responsive mining solutions

Kate Moore, Senior Lecturer, University of Exeter, discusses whether small mining operations can supply the raw materials for manufacturing of modern technologies

The mining industry needs to supply a greater volume of a greater range of commodities than ever before, due to both growing global demand in traditional industries and the emergence of new industries based on innovative technologies. Rocks are extracted dominantly from large 'world-class' ore deposits, and then they are crushed and ground using energy-intensive techniques, before they are processed to extract metals for the construction, electrical and battery production industries, to name but a few.

Large high-grade (i.e. metal-rich) ore deposits are becoming depleted and the mining industry is required to deal with low grades of bulk metals in ore deposits, large infrastructure to deal with high throughputs of rock, and large feasibility studies to prove long-term commercial viability. A mining paradigm has been created that is dependent on innovation in mining techniques that improve the economies of scale.

There is a particular problem in applying the large-scale mining paradigm to raw materials that are produced in small quantities relative to traditional metal commodities. Demand can be satisfied by a very small number of mines in few geographical locations and any disruption to production at one of these mines can impact the supply of strategic raw materials. This can potentially impact global manufacturing of interactive communication devices, low carbon transport vehicles and the infrastructure for renewable energies. The term 'critical raw materials' has been used to describe the commodities that are deemed to be at risk of short supply[1].

A mining industry that can diversify production beyond world-class and low-grade ore deposits has the potential to create a more resilient supply of critical raw materials. History shows us that mining of small, high-grade deposits has been successful since antiquity and suggests that a return to small-deposit mining, for some commodities at least, can be considered as a viable solution.

The economic climate for switch-on switch-off (SOSO) mining

Production from large mines with reduced operating costs (OPEX) requires exceptionally high capital investment (CAPEX) to start operations. Investment is much reduced in the recent economic climate and the raw materials market has stagnated. Many small companies have ceased to trade and only those companies that hold the largest ore deposits are secure. A reduction in the number of smaller operators on the market will concentrate production even further. This can potentially increase risks to security of supply and limit the ability of the raw materials market to respond to increased demand for raw materials or shortages in raw material supply. The problem is most extreme for critical raw materials that are produced in small quantities relative to traditional metal commodities because the potential return on investment is too low.

The IMP@CT project proposes a solution that develops a new switch on-switch off (SOSO) mining paradigm (as opposed to traditional processing solutions that run continuously irrespective of external influences). SOSO mining is a low CAPEX, but acceptable risk, mining solution for well-explored regions, with the flexibility to react to market fluctuations. The flexibility is created by the use of containerised, mobile and modular equipment that can be adapted for geological and metallurgical variability, enabling an individual operator to move operations. It requires total solutions that reduce the volume of rock extracted and reduce the creation of an environmental legacy.

Successful business models for SOSO mining would: 1, lower the barriers to entry of new operators to the market, which would reduce production concentration; 2, smooth possible future over-production crises; 3, facilitate mining of metals that are consumed in relatively small quantities; and 4, allow raw materials production to respond rapidly to global developments in the supply and end-user industries.

Kathryn Moore, Senior Lecturer in Critical and Green Technology Metals

Sustainability in SOSO mining

Mining of large, low-grade ore deposits is accompanied by concerns around the increasing cost of energy consumption and waste generation, and changing patterns of transportation. This has the potential to create space in the market for small-deposit conventional mining with technological solutions that are highly competitive. The whole systems approach that we have adopted to realise the SOSO mining paradigm centres around innovations in exploration, planning and equipment for mining and processing. We consider the innovations for selective extraction from small deposits in the context of social and environmental sustainability. Mining of high-grade deposits requires lower throughput of crushed rock, it generates less waste and uses less land.

Small-deposit mining tends to be a limited, short-term initiative, which raises the pressing need to consider the extended 'afterlife' of mines, and the accelerated transition from a mining to post-mining community. The development of a mining paradigm that is appropriate for commodities required in small quantities hinges on whether mining operations are socially and environmentally acceptable, and of benefit to local communities. Only then can mines be licenced to operate with accelerated mine start-up and for short time intervals.

Recent activities in IMP@CT

The IMP@CT partners have developed a prototype mining tool and mine plans for selective underground extraction, and built a mobile and modularised ore-sorting, comminution and minerals processing test facility. We have undertaken extensive research on the potential for adoption of the SOSO mining method across Europe, new exploration methodologies for small deposits, methods for prediction and mitigation of environmental issues, health and safety practices and social acceptance. To see how the IMP@CT mining solution operates on an active mine in 2019, follow us on impactmine.eu

IMP@CT has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 730411.

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Digital transformation: The bridge to the future

Sneha Mishra, Quality Assurance Manager at InterActive Pro and Edology.com explains why digital transformation is the bridge to the future when it comes to how an organisation delivers value to its customers

Digital transformation is a foundational change in how an organisation delivers value to its customers. This involves the building of a digital ecosystem in which there are coherence and seamless integration between customers, partners, employees, suppliers and external entities, providing greater overall value to the whole. Fundamentally changing how an organisation operates, though, is a component of exponential digital transformation. This requires a fundamental shift in the thinking of the entire organisation and holistically embracing change using digital technology for all processes and interactions, both internally and externally.

It is rightly said that "strategy, not technology, drives digital transformation."

The adoption of upgraded technology does not ensure digital success, as much as being digitally fluent doesn't refer to being a master in technologies. It actually calls for the ability to articulate the value of digital technologies to the organisation's future.

Digital transformation is about transforming how a company operates and engages with customers by leveraging technology and data. Companies today need to continuously find new sources for customer value. Earlier, the value proposition was defined by the company. Today, the value proposition is being defined by changing customer needs as the customer is now at the centre of all business decisions.

Need for a digital transformation framework

The objective of any business is to continuously improve its products and services to meet the changing needs of its customers. This requires businesses to rethink their work to constantly improve margins and decrease costs through a digital business transformation. The adoption of a digital framework not only equips an organisation to improve its operations but also accepts and executes innovative and disruptive strategies.

These strategies enable the company to compete in the rapidly changing market conditions that are highly influenced by changing customer expectations, technologies and new commercial models. The digital framework provides an appropriate strategy and roadmap that allows organisations of different sizes to grow and succeed rapidly in the changing market conditions.

> "Digital transformation has been on the agenda of organisations for years, and 2019-2020 is predicted to be a crucial time for leaders to plan for and implement it across industries."

Probably the greatest example of an existing organisation undertaking digital transformation can be found in the creation and evolution of platforms such as Netflix, going from DVD rentals to online subscription-based entertainment streaming, including original content creation. Digital transformation has become a corporate imperative.

Benefits and challenges of digital transformation

Digital transformation is dependent on managing the exponential growth, intrinsic value and movement of data. It requires incorporating and managing data in a complex, hybrid world where data resides in your data centre, in the cloud, at the edge, and through externally linked applications and platforms. The growth and manageability of that data need to be effectively governed to ensure data sovereignty, security and cost containment.

The future of digital transformation

Digital transformation has been on the agenda of organisations for years, and 2019-2020 is predicted to be a crucial time for leaders to plan for and implement it across industries.

Among senior executives, there's widespread recognition that the role of digital technology is shifting, from driving marginal efficiency to be a catalyst of innovation and disruption. This means that in the coming years, a number of decisions must be made to avoid or risk falling prey to competitors and disruptors.

When it comes to a timeframe, 85% of key decision makers feel they have only two years to get to grips with digital transformation. So, while the past few years have seen some movement in digital transformation, there's now a renewed urgency to get up to speed. Considering that 59% of business leaders worry that it's already too late for them to adapt, time is of the essence.

About the author

Sneha Mishra is a Quality Assurance Manager at InterActive Pro and Edology.com. She has 12 years of experience in the IT, education and food industry, working on project deliveries across various domains including banking and finance, energy and telecom. She has participated and implemented high standard process-oriented quality structures across companies with a global footprint. ■

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Why digital transformation in education matters

Peter Richardson, Senior Marketing Manager PFU (EMEA), explains why digital transformation in education plays a crucial role

When the Final report of the Commission on Assessment without Levels was released, it recommended that schools should build an assessment framework to check what pupils have learned and whether they are meeting expectations, and to report to parents and other stakeholders.

A significant part of this system is collecting assessment data, however, the report acknowledged that many teachers found data entry and management in their school burdensome. This is where the right technology solution can make a difference.

Capturing evidence of progress

Technology can play an important role in capturing the detail of students' work, which helps teachers and parents monitor how a child is progressing. By documenting handwriting and creative work, for example, comparisons can be made at intervals against content already stored digitally, leading to a better understanding of who is improving and who requires more attention.

In addition, when schoolwork is available digitally it can be more easily shared. Some schools already capture all student content each day and share it directly with parents, instead of requiring children to take home physical documents.

Supporting school administration

Document capture solutions also help schools' administrative duties, such as managing permission slips and invoices. An OCR-enabled (optical character recognition) scanning device can extract the relevant data from the forms, saving time on manual data entry. Some universities also use this technology to capture data on lectures.

Instead of asking students to complete online forms to provide post-lecture feedback, they are given paper versions in the room. These are then scanned, and the information captured digitally, which is leading to higher response rates and helping to improve teaching.

Reaching the right stakeholders

Schools that cater for excluded and special needs students face additional challenges as they often have to liaise with a range of stakeholders, such as the SENCO (special educational needs coordinator), child services, councils, other schools and the students' parents, who each regularly require different datasets.

By digitising documents used by, and about, school children – and harnessing OCR – these schools can capture all the necessary data at once and, by using the right solutions, send that information directly to the relevant party safely and securely.

Data compliance

Under new laws, individuals have the right to access their personal data. This is commonly referred to as 'subject access requests' and, while schools currently only receive very few, this is expected to increase. With much of the information currently only available in paper format, responding to such requests is time-consuming and could potentially lead to non-compliance if the requested data cannot be found. Paper records are also less secure than a fully managed digital platform, and security is an issue teaching institutions must address now that the general data protection regulation (GDPR) is in place.

By implementing digital working practices, including the scanning and digitisation of administrative and student material, schools can very quickly see the benefits that they bring to staff members, pupils, parents and wider support personnel.

Visit https://www.fujitsu.com/uk/products/computing/peripheral/scanners/education/index.html for more information about how Fujitsu supports educational institutions.

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FUJITSU

Placecube's Digital Place: Building an ecosystem of digital services

Dr. Gavin Beckett, Executive Director of Placecube, discusses his vision on building an ecosystem of digital services based on common service patterns

In my career to date, leading digital for Bristol City Council, and then working with the Ministry of Housing, Communities and Local Government (MHCLG) Local Digital Declaration team, several things have become clear to me.

- Our services and the whole business model of local government need to be designed afresh, based on an understanding of user need, if we are to adapt successfully to continued austerity and the impacts of Brexit – the new normal.

- There has been good work by a small number of leading councils, tackling a small number of the many things councils do. But it's been limited to those councils and has cost them a lot of money and time.

- As a sector we cannot afford for every council to spend the budget and elapsed time to design every one of their services from scratch. It just won't happen... too many councils will fall off the financial cliff edge before they get very far.

- The answer cannot be for the majority of councils to remain trapped in their current forms with their current IT and digital products and services. Nor can it be for one single system to replace the hundreds in use across the UK – there is no political or commercial support for a single Local GDS, GOV.UK or the equivalent of the ill-fated NHS National Programme for IT.

So, what can we do?

Working with the MHCLG Local Digital team last year I was privileged to be part of the collective drafting and publication of the Local Digital Declaration. I support the intent behind it – when a service is designed in the internet age, the user research, interaction and content design/service patterns, data structures, API and integration definitions should all be published openly so that they can be implemented by other councils and by suppliers who want to support this good practice.

Once there is a recognised pattern and model for implementation of the digitally enabled service that meets user needs, councils should expect their suppliers to offer products built on those patterns – and not to extract a premium for it!

Re-use will lead to reduced costs for a better outcome, and if councils across the country can adopt them easily and cost-effectively, it will contribute to a massive reduction in cost across the sector.

The great digitally enabled services that were built by suppliers with councils like Bristol, Hackney, Camden, Stockport and Southwark are largely based on open source code which in many cases has been published openly on GitHub.

But it's not easy to pick them up and place them down into another council with different technical infrastructure and back-end systems. We need to pay attention to the standards needed to wrap these systems in a way that makes them interoperable and portable, with clean boundaries and well-defined services and interfaces.

If we can define a set of ecosystem standards that enable multiple building blocks to be used together in a way that ensures they will fit – like Lego™ – we will move further towards the vision of local government as a platform that people like me, Dave Briggs and Mark Thompson have been writing about for the last few years.

That's the vision we have at Placecube – we want to create that ecosystem based on open standards, where we can provide a re-usable set of building blocks "Cubes" based on the work we've done with Bristol and Camden, for other councils to adopt easily and cost-effectively.

But unlike many of the legacy suppliers in the local government market, we don't want to lock customers in and push you to buy everything from us – we want to be able to easily incorporate the best digital services from other suppliers, who have already understood user needs, worked to design services and then realised them with new code.

We invite them to work with us on the common standards needed to ensure

Dr Gavin Beckett

services can be composed together by councils who want to re-use the great work that has already been done. And whilst councils are the democratic centre of the local place, we know that people, businesses and visitors to the area interact with hundreds of other organisations that provide services, advocacy or information advice and guidance.

Our vision of an open ecosystem is more than just councils being able to use better digital services, it is to digitally connect the network of organisations in a place, enabling them to provide or access data, services and to collaborate on meeting community, individual and local business needs.

For further information take a look at the Place Designs already being used to run leading UK local public services at www.placecube.com .

PLACECUBE

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Observations on pragmatic digital transformation

Rob Fotheringham, Managing Director at Fotheringham Associates shares his thoughts on pragmatic digital transformation and the observations he has made in this vein which will help you on your journey

First of all, context is everything. We seem to be surrounded by the words digital and transformation. Public sector tenders, job adverts and press articles (and yes, I do realise I have just added to their number) are all talking about something that is not particularly well defined or understood. My objective is not to provide you with a theoretical definition but simply provide a pragmatic example and make a few observations to help you on your journey.

Our team at Fotheringham Associates have considerable experience in financial services and large corporates but have more recently worked within the public sector. Our effort with local government organisations has been on projects focussed on increasing their capabilities in order to meet the challenges of digital transformation and to better manage suppliers on their journeys.

After a good mix of industry sectors and countless projects, we have become pretty good at solving problems. We then met some very committed, passionate people who were trying to solve a really big problem.

Lambeth Early Action Partnership (LEAP) is an innovative £36 million, 10-year programme funded by the National Lottery Community Fund (previously the Big Lottery) as part of their A Better Start initiative to improve the life chances of babies and young children living in the London borough of Lambeth.

LEAP is trying to solve the problem of child inequality in one of the most deprived areas of London. Whilst we do not possess the skills to solve this problem, we knew we could help them with their challenge.

If you want to read about chat-bots and the Internet of things (IoT), then this is probably not the article for you. However, if you want to see a real-life example of using digital technology effectively to enable people to make a difference, then this may be for you.

Our challenge

LEAP is a complex programme consisting of a large range of service providers including several NHS Trusts, Clinical Commissioning Groups (CCGs), three departments of the Council, a number of charities and a host of community groups. These service providers deliver 30 different inventions helping pregnant women, children under four and their families.

The service providers collect information via their own systems and send it quarterly to LEAP who report to the funder on the beneficiary reach. The funder requires the reach reporting to only include unique beneficiaries. The problem was, therefore, how to achieve this when all data is collected by the service providers and new GDPR and data protection rules would inhibit the sharing of personal information openly. We had to understand how the interventions provided by the service providers worked in order to firstly rectify information governance concerns around consent. Once we were happy that personal information could be collected, we had to find a way of sharing it whilst also protecting it, for this we decided to use an open-source pseudonymiser.

Finally, we had to find a way of collating the information and automatically processing it to manage unique beneficiaries across the programme. An Azure Cloud Data Factory will be used to securely martial, pseudonymise and process the data across LEAP. This solution automates the most time-consuming aspects of the data management, delivers the critical requirement of the funder and builds a rich dataset that is ready for the evaluation and analytics stage of the programme, but that as they say is another story.

Some thoughts on your digital journey

Don't become seduced by the "bells & whistles". Having a bot automate part of a bad process just creates bad results and extra work, faster. Focus instead on the aspects that can deliver real benefit from digital change. This pragmatic approach will help to turn digital transformation from a mythical creature into something that all organisations can embrace. In our

scenario, the key area was in the processing and collation of information, data validation and preparing the data for reporting. Even with only half the service interventions up and running, the back-office team were struggling to stabilise the information by the end of the quarter. In addition, the funder's requirement for the identification of unique beneficiaries was still outstanding with no solution known. This, therefore, was our target for transformation.

It might be a cliché, but keep it simple. At least the part that your key users interact with. New digital solutions should be as familiar to use as possible and certainly no more complex than the current situation. In many cases, it is about bringing technology familiar from people's personal life into their work environment. In our situation, expecting potential resistance to change, we looked at alternative ways of the service providers submitting their information. We decided upon the approach that would be the most familiar for them; simply logging into a website and navigating to select a file. This is an operation that the users were familiar with from a host of applications, including the creation of photobooks to show their holiday snaps.

With all that digital technology to think about, don't forget human behaviour. In an increasingly crowded life, many humans will want to take short cuts, leave things as late as possible and focus on what they consider to be their most important task. In our case, that could be clinicians leaving the data preparation to the end of the reporting period and then entering the bare minimum of data that they can remember, or still have close to hand. Their focus, under an incredibly heavy workload, is the practical intervention they make with their clients. However, without good quality data, there would be no funding and, therefore, no interventions to focus on. So as well as keeping processes simple, as mentioned above, we recommended changing the collection periods to monthly rather than quarterly and to introduce automated data quality checks before accepting their submission. This is aimed at driving behaviour to see that the data collection activity is actually part of the intervention with their clients and not simply an administrative task at the end of the quarter.

Now, where did I see that other mythical creature?

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Agile software development and the delivery of digital services

Kent J. McDonald, Content Curator at Agile Alliance lifts the lid on Agile software development and the delivery of digital services

Agile software development is an umbrella term for a set of frameworks and practices based on the values and principles expressed in the Manifesto for Agile Software Development and the 12 Principles behind it. Those values and principles emphasise delivering value to your customers, responding to change, and collaboration.

Agile frameworks and practices are particularly helpful if you work in complex or uncertain environments where you know you have a problem to solve, but you're not exactly sure what that problem is and you certainly don't know what the solution is.

Agile frameworks encourage short feedback cycles in the form of frequent deliveries followed by feedback and adjustment. These short feedback cycles help you to validate assumptions, discover the true problem, and identify a proper solution.

When you work on digital services, you interact with people outside your organisation, such as customers, constituents, or suppliers. Those interactions happen on your organisation's website, mobile app, or through software that allows people outside your organisation to self-serve and engage directly with one or more of your processes.

The minute you interact with people outside your organisation, you inherently enter an uncertain and complex domain. You have no control over whether they use your new digital services, so you have to look at those digital services as you would a product. You have to figure out what will encourage use of the services. You have to figure out how those services can add meaningful value to your customers, constituents and suppliers.

You need to learn what customers, constituents, or suppliers find valuable. You need to learn how to apply the values and principles expressed in the Agile Manifesto to provide them with that value. You can do this most effectively by delivering a small piece of your solution and getting feedback. You need to operate in an Agile fashion.

Digital services add value in the private and public sectors

Many organisations view digital transformation as a way to bring efficiency and cost savings to their organisation and its processes. After all, why employ staff to interact with your customers when you can set things up to allow them to self-serve?

This is a short-sighted view that may do harm to those organisations in the long run. Anyone who has fallen into an endless phone tree loop or been lost in a poorly designed online request form can attest to the damage a poorly designed digital service can do to an organisation's reputation in the eyes of its customers.

If you want to adopt digital services your primary focus should be on providing value to your customers. How can you make getting services from your organisation simpler? How can you make your customers want to do business with you? Design those services right, and they will often add an additional way to interact with your organisation rather than replace an existing means. Design those services right, and you will add value for your customer and generate benefits for your organisation at the same time.

The same applies to organisations in the public sector. Replace customers with constituents, and the above still holds true, but perhaps even more so. When you

create a digital service that is easy for citizens to use and allows them to accomplish what they set out to do, your services are more likely to accomplish the outcomes they were established to provide, and your citizens will have more confidence in your organisation.

Becoming an Agile organisation requires change

In order to deliver digital services that truly add value to your constituents, you have to approach delivering those services in an iterative, incremental fashion. You have to be willing to form hypotheses about your constituents and their needs and prove or disprove those ideas with safe-to-fail experiments.

That type of approach will not happen if the only part of the organisation that changes are the people responsible for developing software. Your entire organisation needs to think how to work in a way that delivers value to your constituents, responds to change, and encourages collaboration. This means that bureaucracy, self-serving actions, and empire building cannot have a place in your organisation.

You have to ask on a regular basis: "How might we structure and operate our organisation in a way that allows us to create and respond to change and deal with uncertainty?" You need to follow up on the answers you come up with.

The change is not easy. The change is not quick. But if you're serious about it, the benefits for your constituents and your organisation are well worth it. ■

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What could GDS and Central Government do better?

Andy Sandford, Director of We are Lean and Agile, answers the question as to what can be learnt from local authorities about processes

Government Digital Service (GDS) and Central Government have delivered so much for digital transformation in the public sector. By leading the way with Agile and the GDS standards, by sharing code, working in the open, creating reusable resources and solutions they have created a path for others to follow. With any process, there are always opportunities to continuously improve as the GDS have with their approach.

One area they can still improve further is process discovery and improvement. I would argue that no matter what approach you are taking to delivering your project you must always understand the current process and be able to improve that and understand the benefits of changes.

> "The local authority, I can confidently say currently is doing this much better"

I see process discovery and improvement as a fundamental building block of any change programme. It's not sexy and new like Agile but lean is a great discipline to deliver real engagement, culture change and benefits. Lean plays a role in all stages of the GDS Agile approach but even more fundamentally maybe, I see it as vital in terms of getting a project commissioned in the first place.

A couple of new (to me) areas of the GDS approach are:

- Spend controls
- Performance platform

I am no expert on either and if you want to get more information have a look at spend controls and performance platform. The reason I highlight these is because I see the need for good governance and the role it plays in supporting the successful delivery of Agile user centred products.

To explain spend controls I can't do better than direct from the GDS page

The **spend controls** process exists to make sure:

- You've considered the needs of the people who'll use the service.
- You get the best value.
- You only spend on programmes and projects that meet government digital and technology strategies.
- Private businesses and members of the public can see how government makes decisions about spending money on digital projects or technology.
- You discover and solve any problems with your service before you spend money.
- You develop services using Agile methods.

I see good governance as vital to delivery and an area where we need to mature in public sector projects. Spend controls to me seem to be ensuring due diligence is followed when commissioning services. For me process discovery and improvement as I understand them (using modern tools) support and deliver outputs to navigate the spend control process.

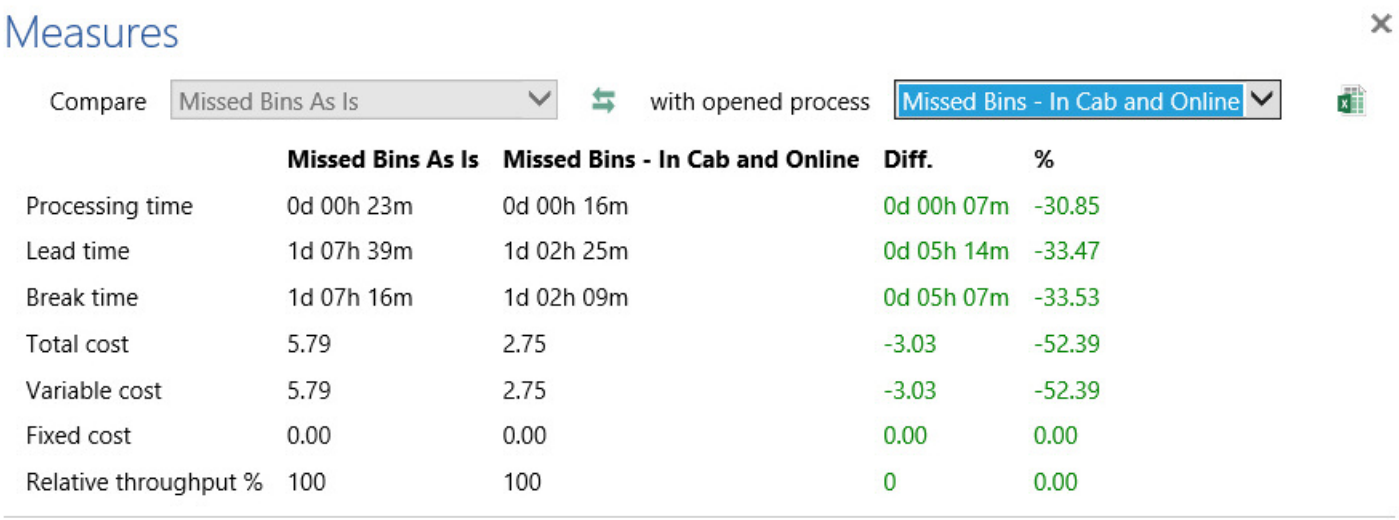
The second item I really appreciate is the **performance platform**. Again, taken directly from the site:

What to measure

You must collect data that shows how your service is performing against these 4 metrics:

- Cost per transaction – how much it costs the government each time someone completes the task your service provides.
- User satisfaction – what percentage of users are satisfied with their experience of using your service.
- Completion rate – what percentage of transactions users successfully complete.
- Digital take-up – what percentage of users choose your digital service to complete their task over non-digital channels.

Again, this is a common governance problem I see as vital to delivery, how do we baseline our current service and measure the benefits of any improvements? This is a common problem and the Performance Platform gives you the 4 key measures all GDS projects must report on (and obviously continuously improve ideally). You can also report additional KPIs specific to your process. In local



	Missed Bins As Is	Missed Bins - In Cab and Online	Diff.	%
Processing time	0d 00h 23m	0d 00h 16m	0d 00h 07m	-30.85
Lead time	1d 07h 39m	1d 02h 25m	0d 05h 14m	-33.47
Break time	1d 07h 16m	1d 02h 09m	0d 05h 07m	-33.53
Total cost	5.79	2.75	-3.03	-52.39
Variable cost	5.79	2.75	-3.03	-52.39
Fixed cost	0.00	0.00	0.00	0.00
Relative throughput %	100	100	0	0.00

government, we often talk about the types of measures to report and this is a great starting point.

In local government, we are always talking about why understanding cost per transaction is vital to the improvement process and how you can measure it very easily with good process discovery and improvement (and modern tools).

What can you (GDS and Central Government) learn from Local Authorities about processes?

We are already working with over 30 innovative local authorities in the UK using our software and approach to support improvement people in their organisations. In the Netherlands, 33% of local authorities use it as well as other public and private sector companies to improve their processes and understand the benefits of change.

Local authorities in the UK are already using our lean process platform to help them understand and improve their processes.

We offer a number of benefits over existing methods of capturing process maps and identifying improvements. I can guarantee the software is beneficial to any approaches.

What does the software help us to do better?

There are many benefits to using this new innovative software, below we list some of the key benefits for your improvement teams:

- Workshop friendly. Build maps live in the workshops projected on a screen. No more wasted time for your improvement teams writing up process maps and no more needs for post-its and brown paper. As the attendees build the maps live in the workshop there are no shocks when they see the results.

- Model, don't map. Our software offers all the benefits of existing mapping tools but on top of that, you are entering times and costs in the process maps. Instead of getting a process map just an image of the process flow you have a fully costed model of your process.

- Powerful analysis tools. With the costs embedded you can now use the analysis tools to highlight bottlenecks, waste and potential areas for improvement.

- Benefits of change. When you redesign your services, you can now compare your current process with the new design and with a button click see the benefits of change.

- Continuous improvement. Don't just put your maps on the shelf after the improvement project. Publish them and use them for team members to collaborate and identify new improvements, challenges or iterations.

Don't just take our word for it have a look at our blogs or get in touch for a demo or the free months trial.

Blog – How do I map and understand my processes

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AgileDS for government and students

University of Hull and Evoco use the Agile Business Consortium's AgileDS™ approach to give graduates the opportunity to develop and grow their skills for government and private sector

The challenge: Matching methodology to demand

Formed in July 2017, Lampada Digital Solutions is a 100% wholly-owned subsidiary of the University of Hull and incorporates the Digital Delivery Academy which is managed by Evoco Digital Services. The Digital Delivery Academy took part in the beta development phase of Agile Digital Services (AgileDS), which was created by the Agile Business Consortium and accredited by APMG International. Through Lampada, university graduates are employed on competitive salaries to deliver live projects to paying clients.

Chris Hewitt of Evoco and Academy Director at Lampada Digital Solutions said an agile methodology was needed that would meet the various educational demands of the trainee developers and the variety of customers they would be working for, which included public and private sector organisations.

The solution: AgileDS

"AgileDS has proved versatile as we are already using it to deliver for several customers including two in central government and one university," says Chris. "For government customers, the developers can fit in really quickly, and for the university, this is a slightly newer way of working but fits in well with their future plans."

One of the key advantages of the AgileDS approach for Lampada is that the training course covers a broad range of topics at different levels of detail. Some are covered in depth and others are at an awareness level with signposting for further resources. This helps give developers a broad understanding of agility and the range of skills needed to fit into a modern team.

Chris added: "The emphasis on user research and user experience has been a real eye-opener as university degrees often focus on more traditional, documentation-heavy methods rather than engaging face to face with real users. This interaction is vital to our way of working and the ability to deliver great outcomes. This is of significant benefit to Lampada's clients, in that they get to see prototypes more quickly, and the outputs are more closely aligned to their needs."

The student developers are receiving training and experience that is closely matched to their future in business, which means that they should be more employable.

The results: Happy students, happy clients

"It's almost like agile has come full-circle from its roots in software development, proven its worth in many other areas and now with the interest in digital everyone in the team needs to know enough about modern software development and AgileDS helps us achieve that."

The most recent intake of graduates started on the AgileDS course on day two of their employment which has given them a flying start when it comes to tackling their first real development project.

Feedback from the students has been good, with AgileDS allowing them to really get to grips with agile working having either only touched on the methods at university or having had no contact with agile at all.

How to find out more:

AgileDS:

AgileDS brings a digital services approach to agile project delivery. The AgileDS qualification provides the knowledge to develop a consistent approach, common language and a skilled workforce for the successful design, delivery and evolution of digital services, using guidance aligned with the Service Manual of Government Digital Service, the UK Government's department responsible for digital transformation.

Learn more and find a trainer:
https://apmg-international.com/product/agileds

Lampada Digital Services:

Lampada Digital Services is based at the University of Hull and is operated in partnership with the Digital Delivery Academy and Evoco Digital Services.

Lampada offers graduates the opportunity to learn and develop their skills on real client projects.

Discover the Digital Skills Academy:
www.dd.academy

Learn about Evoco: www.evoco.co.uk

Agile Business Consortium:

Agile Business Consortium is the not-for-profit professional body for business agility, and we are now in our 25th year. Our mission is to lead, promote and enable business agility worldwide.

We are the brains behind AgilePM®, AgileBA®, AgilePgM® and AgileDS. Through APMG International we have certified over 100,000 Agile Project Managers around the globe. We are the world's oldest agile organization and organisers of the world's longest running Agile Business Conference.

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Leading digital transformation: The demand for software developers in government

The work of the Government Digital Service in leading digital transformation is discussed here, with a focus on their recently promoted initiative to meet the demand for software developers in government

The Government Digital Service (GDS) is a part of the is part of the Cabinet Office in the UK. [1] The main task of GDS is to make government work better for all by leading digital transformation. The aim of GDS is to help people interact with government and support government to operate in a more efficient and effective manner. GDS employs no less than 850 staff throughout the UK and their main office is in Aldgate, London.

The high demand for software developers in government

In early March 2019, we find out that 22 career civil servants, from six government departments in the UK, were chosen to take part in a unique pilot programme that will see them learn vital skills due to the high demand for software developers in government. The Software Developer Accelerated Apprenticeship takes place over a one-year, not a two-year period, and includes the option to take part in a 12-week training boot camp then to spend the rest of the year on placement in their department.

"Investing in developing our people is very important and we knew there were civil servants who had the potential and aptitude to become software developers but not the opportunity to pursue this. We wanted to offer them a chance to reach their full potential and enhance their skills whilst continuing to work for their department, enabling us to bring new talent into the profession."

The programme focuses on retraining already skilled civil servants with new technical skills, which can fit in with the needs of their departments. 182 applications have been received from participating departments, which are: Cabinet Office, Department for Education, Department for Work and Pensions, Department for Environment, Food and Rural Affairs, Home Office and Ministry of Justice.

Kevin Cunnington has led an array of large scale, global and digital transformation programmes and took up the post of Director General of the Government Digital Service in August 2016. [2] In his capacity as Head of the Digital, Data and Technology Profession at GDS, he explains why investing in the development of existing staff is crucial.

"Investing in developing our people is very important and we knew there were civil servants who had the potential and aptitude to become software developers but not the opportunity to pursue this. We wanted to offer them a chance to reach their full potential and enhance their skills whilst continuing to work for their department, enabling us to bring new talent into the profession."

The 22 apprentices took part in a rigorous selection process and all graduated 1st February 2019 and are working on placement in their departments, which is the second phase of the programme. The feedback on the programme has been tremendously positive, such as that from Sharon, a caseworker for the Home Office who is delighted to have the opportunity to re-train, as she explains. "As a civil servant you do not get opportunities as unique as this to re-train. I have always enjoyed solving problems and getting things to work. I have experienced issues as a front end user, but I now know that coding allows you to create solutions."

Another comment comes from Aga, Executive Assistant in the Director General's office at GDS, who explains the remarkable progress she has made: "I am surprised at how quickly we are progressing, and in the first six weeks of training I learnt basic object-oriented

programming, test-driven development, web concepts, and databases. I've learnt more than just coding, I've learnt about testing your code with the right tools."

Transforming public services in the UK

Looking at the wider picture, we know that The Digital, Data and Technology (DDaT) Profession is based at the GDS and works collaboratively across government to assist departments and organisations develop, retain and attract, the people and skills required to transform public services in the UK. Up-skilling public servants in crucial skills areas through various cross government programmes and initiatives, particularly the Data Science Accelerator and the Software Developer Accelerated Apprenticeship is a key part of the Profession's work.

Looking ahead, at the end of the one year programme the apprentices will undertake a final assessment with the British Computer Society and if successful, the Level 4 Software Developer Apprenticeship will be awarded to them which will qualify them to become junior software developers. Following on from these positive results, the Digital, Data and Technology Profession plans to expand the programme across the government. [3] ■

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Helping government bring IT back in-house

OGEL IT discuss the services they provide to help the government bring IT back in-house, in this report

The drive to utilise cloud and "off the shelf" technologies has fundamentally changed the way that government procure IT services and systems, and with that the role of system integrators has changed. OGEL IT recognises this change and is mindful of the new challenges that in-house IT teams are facing in terms of keeping up with constantly changing and evolving cloud platforms and in making full use of these new platforms.

We don't just design a service for you, but instead design it with you, making sure that it's right for your organisation. We use our knowledge and expertise to help and guide organisations to adopt cloud-based solutions, maximise productivity and simplify day to day management.

We work in partnership with our customers to transform their digital services by providing access to additional capability and expertise to make their vision a reality. Our resources have a wealth of experience in designing and delivering successful digital services projects within the government sector that are secure, flexible and easy to manage.

With most departments, bodies and organisations across government having started or completed the transition away from those inflexible and cumbersome long-term outsourced contracts it's a great time to get in touch to see how we can support you with your next transformation project.

Windows 10 migration

With Windows 7 going end of life in January 2020, IT departments face the daunting task of migrating to Windows 10 before Microsoft and third party suppliers cease to provide support and patching. We have the tools and processes to analyse your existing environment and plan for a successful transition.

We can provide a fully managed end user compute build that aligns to NCSC guidance and that has been independently assessed from a security perspective by a CHECK accredited partner.

Our Windows 10 end user compute provision adopts an Evergreen IT approach. This is achieved by implementing automated patching, using a targeted staged deployment model to ensure all devices maintain a high level of compliance but also providing a window for service impacting updates to be caught before mass deployment.

No more dongles or tokens, our remote access solutions provide simple yet secure always on connectivity to provide end users with truly mobile solutions. We're able to support low latency connections to cloud services direct from endpoints without compromising the security or integrity of end user devices providing the best experience for remote and mobile workers.

Simplified management

Unfortunately, unpatched devices and servers, manual software installations and poor management of administrative access are still common place in many organisations. Patching is often seen as a laborious and sometimes risky process but with the correct architecture and controls in place it can almost take care of itself entirely.

We simplify the deployment and management of packaged software by integrating with third party software update catalogues to streamline the process as much as possible. We adopt a role-based access control model early in the engagement and all solution and services deployed conform to the model to ensure a consistent and well structured permission model is adopted across the board.

Cloud hosting adoption

Adopting cloud hosting technologies such as Microsoft Azure provides government departments with an opportunity to reassess the way that they operate servers and services by transforming them into PaaS or SaaS offerings. We have found that often departments just lift and shift existing workloads into the cloud without assessing and reviewing potential options to enhance or modernise the

deployment. We can help you assess your existing workloads, design and architect your target environment and migrate services to the most suitable resource types whilst making full use of the capabilities and features provided by Microsoft Azure.

Flexible support

We offer tailored support services to meet the needs and flexibility sought by our customers. We encourage organisations to take a more active role in the day to day support of their services and we can provide the escalation and access to skills and capability that's not cost effective to retain in-house. We run workshops with existing technical resources to help bring them up to speed with the latest technology being delivered to ensure they feel confident in taking the support and maintenance forward.

Shared networks

Our network services are designed with security and usability in mind, providing secure and simple to manage network services that provide a straight forward and reliable experience for the end-user.

With modern flexible office space often shared between different organisations, departments or hosting customers and guests delivering a flexible but secure network can prove a challenge. We deliver networks that can dynamically adapt to deliver the type of connectivity required based on the device connected. This means you don't need to worry about guests plugging into your network, they can turn up and use your dock, screen and keyboard if you want them to!

Our solutions bridge both wired and wireless meaning devices can freely roam between wired and wireless connections without losing access to the network.

GCloud 10 supplier

OGEL IT offers several services through the Digital Marketplace (G-Cloud 10), providing a faster and cheaper way to purchase services when compared to entering into individual procurement contracts.

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Can Zero Trust Networking work for the public sector?

Mike Thomas, Managing Director of Innopsis details the concept of Zero Trust, strongly supported by the Government Digital Service (GDS), as the way ahead for all the networking requirements of the public sector

The concept of Zero Trust is being lauded by the Government Digital Service (GDS) as the way forward for all the public sector's networking requirements.

So what is Zero Trust?

The concept of Zero Trust was first introduced in 2010 by a former analyst, John Kindervag. He observed that organisations were adopting a 'Keep and Moat' approach to network security. Each CIO built a network that kept outsiders out and only allowed those with the right credentials in.

A "wall and ditch" was built around the corporate data to keep any infiltrators out. However, Kindervag noted that if someone managed to breach corporate defences, they had free access to all of the corporate data assets. He developed a theory that if you knew who a person was, what device they were using and where they were, you could set a policy to allow or disallow them access to services and data.

Whilst organisations kept services within the bounds of the corporate network, accessed only via locally connected computers, or via VPN's, the problem was about how strong you could make the walls guarding access. As the world started to migrate to cloud-based hyperscalers, like Google, Amazon and Facebook, this model started to break apart. Users wanted to access corporate applications and data from mobile phones, their homes, or coffee shops using the public internet.

Adapting to public cloud services

Google was the first organisation, at scale, that discovered the need to change the way it operated due to wholesale adoption of public cloud services. In response, Google initiated its 'BeyondCorp' Zero Trust security framework. With new mobile device management systems, devices and their subsequent users could be identified using biometrics. The systems could prove the individual user and using GPS data from a mobile allowed the geographic location of the device to be identified. The data captured from the mobile devices meant that the Zero Trust model could be realised.

Adding additional capability per user, allowed other devices, such as laptops, to be used. However, this left the biggest issue; identifying who should have access, what devices they had and where they were in real time. It took Google two years to implement the 'BeyondCorp' system by rigidly following HR processes and auditing their ICT environment.

Next, Google categorised its applications, data layers and services and applied a set structure that would allow users to access appropriate services on appropriate devices in defined localities. When the data was complete enough, then access was provided at a high level and then turned down to the optimum operational level.

Google then asked itself whether it even needed a corporate network. It decided that it didn't; the internet worked fine for its purposes and so it was dismantled.

GDS's approach to Zero Trust

GDS is following a similar path. The well-known GDS blog 'The Internet is OK' was the forerunner of the government's Zero Trust Networking approach. The intention here has been stated to adopt Zero Trust Networking and dismantle networks within the public sector. Innopsis is supportive of the first half of the proposed strategy but urges caution for the latter half.

"Imagine the concerns if 'accidentally' the Cabinet Office's traffic was routed to a black hole stopping all communications? Even with the traffic encrypted, given the will and resources, decryption cannot be ruled out."

If we liken the security of the network to physical security at the workplace, we can liken the firewalls and network access protection to the walls, doors and gates leading into the corporate office, guarded by doormen and access control equipment scanning ID cards.

Inside the office, most companies employ door scanners as well as requiring ID badges to be shown at all times. Some establishments insist visitors are accompanied at all times by staff. Even though you can get into the building, you are not trusted. You constantly need to reinforce your identity and right to be there. This is similar to the Zero Trust concept.

However, having cracked the identification issue, most organisations have yet to abandon the office. There are other reasons to visit and work in an office other than security. Collaboration, engagement and environment come to mind immediately. I don't see many head offices closing to allow all staff to relocate to Starbucks!

On the same basis, companies don't buy networks purely for security. Yes, it's part of the mix, but so is Availability, Accountability and Latency. The internet works, because network providers play nicely. There are no SLA's, beloved of government, data packets get through on a best endeavours basis. There are no rules where and how traffic is routed. If it works, it works, if it doesn't, it doesn't.

If the data speed drops, then wait until it will hopefully return. I'm sure we're all familiar with the cry at home 'the internet is slow tonight'. That might interfere with watching "Strictly" on iPlayer, but what would be the impact if the payroll run slowed down to a crawl or when checking passports at immigration if no access was available?

Currently, escalation processes are in place to allow the communications route to be checked and escalated along the entire path. Engineers can re-route to avoid breakdowns and services can be guaranteed. There is no escalation path with the internet. The provider can only resolve from the customer's premises to their internet handoff points.

Increasingly, corporate communications are using multimedia, real-time IP-based communications. To realise these magical devices, the IP packets must be prioritised to enable stutter-free speech, flicker-free video and group calls worthy of television. This facility is not available over the internet. You take your chance

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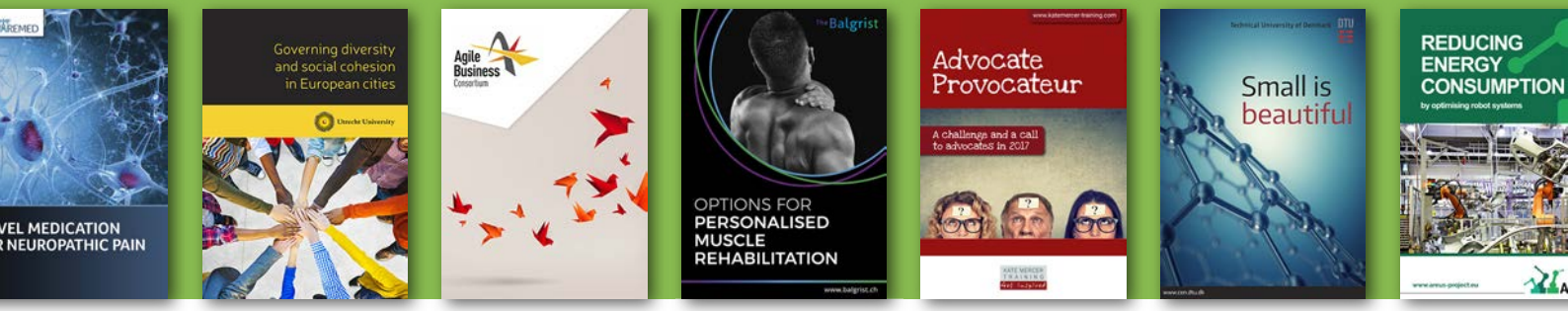

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with all the other data flowing. Is this acceptable? It might be okay to make a cup of tea and come back to watch television after the blimp has gone. It might not be the same if a trial is being conducted remotely or a surgeon is monitoring a patient.

The answer, in Innopsis's opinion, is to take a hybrid approach. This is the adoption of Zero Trust across the network, but maintaining MPLS based networks for the major offices and data centres. This will allow flexibility for remote and mobile workers. Branch offices can utilise internet connectivity, but main corporate offices can have a robust controlled environment to communicate with the data centres, hyperscalers and other offices. Whilst the overall solution may cost more; there is Zero Trust hardware to buy, some savings could be made by using internet connectivity and losing the surety of corporate network connectivity to small offices.

Adoption of Zero Trust

The next big issue to overcome is the adoption of Zero Trust. It is unlikely to be an easy task to implement a single Zero Trust solution for all the public sector. Being able to account, in real time, who exactly the 4.5 million civil servants are, plus identify what devices they have now and are using and are allowed to use, plus knowing where they are and if they should be there, is a challenge that makes Brexit look easy.

A more likely scenario is for each department and council to implement their own version of Zero Trust. The downside of this approach is that there is no common agreed standard between Zero Trust solution providers as is unlikely to be in the short to medium term. This means that if adopted, the public sector will be taken back to the situation that PSN was deployed to fix. Each department, each council, each public sector body could be isolated from each other. Information will not flow between organisations. The progress made over the last eight years to share data will be reversed. This is not progress.

To return to another point about utilising the Internet. The routing of traffic is usually dynamic and related to cost and bandwidth availability. One day, traffic may route via Germany, the next via the U.S., the next via China. There is no control on how or when the traffic is routed. It does not take much for traffic to be interrupted.

Recently, due to an 'accidental' routing error in Nigeria, all of Google's traffic to and from North America was routed via Russia and China where it 'disappeared' for an afternoon. Imagine the concerns if 'accidentally' the Cabinet Office's traffic was routed to a black hole stopping all communications? Even with the traffic encrypted, given the will and resources, decryption cannot be ruled out.

There are many other scenarios which could apply to government, which are unlikely in the enterprise world. This is why we need to cautious and not just adopt a novel approach in the commercial world, especially as the UK moves to be independent on the world stage.

Zero Trust will allow mobile workers to have corporate style working, it will allow occasional home workers and undoubtedly the coffee shops will benefit. Will it reduce cost? That is yet to be proved. Will it increase security? For some users, it will. Is it risky to move all traffic to the internet? Yes. Very. Some traffic will be fine, but not all. ■

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How have UK police adapted to funding cuts?

David Hughes, Crown Workforce Management, discusses what can be learnt from how the UK police force has adapted in the face of funding cuts

A recent study by the Police Federation highlighted that successive budget cuts since 2010 had led to 22,000 fewer officers and that the "once revered British model of policing is currently on its knees and facing extinction". The unyielding axe to public spending has now spanned best part of a decade, an epoch where public sector leaders have been forced to consider ever-more inventive ways to do more with less, yet still deliver core services to their communities.

As a company that works with more than 40% of all British and Irish police constabularies, Crown Workforce Management has experienced this impact first-hand and helped them in developing organisational delivery mechanisms to put their people in the right place at the right time, albeit with a lighter presence.

It is a quandary that faces all public sector executives, how can we do more with less? When lean management is on the brink of emaciation, can we undertake further organisational change that will allow the 'machine' to continue to operate without breaking down completely?

Here, we examine how our policing partners have approached this conundrum when public and officer safety has to be balanced with the delivery of essential services. What strategies has the thin blue line applied to remain effective under pressure?

Transformational change – West Midlands Police

Crown Workforce Management won the contract to supply England's second largest police force with its time and attendance and rostering software.

The system underpins its 2020 transformation programme – a radical force-wide review which will deliver a new policing model incorporating culture and values, leadership, technology, services and systems and processes.

It is the biggest reorganisation ever undertaken by the force, which has more than 10,800 employees, including 6,944 police officers, 3,131 police staff, 506 Police Community Support Officers (PCSOs) and 303 Special Constables. West Midlands Police needed a duty management system that would fully integrate with other IT applications and assist new working requirements – such as rostering – needed to fit the expectations of WMP2020.

This root and branch approach is giving WMP the opportunity to 'reimagine' itself for a new era. The strategic approach has been thorough, not simply to address spending but also to consider how it does business in a new era where new demands compete against traditional expectations. At its heart is service delivery is underpinned by integration across business areas.

Shared services –

Surrey, Sussex and Thames Valley Police

The Crown Duty Management solution is an integral part of an IT solution which has allowed three police organisations to join forces for greater collaborative working.

The Enterprise Resource Planning (ERP) solution for Surrey, Sussex and Thames Valley Police, is based on a Microsoft Dynamics platform which is delivered by KPMG Crimsonwing.

The software solution is being rolled out to more than 18,000 employees – assisting greater collaboration and improved flexibility via mobile working using 'the cloud'. The solution comprises the following elements; finance, fleet, procurement, HR, learning and development and payroll. Crown provides duty management and rostering functionality.

This approach applied economies of scale with efficiencies. Shared services across three force areas provides a foundation on which front-line services can be applied, ensuring continuity of resource allocation across neighbouring force areas. This approach also allowed specialist resources with defined areas of expertise to be grouped and applied accordingly.

Automating and improving processes –

Greater Manchester Police

In its drive to deliver more effective services to the public, Greater Manchester Police (GMP) identified that it needed to adapt the methods through which it managed its duty rosters and officer availability. The existing manual based approach was causing cross-departmental business processes to be unduly complicated. Additionally, multiple data entry activities resulted in inconsistent data and delays in information being available for management purposes.

GMP identified that an automated approach would move it closer to its goals and a Crown Duty Management System was chosen.

Looking at what we do and how we can do it better, particularly through an established programme of review, allows an organisation to take stock and identify if efficiencies can be made, improving processes, productivity and cost-saving.

The three examples demonstrate a range of different approaches – from the wide-reaching to a specific process-led review – but all embrace change which affect the bigger picture.

It could be said that the police service has always embraced change. Its drivers: political, technological and cultural have determined those requirements, from changes of government and Home Office policy, to the changing nature of crime and how it is addressed. New and exacting standards, governance, transparency, checks and balances have triggered wholesale change... a constant flux of requirements that never stop.

Policing is resilient – even when faced with the unprecedented financial constraints that have challenged all our public services. The thin blue line may be thinner than before but its resilience is a blueprint for evolving organisations everywhere.

To download our free white paper on The Workforce Management Renaissance within the Public Sector click the link above.

For more information on Crown Workforce Management visit: www.crownworkforcemanagement.com

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Crypto Valley: Why Switzerland is a world-leading location for blockchain companies

Heinz Tännler, President of the Swiss Blockchain Federation, Government Councillor and Finance Director of the Canton of Zug, explains why Switzerland has become one of the world's leading locations for blockchain companies

In recent years, Switzerland has become one of the world's leading locations for blockchain companies, enabling a variety of business models to be explored here. Crypto Valley, between Zurich and Zug, is home to numerous companies and organisations in the blockchain sector. Start-ups come to Switzerland primarily because of legal certainty, Switzerland's world-class infrastructure, and the Valley's increasingly strong ecosystem. Moreover, the willingness of political decision-makers to maintain and enhance Switzerland's attractiveness for new technologies and companies, as well as the Valley's proximity to universities has also contributed to the expansion of the sector in Switzerland. An example of this dynamism is the establishment of the "Swiss Blockchain Federation" last October, a public-private partnership for the strengthening of blockchain technology in Switzerland. The publication of the Federal Council's report on the optimisation of the legal basis for distributed ledger technology and blockchain in Switzerland at the end of 2018 also provided an important impetus.

Legal certainty is of great importance

Companies are in need of legal certainty, as transactions and business activities based on blockchain technology cannot always be clearly supported by the existing legislation. In order to ensure the breakthrough of the blockchain technology and the success of the companies involved, it is critical that business operate on a long-term, secure legal basis.

The publication of the report by the Federal Council marks an important step in this direction and provides a detailed survey of the legal challenges that these new business models create. The report does not call for a separate blockchain law, preferring to amend existing civil and financial market law. This reflects the objective of setting the framework conditions necessary so that Switzerland can strengthen and extend its leading position in blockchain.

Switzerland is taking a pragmatic approach, which is in line with proven Swiss principles and is to be welcomed. The Federal Council report must now be quickly followed by its legislative implementation because Switzerland needs this certainty for the basis for further development. A 10-point programme launched recently by the Swiss Blockchain Federation to strengthen blockchain technology in Switzerland also calls for a binding agenda from the regulator. The programme spells out the social policy, regulatory, and public interest issues that need to be settled if Switzerland is to be a successful blockchain location.

Excellent starting position

In comparison to other countries on the international stage, Switzerland has "excellent cards because it has good prerequisites as well as entrepreneurs, developers, scientists and doers," said the Swiss Finance Minister Ueli Maurer on 3 December 2018 at the opening of the "Infrachain", the first blockchain conference for the public sector and infrastructure companies in Bern, the Swiss capital. "Blockchain applications will explode in the next few years, and Switzerland is one of the leading developers of blockchain technology and its applications," Maurer added. This should encourage start-ups to set up their business in Switzerland.

The number of blockchain companies in Crypto Valley is growing rapidly. In December 2018, over 750 companies with over 3300 employees in Switzerland were registered on CV Maps, an online directory of the

Image: © Christa Eder | Dreamstime.com

The idyllic canton capital Zug on the lake of the same name

Blockchain industry. Numerous sub-sectors of the blockchain industry are represented in Crypto Valley, from HealthTech to data analytics to e-government. The 50 largest blockchain companies had a market capitalisation of around $20 billion as at the end of December 2018.

Public administrations are also using blockchain in Switzerland: The canton of Geneva is testing electronic identification and the use of digital signatures for its commercial register. Schaffhausen operates an e-government platform on blockchain in collaboration with a start-up company.

Too important not to be used

In a World Economic Forum analysis, six sources of value creation through blockchain have been identified: the simplification of internal operating procedures, more efficient interaction between regulators and supervised financial firms, the reduction of counterparty risks in transactions, time savings in the handling of financial transactions, better use of a company's equity or liquid assets, and a greatly reduced risk of fraud. The Internet has changed the way we communicate, and blockchain is changing the way we trust each other.

The still young technology with its countless application opportunities will shape our future and is indispensable. Switzerland is determined to play a leading role as a location for successful companies. ■

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World Bank blockchain pilot sows fresh narrative for Haiti's farmers

AgriLedger, an agricultural-focused blockchain systems provider, is working on a World Bank backed pilot that offers end-to-end full traceability through their platform to enable transparency along the value chain

As blockchains, distributed ledgers and smart contracts get put through their paces in food supply chains around the world, this fledgling technology market is expected to grow to over $360 billion by 2026 and surge to more than $3.1 trillion by 2030. Driven by a thriving community of active entrepreneurs and developers who are keen to create transparency, reduce operational costs and improve global food safety, the next generation of software architecture is cropping up in provenance and payment systems for daily fare like orange juice in Holland, organic oats in Australia, free-range beef in the United States and chickens in China.

While most of these blockchain pilots and applications in agriculture have commercial gain and significant savings as common goals, a few leaders are going one step further by setting farmer empowerment at the heart of their efforts toward global food security. Genevieve Leveille, CEO of AgriLedger and Mission Chief of a World Bank-backed blockchain pilot underway among Haiti fruit farmers, is one such unsung hero. Born in Haiti, Genevieve is excited about the opportunity to give back to the country of her birth. AgriLedger has joined forces with SourceTrace, and local Haitian partner Ecole Supérieure d'Infotronique d'Haïti (ESIH) to forge a new narrative for Haiti's rural communities.

The heart of rural Haiti

As soon as you mention Haiti, images that often come to mind is a nation deemed one of the poorest. Haiti's history of colonisation, slavery, foreign exploitation of resources, revolt, independence tied to debt, foreign occupation, deforestation, the earthquakes and aftershocks of 2010, Hurricane Mathew in 2016, a reliance on imports, little infrastructure and inadequate education are, after all, the tales told in worldwide headlines. It just might look as though Haiti is a nation on its knees until one takes a moment to notice the resilient core of the Haitian people. It's easier to see the effects of the Haitian community spirit in places like the Artibonite Valley, where thousands of trees are planted every day and the forests are returning.

There is, if you will, a tangible sense among the rural people of Haiti of taking care of their natural resources and of each other. In the cities, this is echoed in communities of tech entrepreneurs and advocates like Banj and Consortium partner ESIH who are back stronger now with more resilient systems than before. Beneficiaries of the Blockchain/DLT Pilot underway the first quarter of 2019 are the Haitian fruit farmers, their customers and families who can look forward to this year's harvest and to reaping the benefits of market inclusion and improved food security. Binding agriculture to digital technology by tagging fresh produce from farm to table broadens the interaction of communities.

Access to efficient markets

Perhaps no one understands better the effects of untold losses and hardships than the farmers and their families. Yet their focus on the future, with a 'Transparent Trade Ledger' places the hard-earned high-quality produce of Haiti's smallholder producers into a system that will see any intermediaries not adding value disappear unless they provide a much-needed service at a reasonable cost. Margins that were arbitrated by local exporters will revert back to producers and their families. The Blockchain/DLT solution enables farmers to sell in more efficient markets where the spot price for their produce is determined by supply and demand rather than by the power of negotiation.

To help accomplish this, AgriLedger together with SourceTrace and ESIH are supporting the formation of businesses as platforms based on Blockchain/DLT. A custom-built platform for fresh produce chains in Haiti allow buyers to scan a mango's QR code and see whose tree the mango comes from, how the mango was packaged and transported, and what costs were involved at each step from the moment a mango was picked from a tree to the moment it's paid for by a buyer. The cold-chain logistics data including registration, certifica-

tion, transport and sale documents collected along the path are made immutable and visible in friendly formats on the web and a smartphone.

Reducing risks in the chain

Starting this year, the Consortium's Blockchain/DLT solution will progress from its beta version to full commercial operation within the fruit value chains in Haiti and to other commodities. In many ways, the Haitian farmers of mangoes, avocadoes and pineapples will see more robust protection against the many risks they face in bringing their fruits to harvest and offering their produce up for trade. The payment system makes transaction data available to all participants in real time, with only the vetted endorsers able to validate transactions, while keeping track of how much is owed to those on the value chain.

As Genevieve Leveille explains: "Maintaining security at each step in the chain is a priority because we're setting out to benefit the farmers by increasing their livelihoods and those of their families. By consulting with and training community members in the use of the Blockchain/DLT solution, we hope to see long-lasting improvements within the farming culture of Haiti with sustainable finance mechanisms to ensure the longevity of the project. With responsibility for security distributed across the chain through a SecOps approach, we're encouraging collaboration and transparency. Ecole Superieure d'Infotronique d'Haiti (ESIH) students will participate in the community training sessions and cross-functional team activities so that local preferences and norms are embedded within the solution."

Stronger together

In collaboration with the World Bank, the Consortium plans beyond this pilot, to extend its Blockchain/DLT solution in Haiti to include other value chains. This will see the mango, avocado and pineapple farmers move closer to broader market inclusion and improved food security soon followed by the producers of coffee and cocoa. It's easy to see why this pilot underway in Haiti has a lot going for it, with Mission Chief Genevieve Leveille originating in Haiti and homegrown technology students involved in its development, along with deep local partners in place.

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Forming HEdpAY Alliance Group for adoption of crypto banking

Founder and CEO of HEdpAY explains how the creation of alliances in various sectors of business can provide financial services solution within the crypto banking ecosystem

Both traditional banks and crypto banks have their place, and, with the current mood of distrust, they need each other. There is a bridge that needs to be built to align both." Future banking operators like HEdpAY are building a platform that connects crypto with fiat currencies and supports decentralised control.

First tests and business adoptions start by using HEdpAY systems to overcome these challenges and bring crypto use to the mass market, starting with SMEs, funding them and financing their projects with HEdpAY.

One of the major alliances and partners to start the HEdpAY Future Banking Solution is "LIKER" Liker world Ltd in the education sector. Education is the power of modern society and builds the future generations, therefore, HEdpAY with Liker has created a possibility to study anywhere and anytime you want.

Liker is an educational blockchain-based content platform. Users not only get access to all educational materials and activities but also get rewarded as they study. With the help of the HEdpAY LIKER application, users can learn, get rewards, and grant their funds to educational projects for their future within the network.

HEdpAY signed an alliance partnership agreement with LIKERWORLD, as e-banking solution company based in London, the home of Fintech, and completed a $500,000 mutual investment. With the 2020 Tokyo Olympics in sight, Alliances plan to utilise the e-banking system, a superior blockchain of Hedpay Ltd, to support real-time transactions through POS, ATM devices and crypto prepaid cards.

To this end, Solomon Capital Japan, which obtained permission to transfer money from Japan's Financial Services Administration, joined the Alliance Group. The company is already in business with a company that has acquired BitLicense in New York, leveraging Hedpay Ltd. technology in the UK, Japan, New York, Asia, Russia and European markets.

> "Education for future generations will bring crypto to the mass market adoption".

HEdpAY is one of the first projects connecting traditional bank and the crypto world, and one of the first to be creating investment funds in crypto, with the alliance group globally, in order to maximise profits and minimise losses," explains Vicken. It has been created to be the first and most authoritative financial institution enabling users to transfer their fiat currency in crypto quickly, safely and compliantly, using the following services: current account, debit card and exchange.

HEdpAY also gives investors exclusive funding opportunities: creating their own blockchain, helping entrepreneurs and SMEs developing new projects following detailed compliant protocols, and then by selecting the best projects and evaluating their currencies that already included in the market, to finance them and fund their future plans.

The company's goal is to showcase how its futuristic solution between crypto and traditional banking to revolutionise a financial system, that is still anchored to old banking standards," in the words of Vicken. He believes that the real opportunity is the benefits blockchain can bring to the financial services industry.

"While the crypto market has witnessed saturation over the past few months, the real opportunity is more about the benefits that blockchain can bring to financial services and crypto banking. The major industries are primed for the integration of blockchain technologies. Other opportunities can be seen in education, medication, genetic analytics, voting, forecasting, government, crowdfunding, retail and real estate. I think the possibilities are endless".

> "...Educate the future generation to revolutionise traditional old systems in finance and all other possibilities"

Despite the perceived negativity around cryptocurrencies in regard to the puzzle of jurisdictional risk and regulation, Vicken is positive about the future of crypto and blockchain, whilst establishing and cultivating compliant relationships with the regulatory bodies, global financial, educational, medical institutions and businesses.

"HEdpAY's purpose is to provide the services of the modern traditional bank whilst implementing the prospects of a bank for cryptocurrencies, and at the same time ensuring better regulation of the cryptocurrency market and its use, said Vicken."

In the past year HEdpAY has reached some significant milestones, most recently the company announced its Partnerships and Alliance groups for the creation of biggest fund in crypto banking system. The company offers a pallet of project finance by its Hdp.ϕ Tokens

A residential property development in Italy, named "Green Park", environmentally friendly and fully green ecosystem, budgeted the equivalent of 40 Million Euros in Hdp.ϕ, will be built and financed by HEdpAY banking system on blockchain.

An educational system joined with LikerWorld Ltd. For the future generation have the full capacity and means to be educated, where ever they are and however their situation be,

Medical cosmetic research and development, product production for anti-ageing using biotechnologies and eco-friendly products, financed and supported by HEdpAY systems on blockchain.

"Hdp.ϕ tokens will be used within the HEdpAY project's ecosystem to ensure the success of the future banking solution and the development work on our revolutionary platform ongoing with various projects and plans toward the future, added Vicken."

Going forward, the company's ambition remains undimmed. "HEdpAY has an exciting future ahead in terms of the completion of our targeted goal, the future launch of the HEdpAY Alliance Group Fund and our full set of banking services," says Kaprelian. "In a year's time, we would like to see the crypto banking mass adopted, thanks to our pilot projects and for the wider benefits that can be realised through blockchain technology."

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Decentralising security for mobile devices: Is blockchain the viable solution?

Steven Sprague, Cofounder and CEO of Rivetz reveals a viable solution when it comes to decentralising security. He argues that there is great promise for creating mobile device security with blockchain technology

The world was introduced to the first commercial mobile phone in 1983 with the launch of the Motorola DynaTAC 800x, which stood at a height of 13 inches, weighed 1.75 pounds and took 10 hours to recharge. In the early days of the mobile phone industry, it was incredibly simple for attackers to clone a phone's identity and run up all sorts of charges on your account.

Over the last few decades, mobile has experienced quite a metamorphosis from the "brick" of the 1980s to the compact, feature-packed smartphone of today. Now, mobile is king – people across the globe use their mobile devices not only to communicate but also to read the news, get directions, stream music, check bank accounts, store assets and so much more.

As we increasingly rely on our mobile devices, new avenues of attack continue to emerge. So much of our sensitive personal information and digital assets – such as corporate data and bank account and credit card numbers – are accessible via our mobile devices. They have become treasure troves for attackers.

Blockchain and mobile device security

There is great promise for creating mobile device security by combining secure enclaves – also known as 'roots of trust' – with blockchain technology. Blockchain is a distributed ledger technology that protects a digital transaction through complex mathematical algorithms. Because of the strength of this math, the transaction can only be created by those who hold a valid private key.

Private keys were developed as a means of protecting our digital transactions. A private key is a piece of cryptographic code that allows a user to prove who he or she is – in other words, it's a digital signature that says the user is, in fact, the one who is executing a digital transaction.

Private keys are used to secure a variety of transactions on mobile, including messaging, cryptocurrency and more. Here's the downside: if an attacker steals your private key, they can impersonate you, and then access and abuse your data and digital assets. The prevalence of mobile devices has made them some of the largest repositories for private keys.

The biggest challenge in decentralised cybersecurity is that we cannot prove the transaction was intended. If an attacker steals your private key and transfers $5,000 to a third person, there is no way to prove that the attacker – and not you – performed the transaction. Rivetz ensures an intended transaction by establishing that it occurs from a known device, in a known condition, with an authorised user, under the required conditions. Rivetz performs "device attestation" to ensure a user's devices are in a "known" condition by executing regular health checks to ensure the device integrity. Each device's integrity is recorded on the blockchain so future health checks can be compared with the baseline, establishing that those devices are in a condition the user intended.

As the rise of the internet brought digital fraud and attacks on identity, innovative industry leaders banded together to fight that fraud and formed organisations such as the Trusted Computing Group (TCG). TCG developed specifications that have become standard for securing devices, as well as the data and identity on those devices, such as personal computers and laptops.

Trusted computing uses hardware to protect users. It ensures a device will consistently behave in the expected ways, protected by a secure enclave or a 'root of trust' embedded within the device's hardware. A root of trust is isolated from the device's software operating system (OS), allowing it to execute code that cannot be seen by the OS. One such root of trust developed by Global Platform is the Trusted Execution Environment (TEE), which

enables trusted computing technology for mobile devices. The TEE already is built into the hardware of more than 1 billion mobile devices. Today, most private keys are generated within software, which is much more susceptible to attack than hardware. The TEE is capable of protecting a user's private key within the device hardware, a method that is far more secure than performing these operations in standard software.

A single system of security may not be enough to protect against the variety of cyber-attacks possible today. It is more pressing than ever to provide multi-layered protection of digital assets across two or more security domains. That way, even if an attacker were to breach one point of security, the other(s) still would need to be compromised, offering an extra layer of protection for important digital assets – whether that's your personal information or your hard-earned money.

One of the most ubiquitous roots of trust is the subscriber identity module, or SIM card. The SIM is a protected hardware environment and was created to combat mobile fraud and to protect the device identity. With the pervasiveness of both the TEE and the SIM, Rivetz saw an innovative opportunity to use these isolated roots of trust to work together to protect mobile users. In conjunction with ElevenPaths, the cybersecurity unit of Telefónica, the world's third-largest mobile carrier with more than 300 million subscribers, Rivetz uses both the TEE and SIM to protect our private keys – introducing the Dual Roots of Trust.

The solution leverages the TEE along with the SIMs deployed by Telefónica. With Dual Roots of Trust, Rivetz-enabled apps generate private keys in hardware, then cryptographically distribute those private keys between the TEE and the SIM. This delivers built-in security from both the mobile carrier and the device manufacturers, to create decentralised key protection.

By distributing a private key across these two roots of trust, attackers would have to breach both secure systems in order to steal a single private key. As an added security feature, two different entities – or independent control planes – aid the user in controlling their private keys. Through a special application authorised to perform activities inside the TEE, the user remains in control of the secrets stored in the TEE. If your mobile device is lost or stolen, a simple interaction with your mobile carrier can disable the SIM, permanently or temporarily until the device is found. So even if a thief has your device, you remain in control and your private keys are still safe.

The Rivetz solution has an unlimited number of use cases, such as sensitive work apps, mobile wallets, social media accounts and mobile banking. One of the most unique applications of Dual Roots of Trust is the ability to provably control specific applications on a device. This feature is especially useful for enterprises. Let's say a company has its own proprietary Rivetz-enabled app that employees use for work on their personal devices. If an employee is terminated or leaves, the company has the ability to revoke access to that app on the former employee's personal device with Dual Roots of Trust.

As our mobile devices have become more important to our everyday lives and contain so much of our personal and private data, we need better ways to protect ourselves. The solution lies in the roots of trust that already exist on millions of mobile platforms: the SIM and the TEE are two of the most common secure enclaves. Dual Roots of Trust is the next step in ensuring our assets stay safe.

rivetz

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The top technology trends in hospitality for 2019

Riccardo Campione and Dr Alain Imboden, Associate Professors at Les Roches Global Hospitality Education in Switzerland, discuss the top technology trends in hospitality for 2019: AI, IoT, blockchain and cryptocurrency

Technology is transforming the way travellers interact with brands before, during and after their journey. Far from pulling hospitality away from its soul as a people-centric industry, the adoption of new technologies allows businesses to deliver greater personalisation and better service. With the help of artificial intelligence (AI), the Internet of Things (IoT) connectivity and other new technologies, businesses can offer a more engaging brand experience while meeting and even anticipating guest needs.

Artificial intelligence (AI)

From chatbots and robots to machine learning, AI is already present across the hospitality industry. But the technology has the potential to evolve much further, bringing customers a convenient on-demand service, greater personalisation and closer engagement with brands.

Over the last few years, travellers have been meeting robot butlers and concierges in hotels like Hilton's Connie, powered by IBM Watson AI technology. Able to answer guest questions, handle check-ins and deliver discreet room service, these helpful robots can lessen the burden on human staff, enabling them to spend more time with guests who seek personal interaction. Customer service robots have also been appearing in retail stores and airports; SoftBank Robotics' Pepper, a humanoid robot developed with IBM Watson, has been introduced at Munich Airport and Václav Havel Airport Prague, where the robot informs and entertains passengers by dancing and offering to take selfies.

Gartner predicts that 85% of customer interactions will be managed without a human by 2020. On Airbnb, travellers receive customised search results based on their browsing and booking history thanks to powerful machine learning algorithms. And chatbots, already in use by leading travel brands such as KLM, Kayak and Booking.com, provide customers with useful information, personalised recommendations and rapid response times. But AI also offers businesses an opportunity to further reflect their personality and develop brand loyalty.

> "Offering transparency, security and control, blockchain technology has the potential to change business models across industries. It can revitalise loyalty programmes by ensuring that points are kept securely and can be exchanged across multiple platforms; Japanese e-commerce platform Rakuten has announced plans to transition its loyalty points into Rakuten Coins, its own digital currency."

At The Cosmopolitan of Las Vegas, guests are invited to text Rose, the hotel's "resident mischief-maker" and chatbot, for VIP access to clubs and other insider tips, as well as room service requests. In addition to serving as a virtual concierge, Rose answers guests with humour; tells the bot, "I love you," and Rose replies with a diamond ring emoji and the message, "Back that up with some hardware and we'll talk." Guests who interact with Rose are said to spend 30% more in the hotel than those who do not, and are 33% happier when they leave.

Facial recognition and voice technology

While technology is not a replacement for human interaction, lifelike features can make technology more appealing to users. Intuitive attributes, such as facial recognition and voice activation can offer users a faster service and better customer experience.

At Intercontinental Shanghai Wonderland, face scanners enable guests to verify their identity at check-in, pick up a digital room key and gain access to the dining room at breakfast. The hotel has partnered with Chinese messaging and mobile payment app WeChat to offer travellers a seamlessly connected experience.

Ebookers, a travel site owned by Expedia, has introduced SenseSational, an online tool which uses real-time facial recognition software to track users' faces as they look at certain images and sounds on screen. The tool then reveals the user's identity as one of four "tribes" – The Adventurer, Culture Collector, Sun Seeker and Bon Vivant – and suggests destinations and activities that match the tribe's travel preferences. Beyond the screen, facial recognition could have other practical uses soon, such as enabling swift check-in at meetings and events, and quick access to public transportation systems.

Many hotels have added in-room smart speakers and voice assistants that let guests simply say what they need, but this technology is also still in its early stages. Besides enhancing the guest experience, voice technology can improve back-of-house efficiency as well. Two Roads Hospitality has partnered with Amazon and Volara to develop a customised Alexa for Hospitality platform that facilitates daily tasks for staff, such as identifying maintenance problems or signalling that a room is ready for check-in.

The Internet of Things (IoT)

A guest unlocks the door with her smartphone, walks into her room, and based on past preferences, finds that the air temperature, lighting and music are set to just the right levels. Such are the possibilities of IoT technology, which offers guests a growing range of options to personalise their environment using an in-room tablet, smart speaker or their own smartphone.

Luxury hotels like The Plaza New York, Aria in Las Vegas, The Torch Doha in Qatar and GHM Hotels have all introduced high-tech smart rooms. Meanwhile, Hilton has developed its own proprietary IoT platform, and Marriott has partnered with Legrand's IoT programme and Samsung's ARTIK cloud-based IoT platform, with both hotel chains aiming to roll out IoT connectivity across their properties.

Further integration of the IoT within hospitality could prove especially attractive among mobile-savvy Millennial and Gen Z travellers. Notably, such technology may also help hotel groups set themselves apart from tough competitors like Airbnb and HomeAway. A seamlessly customised experience is challenging for private residences or boutique hotels to offer, even if they have some smart technology on the premises.

Blockchain and cryptocurrency

Offering transparency, security and control, blockchain technology has the potential to change business models across industries. It can revitalise loyalty programmes by ensuring that points are kept securely and can be exchanged across multiple platforms; Japanese e-commerce platform Rakuten has announced plans to transition its loyalty points into Rakuten Coins, its own digital currency.

Blockchain transactions also eliminate the need for third-party mediators. LockTrip (LOC), blockchain-based hotels and vacation rentals marketplace, enables hotels to manage bookings and guests to make reservations without a commission being taken from either side. Travellers can browse hotel listings with prices given in LOC, a cryptocurrency whose exchange rate is shown in real time. To book, users pay the equivalent amount in euros, pounds or dollars, which is converted to LOC. The amount in LOC is released to the hotel once the guest checks out, and the hotel can then convert the cryptocurrency into their preferred currency. By eliminating the need for a middleman, this technology enables hotels to offer prices that are 20% lower without affecting profits. ■

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Blockchain interoperability: Sharing data across the care continuum

Paul De Raeve, Secretary General of the European Federation of Nurses Associations (EFN) sheds lights on how blockchain interoperability is enabling sharing data across the care continuum

The interoperability of electronic health records (EHR) in Europe is key, especially now the European Commission plans to publish a recommendation on the technical specifications for an EHR exchange format. Although the EHR exchange format is part of a bigger plan of the digital transformation of the health and social care in the Digital Single Market, the EU financing of two H2020 projects, 'Smart4Health' and 'InteropEHRate' can lead to large-scale interoperable designs, especially at a time when a variety of government agencies are moving their infrastructure on to new technologies offering optimum security and data privacy. The policy outcome, adopting an EHR exchange format at EU level, could end the endless and costly interoperability discussion we have had for the last two decades. Despite some advancements towards more seamless interoperability in the healthcare sector, frontline deployment of continuity of care, based on data sharing in clinical care pathways, could benefit more from new IT developments.

Although called 'disruptive', we recognise these new systems compete for market shares struggling to make a business case for sharing the data they've gathered, sorted, collected, aggregated and secured. Therefore, it becomes key that the IT industry, the EHR vendors become connected to the frontline practitioner so products become co-designed, fit-for-purpose, reduce the endless hours nurses spend on data entry, leading to a general malaise towards software solutions that were supposed to help, but it really just means more work for the frontline. So, it becomes high time to get interoperability right!

Co-designing interoperable solutions

A favourable ecosystem of trust and political support to use blockchain as a way to tackle interoperability is not the main challenge, but what we miss are the practical use cases showing blockchain works better for the frontline due to solving the interoperability challenges we currently have in the healthcare ecosystem.

It is argued that blockchain makes it possible to exchange data from different sources, in different formats, among the end-users, at their fingertips to plan and provide frontline healthcare. Within this context, nurses have an opportunity to co-design an EU interoperable EHR as end-users, respecting the existing national EHR developments. Therefore, EFN partnership in the H2020 granted EU projects focusses on co-designing a fit-for-purpose interoperable EHR, aiming to prototype:

- A citizen-centred implementation of a platform that can be integrated with a federated platform structure, easy-to-use and secure, constantly accessible and portable within any other Member States of the EU and;

- A data-driven platform to help the scientific community to benefit from the user-generated data (health, care, and health-related) going beyond the currently established interoperability level.

Nurses are in the unique and privileged position in co-designing interoperable solutions as they have direct access to the daily care needs of people and have an in-depth knowledge of the patients' experiences and contextual environments in which the continuity of care takes place. As nurses are central in empowering citizens/patients to have access to health and social services, they play a significant role in addressing trust and ensure the appropriate allocation of nursing data in the EHR to facilitate continuity of care and as such, to ensure better health outcomes.

Defining the end-user requirements and scenarios to be supported by the new EHR interoperability, co-designing a set of services fulfilling the end-user requirements for realising the incremental cross-border interoperability, could become key for successful blockchain case studies at EU level.

Moving beyond interoperability

Understanding the potential of blockchain in the health and social care sector and how to realistically implement it in cross 'border' care (could also mean across the street!) is not always clear to the end-user. Often, when addressing audiences, and they pick up the word blockchain as a possible solution, participants often react by asking, "What do you mean by blockchain?" and some react as, "It is just a hype, just forget it!"

> "A favourable ecosystem of trust and political support to use blockchain as a way to tackle interoperability is not the main challenge, but what we miss are the practical use cases showing blockchain works better for the frontline due to solving the interoperability challenges we currently have in the healthcare ecosystem."

However, when co-designing with nurses, key criteria such as transparency, trust, and smart contracts will come immediately on the design table. One of the most significant ways blockchain can potentially help the health and social care sector is by empowering patients/citizens, therefore, allowing each individual/provider access to the chain of data relevant to deliver care. As blockchain is based on a smart contract within the peer-to-peer (P2P) network, empowering the patient/citizen in a people-centred healthcare ecosystem, the concept of gatekeeper in the healthcare system disappears.

As the P2P network records transactional data, each maintaining its own copy of the ledger, with all ledgers being kept in a historical and synchronised way, this constitutes the single source of data needed within nursing care pathways (scenarios). For nurses, it is key to have access to real-time health and social data eliminating the need for reconciliation. This native features of blockchain allow patients/citizens and multiple health and social providers to share anything of value across the system in a more transparent, efficient, and secure way.

Paul De Raeve

Conclusion

Interoperability is required to provide person-centred, proactive and well-coordinated care in the EU, even cross-border. A P2P chain, without any gatekeeper, can decrease the continuity of care frustrations and high costs, by simplifying processes, reducing delays for the patient/citizens, and more important, reducing the administrative workload of frontline nurses. Within the Digital Single Market Strategy for Europe, it is key to prioritise the EU EHR for citizen empowerment and person-centred care deployment, taking into account the views of the end-users to make solutions fit-for-purpose. One field where blockchain technology has tremendous potential is health and social care, due to the need for a more people-centric approach, connecting existing national electronic healthcare records (EHRs). ■

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Product safety, supporting small business growth and implementing the Industrial Strategy

The work of the Office for Product Safety and Standards, which is part of the UK's Department for Business, Energy and Industrial Strategy (BEIS), around product safety, supporting small business growth and implementing the Industrial Strategy vision of simplifying regulation are explored here

The Office for Product Safety and Standards was created in January 2018 as part of the government's response to recommendations from the Working Group on Product Recalls and Safety – a group of consumer, fire and product safety experts.

Part of the Department for Business, Energy and Industrial Strategy (BEIS), the Office has grown rapidly, creating dedicated national capacity for product safety while taking forward work on supporting small business growth and implementing the Industrial Strategy vision of simplifying regulation.

The Department is responsible for UK government general policy on everything to do with standards-making (but not specific individual standards). Its aim is to improve the standards of infrastructure so that it meets the needs of UK industry, and to make the processes more relevant and business friendly.

The Office works closely with the British Standards Institution (BSI), the National Physical Laboratory (NPL) and the United Kingdom Accreditation Service (UKAS), to oversee standardisation, testing and measurement, and certification and accreditation in the UK as part of the UK's National Quality Infrastructure (UKQI).

- **Standardisation:** creating the national and international standards that specify how things should be made and done in a way that is mutually acceptable.
- **Testing and measurement:** implementing specifications and standards to ensure validity and consistency.
- **Certification:** ensuring those who use standards and codes are applying them in the right way.
- **Accreditation:** ensuring those who carry out testing, certification and inspection are competent to do so.

UKQI partners also provide a comprehensive range of consultancy services to overseas governments, including needs analysis in order to target the intervention efficiently; legislative review and advice; consultancy and training; technical assistance covering standards, accreditation, metrology and quality assessment.

Specialist services provided by the UKQI include the full range of UKAS accreditations, support with developing a standards and metrology strategy in an innovative area or emerging technology, training for legal/regulatory metrology personnel, and type approval services to companies manufacturing measuring instruments.

Conformity assessment and accreditation are important parts of the nation's quality infrastructure. By providing confidence in goods, services, management systems and people, they make a significant contribution to the economy, health and safety, and environment.

Other work

The Office administers Primary Authority, a flagship programme for making regulation work, protecting citizens and supporting businesses. Primary Authority is available to all businesses, including start-ups, enabling them to receive assured and tailored advice on environmental health, trading standards or fire

safety regulations through a single point of contact. This enables all businesses to invest with confidence in products, practices and procedures, knowing that the resources they devote to compliance are well spent.

The Primary Authority Register, an online portal managed by the Office, enables regulators to share information about businesses, so they can focus their resources where they are most needed.

Since it was launched in 2009, Primary Authority has become the established route for helping businesses to comply with regulation, saving time and money but most importantly underpinning the confidence necessary for investment and growth. There are now over 73,000 businesses in primary authority partnerships with 170 local authorities (October 2018).

The Office's Local Regulatory Delivery team (LRD) coordinates the Better Business for All (BBfA) programme, supporting the simplification of the way regulation is delivered in local areas.

Local BBfA partnerships bring together businesses and regulators to identify the issues facing local businesses and shape the provision of effective support services to them. LRD encourages Growth Hubs to include Primary Authority in their business support offer, in line with the government Industrial Strategy's aim of ensuring the scheme is available to every business.

LRD provides support to local authorities, LEPS and Growth Hubs by explaining the role that well-delivered regulation has in keeping people and the environment safe while enabling businesses to prosper and grow. LRD works with local partnerships to assist them in identifying ways in which to support local priorities and simplify the way in which regulation is delivered. This includes facilitating discussions between key stakeholders, staging workshops and managing the toolkit of resources for them, drawing on good practice and material provided by LEPs and regulators. BBfA is driven by local activity and benefits from a national perspective. A key role for the team is ensuring that learning is shared across the local regulatory system.

There are now 32 partnerships accounting for 82% coverage of all LEP areas. ■

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Who are UKAS and how can accreditation help deliver policy objectives?

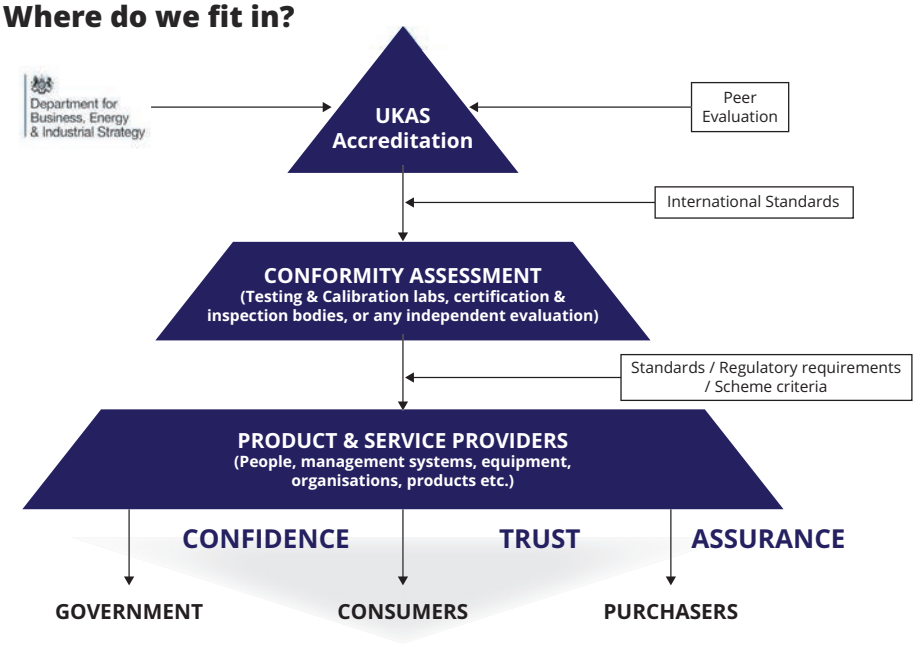
Here, Suzi Daley, External Affairs Advisor UKAS, explains the role of United Kingdom Accreditation Service (UKAS) and how accreditation can help delivery your policy objectives

The United Kingdom Accreditation Service (UKAS) is the sole body recognised by the UK Government to assess the competence, integrity and consistency of organisations carrying out conformity assessment activities against internationally recognised standards. By conformity assessment we mean organisations offering testing, inspection, calibration, verification and certification services.

UKAS is a non-profit-distributing company limited by guarantee and is appointed as the national accreditation body by Accreditation Regulations 2009 (SI No 3155/2009) and the EU Regulation (EC) 765/2008. It operates under a Memorandum of Understanding with BEIS on behalf of government.

UKAS is regularly reviewed by international peers to demonstrate its competence to be a signatory to European and International accreditation multilateral mutual recognition agreements (EA, IAF, and ILAC respectively). Through these multilateral mutual recognition agreements the need for multiple assessments of suppliers is reduced therefore UKAS accreditation also helps to facilitate international trade. This can be demonstrated by the reference to accredited conformity assessment in the WTO's Technical Barriers to Trade Agreement.

Where do we fit in?



So how is this relevant for government policy makers and regulators?

Conformity assessment and accreditation are important parts of the nation's quality infrastructure. By providing confidence in goods, services, management systems and people, they make a significant contribution to the economy, health and safety, and environment.

But equally the confidence and assurance that UKAS accredited organisations provide can play an important role in improving the regulatory landscape; providing an opportunity to reduce the burden of regulation whilst ensuring quality standards and important safety measures are not compromised or reduced.

UKAS accreditation has been successfully used by regulators and policy-makers to support and complement existing regulatory regimes; enabling regulators to use a more risk-based and outcomes-focused approach which has resulted in better targeting of resources by regulators.

UKAS accreditations also underpin government policy in areas as diverse as environmental management, food

safety and quality, medical services and forensic science. More recently UKAS has been working with government in areas such as climate change, aesthetic medicine, and digital and data-driven technologies. Accredited conformity assessment is being used by policymakers and regulators in a number of ways including:

Self-regulation

Accreditation can be used as part of a self-regulatory regime. Providing assurance to regulatory agencies (and the public) that businesses are complying with voluntary standards, codes of practice or conduct.

An example is the Health and Safety Executive's approved code of practice on the Control of Legionella which requires employers and landlords to carry out risk assessments undertaken by a "Competent Person". UKAS accredits inspection bodies against the recognised BS standard for Legionella risk assessment and the rigour and impartiality of a UKAS assessment means that business and the HSE can have confidence in the outcome of the risk assessment.

Earned recognition

Earned recognition is where businesses can 'earn' recognition from regulators, in the form of reduced costs or inspections, for demonstrating high levels of compliance. For example, the Drinking Water Inspectorate (DWI) operates earned recognition to support its reassurance that public water supplies in England and Wales are safe and that drinking water quality is acceptable to the public.

Accreditation of laboratories under the Drinking Water Testing Standard Scheme (DWTS) significantly reduces the burden of DWI audits, as the need for the Regulator to routinely audit or inspect the laboratory is removed. Conversely, if a laboratory chooses not to adopt DWTS, they will be subject to risk-based vertical audits, including audits of samplers by the DWI. The costs of DWI audits or inspections of laboratories used by water companies are recovered by the DWI, and so there are clear financial benefits of being accredited under the scheme.

> "UKAS accreditation has been successfully used by regulators and policymakers to support and complement existing regulatory regimes; enabling regulators to use a more risk-based and outcomes-focused approach which has resulted in better targeting of resources by regulators."

Co-regulation

Co-regulation is where government sets the top-level regulatory requirements and leaves the sector to define how these general principles are met in terms of technical solutions.

An example of this is UKAS's role in the delivery of the eiDAS Regulation (Regulation (EU) 910/2014). The Regulation requires that Trust Service Providers' (TSPs), the bodies providing digital certificates for the creation and validation of electronic signatures, are audited by a UKAS accredited certification body to the requirements of the international standard for organisations certifying products, services or processes (ISO/IEC 17065). UKAS worked with the Information Commissioner's Office to produce guidance for the implementation of eiDAS in the UK.

UKAS accredits certification bodies to certify TSPs under the ETSI (European Telecommunications Standards Institute) standards for the operation and certification of TSPs which were designed to meet eiDAS. This means that government and consumers can have confidence in TSPs without direct government intervention.

These are just a few examples of how UKAS is working with government, regulators and business to deliver policy and regulatory solutions. As both policy and industry, UKAS will continue to work closely with all government departments to ensure accreditation remains an effective, market-led and valuable tool that delivers policy objectives in a reliable and cost-effective way.

You can find out more about UKAS at: https://www.ukas.com/about/working-with-government/

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Procurement frameworks: The role of the public sector in energy demand

Adam Garbutt, CCS Category Lead for Utilities & Fuels (Strategic) at Crown Commercial Service – HELGA explains the role of the public sector when it comes to tackling the so-called ' energy trilemma' in terms of procurement frameworks

The UK is not alone among nations facing the so-called 'energy trilemma', a puzzle which requires the balancing of three challenges: affordability, sustainability and security.

The public sector has a significant role to play in helping solve this problem and indeed has set a voluntary target to reduce its own carbon emissions to 30% of 2009/10 levels by 2020/21.

Crown Commercial Service (CCS) has been tasked with supporting this aim through a number of energy agreements – sets of terms and conditions which suppliers agree to abide by when dealing with public bodies.

One of our newest and most noteworthy agreements is the HELGA (Heat Networks and Electricity Generation Assets) Dynamic Purchasing System (DPS), which will help public bodies and the wider public sector find the right suppliers for solar panels, wind turbines, heat networks, battery storage and more.

By self-generating, the public sector will benefit from energy security, lower costs and demand reduction. All these measures will increase the uptake of renewable energy and reduce the environmental impact of the public sector.

HELGA supports public sector customers and provides the specialist suppliers – whatever their size – access to those customers.

For customers, HELGA is a flexible and compliant way to access a full range of market participants for any energy generation or efficiency projects they wish to run. The benefits include an OJEU-compliant competition process, and pre-existing terms and conditions to reduce paperwork.

It will allow filtering by project size and location, assisting SMEs to participate in the call for competition and allow the public sector to fulfil its ambition to increase its spend through the SME market.

For suppliers, once they are registered they will be included in any relevant call for competition run through the HELGA system, increasing their visibility of new projects and potentially opening up whole new markets.

The market for energy demand reduction is growing all the time, and we see up to £800 million of public spend being delivered through this agreement over its four-year lifespan.

CCS has engaged closely with the energy demand management market to better understand its fast-moving and evolving nature. We've looked over the horizon too, putting in place an agreement which fulfils the needs of the sector today while being flexible to ensure it captures future requirements.

"The market for energy demand reduction is growing all the time, and we see up to £800 million of public spend being delivered through this agreement over its four-year lifespan."

It was, for this reason, CCS opted for a DPS, which allows both suppliers and services to evolve as requirements change. It puts HELGA and CCS at the forefront of energy demand management tools. It also allows suppliers to register at any time during the lifetime of the agreement. We have had over 70 suppliers register to be on the agreement since it launched in November 2018, with many of those now approved and ready to serve customers – this figure will grow over the next four years.

CCS is uniquely positioned to offer services to both Central Government and the wider public sector, as well as offering solutions for the full range of technologies and services.

Although innovative and digital, HELGA retains the human element that CCS customers like. It allows for specialist design and advisory services to be bought if customers need help to create these specs, and the HELGA team is always on hand to help customers.

But HELGA is just one of the ways we are looking to help our customers meet their energy needs as they try to address CO_2 and energy security issues.

We have a long-term strategy to help the public sector reduce the cost and impact of all aspects of its energy consumption, by providing a range of services to cover the whole end-to-end process of utility management.

In addition to our frameworks for electricity, gas, water and fuels, which allow customers to buy utilities at a low cost, we have recently introduced frameworks to help manage and reduce their energy consumption. These include Utilities Management Software, Metering and Ancillary Services (RM3800) and Demand Side Response (RM3792) frameworks. We are currently developing a Smart Energy Cities offering to manage new 'Smart' technologies and their impact on the way our customers use energy.

We believe this will provide our customers with the tools they need to help them manage the uncertainty of long-term energy prices and ever-changing technologies.

The challenge facing CCS is that it needs to be influential – the place people turn to for public procurement excellence. That's not just about developing innovative market-sensitive frameworks, but also about being in tune with policy initiatives that want to improve the lives of citizens throughout the country. HELGA is a great example of that kind of thinking, and this kind of leadership is how CCS can really make a difference. ■

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The Tip of the Iceberg – but what lies beneath?

NFI 2016-2018 report confirmed £4.3m in 'Error payments' made to Suppliers (£4.5m – previous period), out of £275m in overall errors identified. Does this make sense?

Government has concluded that the potential range for likely losses in unmeasured areas of government spend ranges from £1.96bn to £19.6bn, or 0.5% to 5.0% of public services expenditure.

(source: Cross-Government Fraud Landscape Annual Report 2018, published by the Cabinet Office)

What proportion of potential errors relate to Spend with Suppliers (Trade Creditors)?

With £100m's being identified and recovered in error payments to Suppliers within the Private Sector, why would the Public Sector be any different?

Is it time to find out what lies beneath…

twice2much

At the forefront of
Spend Recovery Services

twice2much

At the forefront of
Spend Recovery Services

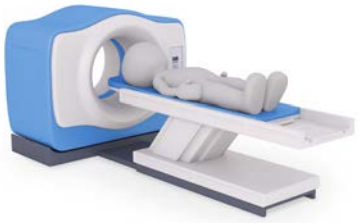
Twice2much Supplier Health Check

Our reviews enable Clients to benefit from a detailed forensic review of their Accounts Payable transactions bespoke to their own organisation.

To draw an anology with our own Health, we would compare our reviews to an MRI/scan approach rather than a GP check-up. The depth of our reviews enables the identification of errors previously unknown to the organisation.

STAGE 1 - Identification/detection

- Access to £100,000's of technology, analytics and resources
- Access to dedicated experienced professionals
- Provides multiple-layer interrogation of transactions with Suppliers
- Specialist expertise in reviewing Supplier transactions and identifying anomalies



STAGE 2 - Verification/validation

- Expert detailed analysis of transactions at individual Supplier level to validate and investigate anomalies
- Obtaining evidence to support initial findings

STAGE 3 – Recovery/Reporting

- We supply the system, processes and resources to recover the errors found on our Clients' behalf
- Flexible but targeted reporting provides significant additional benefits to Clients

Our Supplier Health Checks are carried out on a NO RECOVERY - NO FEE basis enabling Clients to benefit from a FREE Health Check if no errors are found.

The secret to millennial engagement? Progressive politics!

Maria Joao Rodrigues, President of the Foundation for European Progressive Studies (FEPS) and Vice President of the S&D Group in the European Parliament, argues that the secret to millennial engagement is progressive politics

A recent article by The Economist speaks about "The Rise of Millennial Socialism". [(1)] Its main claim is that socialism is emerging as a popular ideology amid millennials who, in turn, wish to see greater control over the market economy, strong global action against climate change and open participation channels in contemporary political systems. The Economist additionally claims that this generation misdiagnoses what sort of public policies could address the world's problems and – most importantly, that millennials' dreamy expectations are misguided.

Articles such as this one – and many others that determine millennials (those youths born between 1980-2000, aged 18 to 35) to be an idealistic yet at the same time, a politically apathetic generation – has prompted The Foundation for European Progressive Studies (FEPS) to bring about a greater understanding about this demographic, their values and expectations with regard to society and political systems. This generation has been a research priority for FEPS since 2015 exactly because of hyped journalistic diagnosis and a lot of general misperceptions about this generation.

In addition to the reason stated above, for FEPS it was equally important to focus on a generation that consists of roughly a quarter of Europe's entire population [(2)] and that, consequently, is a demographic that should be better understood by the media and differently engaged with by politics.

Sparking fresh, forward-looking and balanced ideas on how progressives need to respond to this increasingly powerful and influential cohort was FEPS's contribution as the only Progressive European Union (EU)-level Think Tank in view of bridging the gap between millennials and social democracy.

Maria Joao Rodrigues

But how do millennials actually see today's world – and, most importantly, how they participate in public life and what sort of public policies would they like to see governments realise?

These questions become even more pertinent especially in the year of change ahead in the European continent – the 2019 EU elections – and also because sometimes compelling headlines deserve a more attentive review.

It is, therefore, not surprising to see this generation rise up to the number of problems that Western societies are facing rising inequalities, climate change and a general disempowering feeling that your voice does not matter and that is not being heard by today's political class. We have seen massive mobilisations on these issues by this generation in the U.S., Europe and beyond. What is surprising though is the Economists'

claim that the dreams of this generation are naïve and to some extent that these should be tamed or even dismissed.

As the future generation millennials matter and I believe that it is, therefore, extremely important for social democrats to encompass the power of this generation and embrace it – this generation is indeed the vessel to bring about the progressive change that we want to see in the world and as progressives our role is to be the leading political force to realise this change via progressive policies.

In fact, the FEPS Millennial Dialogue survey shows that this generation is in favour of progressive policies. A strong wish for a social safety net in uncertain times is reflected in the survey. This is a generation that is clearly expecting more from the EU leadership in terms of social welfare policies, such as access to healthcare and education, job creation and an EU-wide minimum wage, for example. While millennials are often described as apathetic, our research showcases that they react to major global issues. Millennials also support the EU to have stronger powers to fight more vehemently climate change and to have a leading role in this fight on the world stage.

An interesting insight with regard to economic policy specifically was also the wish expressed by 82% millennials that citizens should have a greater say on how the EU handles the economy. Such a significant percentage of support highlights indeed that this generation wants to have a greater say on how decisions that directly affect them are made.

What is certain though is that even though millennials value the EU, they have an issue with the EU ballot box. Just 27% of youth aged 18 to 24 voted for a member of the European Parliament in 2014. To reverse such trends, it needs to be widely understood it is not lack of knowledge or willingness to engage that keeps millennials away from politics in the traditional sense, such as voting – this generation is engaging and mobilising politically in a different way.

In the run-up to and beyond the EU elections the recommendation is clear: for social democracy to gain the hearts and minds of this generation it needs to stand by its values-based mission and make greater efforts to encourage millennials' participation in decision-making processes as equals and take clear action on the issues millennials care and most importantly that they dream about. ■

References

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What is progressive state leadership today?

Professor Richard Beardsworth, Aberystwyth University, examines what progressive state leadership is in the world of politics and how it can be implemented

Our contemporary era is defined by a tragic paradox of governance: a return to a politics of national borders at the precise moment when the most important threats to be governed – climate catastrophe, nuclear dis-order, global inequality and the fundamentalisms it spurns – are, to varying degrees, border-less. This paradox emerges from both long and short histories. Long-term, 500-year processes of interdependence (including worldwide industrialisation and a now globalised system of states) have produced a governance gap between the threats states face and the capacities and responsibilities of these states to address them. Short-term, the practices of post-Cold War liberalism short-circuited the national by moving too swiftly to the 'post-national' and 'supranational' in order to govern a globalising world; in so doing, it produced the national-sovereign backlash against this world.

Today's paradox of governance is accordingly the result of an unresolved and, therefore, recurrent tension between trans-border processes of interdependence and a system of bordered political units. This paradox insists because there is no exit from it. The state system remains our international political condition, and, due to the imminence and urgency of the above threats, it is only through this system that these threats will be addressed. The paradox tempts one to despair of the promise of politics: hence contemporary modes of catastrophism regarding a new nuclear arms race, climate chaos, and digitised extremism – 'it is too late!.'

If the state system presents the means as well as the obstacle to confronting global threats, then the question of remedial political action becomes: which states can lead other states towards effective global action? In sum, the despairing 'It is too late!' becomes the narrower question: 'What is *progressive state leadership* today?' To so focus the political lens denies neither the political agency of non-state actors nor the imbalances of power among states (imbalances that any claim to state leadership can always reproduce). It rehearses, rather, a *necessary* condition of response to global threats given the above

paradox and its histories. To argue for progressive state leadership proves accordingly an urgent intellectual and political task. There are three major traits to the former.

First, state leaders need to construct concepts of national security and national interest that encompass, *within* the very notion of the national, global interest and value. Post-cold war liberalism failed to dovetail national and global interests for several reasons: foremost, the non-liberal outcomes of market fundamentalism and of humanitarian interventionism. Re-territorialising conceptions of interest and security form part of the backlash against these outcomes. If, however, the primary duty of government is to protect its citizens, and if the all-important threats to these citizens are of a trans-border nature, then it is the duty of state leaders to address these threats not by framing them as threats to national interest and security but by re-framing national interest and security as constitutively harbouring global interest. The political responsibility of progressive state leadership is thus to *re-frame the problem of borders* and present a political narrative that runs something like this: 'one must go abroad to come home'.

States must, therefore, act collectively with other states to confront a trans-border threat. This second trait is well understood; regional organizations (NATO, the EU, ASEAN, etc.) are based on its premise. However, as Mancur Olsen wrote in his 1960s classic *The Logic of Collective Action*, leadership is required to make collective action possible in the first place given the 'free-rider problem': states may have a particular interest in submitting to a common interest, but not in paying the costs. In a hierarchical system of states, progressive state leadership is required to both transcend the problem of short-term cost and transcend it while reducing hierarchy. Take climate mitigation and adaptation. Coalitions and alliances must be formed across rich and poor, resilient and vulnerable states so that collective action against climate catastrophe is possible. To transfer funds and/or technologies to vulnerable states is in the *ultimate interest* of all states given the comprehensive nature of the threat to sustainable living systems.

Leadership is thus required to frame these coalitions of interest as of greater benefit than the benefits of short-termism (fossil-fuel interests, consumerism, and national comparative advantage from global warming). Further, leadership is required to frame these coalitions in such a way that international hierarchy is re-worked, under the normative focal point of the sustainable development goals, towards greater equity among states and their populations. Responsibility towards climate change is often correctly pitted against development, from those on the right and the left in the north and south of the world. In contrast, progressive states are those that seize the opportunity to *make threats meet*, leading the way towards economic and political transformation: a carbon-neutral economy that is fairer to all and that narrows the gap between the earth system and the state system.

These two traits suggest, finally, a specific *style* of leadership appropriate to the nature of urgent trans-border threats, their essential unpredictability, and the emerging international order: the ability to engage in *multilateral diplomacy* and to *lead with humility*. To build collective action today means to form coalitions and alliances across rich and poor countries, across nuclear-weapon states and non-nuclear weapon states, and across states and non-state actors. To do this requires the skills of multilateral diplomacy: to synthesise and upgrade complex economic, social and environmental interests into a common interest and to lead by example. In today's world to lead by example means to work as an equal among multiple stakeholders and to give to others not by 'leading from behind' but, precisely, by moving ahead oneself.

The present backlash against globalisation has undermined the pooling of sovereignty. It is incumbent upon state leadership to reframe such pooling as an act of sovereignty in the very defence of its citizens. It is this paradox that responds to the paradox of governance with which I began, and it is progressive state leadership that can own the paradox by re-framing the problem. Let us go abroad to come home.

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How do you embed commercialisation into your local authority?

When making commercialisation part of your organisation's DNA, do you focus on having the right culture, structure or strategy? Anthony Roche, Deputy Chief Executive at North Hertfordshire District Council, explains all

Why are we going down the road of commercialisation – it's simple, money. The need for local authorities to consider increased commercialisation is driven by financial pressures, so how do we embed commercialisation in our organisation's DNA? Is it all about having the right culture, structure or strategy? I believe it needs all three.

After looking at the work of others, we've identified those three strands for embedding commercial culture. And these are the initial questions you will need to ask:

1. Structure – who are your people, how are ideas are brought forward and tested, how are decisions made?

2. Strategy – what parameters are you setting for commercial activities and what level of returns are you expecting?

3. Culture – how do you create that political buy-in, how do you engage your workforce, how do you provide training and support to develop your workforce?

Let's look at structure. This year, we've undertaken a senior management restructure, we appointed Steve Crowley, Service Director for Commercialisation, in June. We created that new role for two reasons; one, financial pressures have meant that we need to speed up that pace of change, and two; we can't just be coming up with single ideas in single departments, we need to have a much more commercial approach across the organisation.

The structure is the staffing, internal decision-making structures, finding out who leads on ideas. Is it the commercial director and his team, or the service areas who work in partnership with the commercial team?

Anthony Roche

How are your different organisations bringing ideas forward?

So, you're generating the initial ideas – how do you capture them and how do you test them? Now for strategy. Historically at North Herts, our approach has been service led, working on a project by project basis. What we've not had to-date is that overarching strategy that allows you to make those quick decisions.

What we've discovered is that North Herts' strategy can be far more service-specific than a larger authority, because it is a relatively small authority. Additionally, due to either existing capital or our ability to leverage in at low-interest rates, we can make projects viable when private firms are unable to. If local authorities have confidence in our abilities there is no reason why we cannot deliver projects without private firms taking a whole load of the profit!

And finally, culture. If you were to get all of your members and officers in a room and ask them for a definition of commercialisation, you'd probably have more definitions than those in the room. Getting your messaging and your goals clear from the start is crucial in engaging your whole workforce.

> "The structure is the staffing, internal decision-making structures, finding out who leads on ideas. Is it the commercial director and his team, or the service areas who work in partnership with the commercial team? How are your different organisations bringing ideas forward?"

Ultimately though, as local authorities, what are we here to do? Yes, generating income helps support services and helps deliver new services, but the whole point is we are here for our community. Repeating this message to your workforce will help instil the correct culture to move forward. If we keep this in mind, along with the three key points mentioned above, we can embed commercialisation deep within the roots of our organisations.

If you would like to share examples of good practice, please contact Steve Crowley or me as we are keen to carry on the conversation.

Anthony Roche was speaking at the recent Local Government Partnership Network event, hosted by Partnership Network Events. www.partnershipnetworkevents.com . ■

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The UK's ' productivity puzzle': The price of real economic measures to address this

Nigel Wilcock, Executive Director of the Institute of Economic Development sheds light on the UK's ' productivity puzzle', including the price of real economic measures to address this

UK economics analysts are once again wringing their hands over the country's poor productivity performance – but for most of the business sectors which determine the level of productivity in the UK, the measure appears somewhat abstract to their day-to-day activities and distant from their own decision-making.

There are many reasons for the UK's poor productivity performance and these have been widely discussed in the media. However, what is missing from the conversation is the need to interrogate the underlying structural issues that have had a huge impact on the problem.

Firstly, the typical performance measures used by businesses disincentivise activities which would drive up productivity; and secondly, government policy over the decades tends to run contrary to its productivity heavy rhetoric.

The frequently repeated economic ill of 'short-termism' is highly relevant here. In large businesses, maintaining the share price, maximising dividends and maximising executive directors' pay all disincentivises productive capital investment. Jam tomorrow is often seen as an unattractive option for shareholders. The same structural issue disincentivises R&D, training and the recruitment of higher paid and higher skilled workers. Businesses too frequently ignore the longer term jeopardy of under-investment in favour of immediate returns.

This rationale is also true, perhaps even truer, of the micro business sector. These companies are often vehicles to maintain their directors' remuneration rather than businesses which undertake significant long-term investment in an attempt to ensure long-term and highly productive growth. These businesses make up the majority of companies in the UK but are unlikely to drive productivity growth. In the public sector as well, how often are schemes that will save money in the long run ignored government policy?

Perhaps short-termism is now completely embedded in the UK's economic psyche – and this is not a good recipe for strong productivity growth.

> "A carrot-and-stick approach involving incentives for capital investment, whilst at the same time ensuring that employers pay the true cost of maintaining a workforce combined with higher taxes on profits which are not reinvested, can start to shift the structural issues around productivity."

Given the column inches devoted to productivity, you could be forgiven for thinking that every clause of government policy must have productivity improvement enshrined at its core. In fact, the government could be argued to be schizophrenic on the subject with lower unemployment being the main economic indicator continuously trumpeted.

Now, there is clearly nothing wrong with low unemployment – and for most working-age individuals this may be the most relevant economic measure for them – but strictly in productivity terms, policies to ensure low unemployment often run counter to the policies which would be required to make a large impact on productivity.

Clearly, it is not a simple task to address structural failure in the economy, but here are six steps that the Institute of Economic Development believes should be taken that would begin to shift the incentivisation structures and nudge the economy towards those measures that will address productivity failings.

1. Radically change the corporate tax system

Higher taxes on corporate profits and dividends could be used to fund far higher capital allowances for capital investment, and this, in turn, would create a far larger incentive for businesses to reinvest for the future.

2. Change the corporate decision-making structure of businesses

Adopting a European idea of greater workforce participation in decision-making (and potentially share ownership) would potentially help shift planning horizons away from the short-term and prevent hard-earned profits being quickly distributed out of the business.

3. Phase out working tax credits in line with raising the living wage

Whilst this policy was introduced with the very best intentions of reducing poverty, it has in fact allowed business to keep their wage rates at artificially low levels with the government picking up the shortfall. In effect, the taxpayer is currently subsiding the business rather than the low paid, and a greater burden of responsibility should, therefore, be shifted to employers.

4. Overhaul National Insurance flaws

Very simply, we need to ensure that various loopholes allowing employer avoidance are closed. This, together with other measures, have allowed employers access to cheap labour and ensured that capital investment decisions are less favourable compared to maintaining the labour force.

5. Reduce discount rate for government capital appraisals in under-performing areas

This would ensure that investment cases are made more easily in these locations. In fact, at the government and corporate level, capital appraisal techniques appear to have discounted long-term returns too aggressively in an economy that has had ultra-low interest rates for a decade.

6. Re-introduce grant funding incentives for capital investment

Building on the above, this would address the productivity issues of the weakest regions economically. Previous regional aid schemes prompted investment whilst quickly being repaid to the Treasury through taxes paid by recipients.

Nigel Wilcock

In summary, whilst there are lots of micro policy interventions which can be introduced to improve education and training and, therefore, help make the workforce more productive, the impact of such policies on overall productivity is likely to be negligible without addressing some of the structural issues in the economy.

A carrot-and-stick approach involving incentives for capital investment, whilst at the same time ensuring that employers pay the true cost of maintaining a workforce combined with higher taxes on profits which are not reinvested, can start to shift the structural issues around productivity.

In normal circumstances, such policies might be considered likely to impact on employment – but at a time when labour markets are likely to further tighten as a result of Brexit and changes to immigration legislation, now might be the perfect moment to grasp the opportunity. ■

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Putting the "local" into Industrial Strategies

Paddy Bradley, Director of Swindon and Wiltshire LEP explains how Local Enterprise Partnerships (LEPs) across England are working on Industrial Strategies relevant to their areas and co-produced with government

The aim is that by March 2020, all areas of England will have produced Industrial Strategies that are focussed on the recognisable economies and natural capital of their place, increased rates of growth by linking to relevant Grand Challenges, improved the productivity of UK plc by strengthening the foundations of productive endeavour and taken an inclusive approach to building prosperity.

The co-ordination of local industrial strategies, guided by a national framework, covering the whole of England is a huge step forward and one which is welcomed by LEPs. Our raison d'être is sustainable economic growth so this is our opportunity to make a significant difference to our country.

"Local" knowledge and understanding are at the core of effective "local" industrial strategies. We know the importance of our natural environment, the contribution of and the challenges facing the rural economy as well as the need to create exciting spaces for new ideas to develop. LEPs are business-led organisations but work in a public-private sector zone of influence. Each partnership needs to understand the role of all the partners and especially the way Local Authorities and LEPs address economic development. It is the responsibility of LEPs to produce Local Industrial Strategies and it is LEPs which will be accountable to the government for their implementation.

Our strategies need to build resilience in our local economies. For example, Salisbury has suffered a significant economic shock because of the major incidents in 2018. The ancient and beautiful city has a strong dependence on retail and tourism, both badly affected over this last year.

"The government has set LEPs the task of ensuring anyone can recognise the "place" within each local industrial strategy. LEPs are working to achieve this by building a robust evidence base for change which is independently verified."

Through our strategy, we will take Salisbury beyond recovery to growth through investment in digital connectivity, a revitalised retail offer, enhanced provision for higher skills in in-demand sectors and transforming the visitor and night-time economies.

Salisbury is a great place to live for the people taking up the thousands of new, high-value jobs we anticipate being created in South Wiltshire due to the tremendous opportunities provided by defence, security, life sciences and aerospace.

The government has set LEPs the task of ensuring anyone can recognise the "place" within each local industrial strategy. LEPs are working to achieve this by building a robust evidence base for change which is independently verified. The government has provided financial and technical support for this which is very much welcomed. Our strategy will include priorities that businesses and residents want and will reflect growing local trends in employment and exploiting technology to produce new products and processes.

In Swindon and Wiltshire, we are building new workspaces for digital talent using the draw of our heritage and natural environment; and supporting the growth of exciting engineering talent to help restore the importance of a "makers" economy.

All places are looking for that which is unique – by definition, there are few examples in the country. In our case, we do have one – Porton Down and our Local Industrial Strategy will seek to work with DSTL and Public Health England on the commercial opportunities provided by the research and development they undertake.

Our local knowledge and understanding includes knowing the granular detail of our economy and where the strengths and weaknesses lie. It is crucial that businesses are at the heart of the development and successful deliv-

ery of local industrial strategies. Our local economies are not constrained by LEP or local authority boundaries and cross-LEP working is a natural outcome of giving 38 business-led organisations the responsibility for improving productivity and sustainable economic growth.

Swindon and Wiltshire LEP has great connectivity east and west; room for improvement north and south and we know we will not grow sufficiently if we do not help businesses to strengthen their existing links beyond our boundary. The physical distances are minuscule in this country compared to other nations of the world. Digital technology can make some irrelevant.

In Swindon and Wiltshire, we look to the east to the Thames Valley and the Oxford – Milton Keynes-Cambridge arc for life sciences, advanced engineering and improved transport links, including to Heathrow and the City. We are working with LEPs in the south-west to implement the recommendations of our joint Rural Productivity Commission, identified as an exemplar in the National Industrial Strategy.

To the north, we want to build on our cyber resilience alliance with GFirst, The Marches and Worcester LEPs. Looking both east and west, including into Wales, we wish to use the marvellous economic opportunity of the M4 to build a corridor for new energy vehicles and exploit further our expertise in hydrogen technology. The southern ports are essential to our export potential and improved road and rail connectivity will be much-needed additions to our strengths.

No LEP wishes to write a well-argued, impeccably researched local industrial strategy that remains unopened due to lack of resources. The UK Shared Prosperity Fund is vital and we await the final details on this. Brexit plays its part! Clearly, the means by which we disengage from the EU, or engage for a little longer or whatever is decided are determining factors in the way the UK Shared Prosperity Fund is positioned and resourced.

> "In Swindon and Wiltshire, we are building new workspaces for digital talent using the draw of our heritage and natural environment; and supporting the growth of exciting engineering talent to help restore the importance of a "makers" economy."

What is apparent, however, is that LEPs will need to be cognisant of the UK Shared Prosperity Fund as this will be a major resource to implement their local industrial strategies. The previously circulated ideas underpinning the UK Shared Prosperity Fund ensure that LEPs embrace inclusive growth in their strategies and enable bids to the fund to have strong hooks into the locally determined priorities. We hope for a mix of revenue and capital, giving a sustainable financial future to LEPs and building on the successes of the Local Growth Deal.

However, notwithstanding our local prioritisation, we cannot deliver our objectives without:

1. A commitment by government to deliver the road and rail strategic transport priorities already confirmed – in our case A303 – probably through some public/private financing model;

2. Accelerated delivery of the universal service obligation for broadband (by 2025);

3. Funding and greater devolution to sub-regional areas (through Combined Authorities and LEPs) commensurate to the scale of the area and existing Local Growth Fund and European Structural Investment Fund allocations;

4. Sector Deals include at their core recognition of place as has been achieved although not yet implemented in the Nuclear Sector Deal; and

5. Greater recognition of the importance of retaining sovereign capability particularly for example in defence – once it's gone, it's gone.

Having produced local industrial strategies, LEPs are very well placed to manage the delivery of the UK Shared Prosperity Fund in their areas.

Swindon & Wiltshire
LOCAL ENTERPRISE PARTNERSHIP

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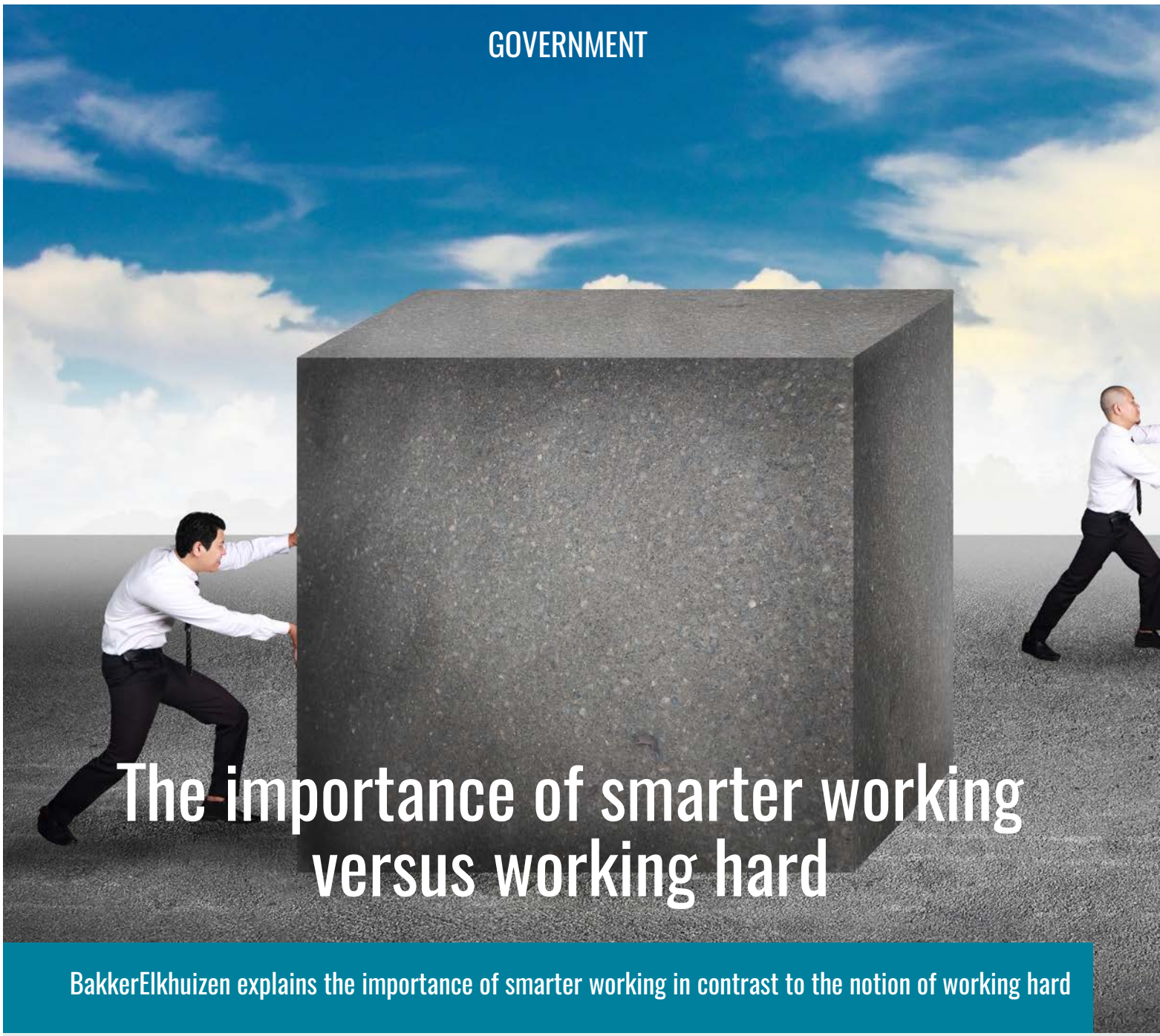

The importance of smarter working versus working hard

BakkerElkhuizen explains the importance of smarter working in contrast to the notion of working hard

Businesses, whether a SME or large organisation, are now more aware than ever of the importance of utilising office space, employee time and productivity. The benefits aren't just another money saving incentive to make the companies more profitable and staff to work harder. Working hard is something we've all been taught since our childhood but the paradigms are evolving and 'working hard' isn't the way of the modern office. Working smart is very important, but working smartly can be quite hard if you don't know how.

Companies and employees are smart when they can figure out that the tasks they are doing can be done in a more efficient manner, thus by optimising their efforts it will result in more efficient results.

Less effort = more results. But, how do you figure out a way to complete tasks with less effort and better results? The answer is simply by working in an enriched working environment. The way we embrace our own space, office space and working habits all join to make a more beneficial working atmosphere. Simple changes from making the office more visually appealing, better lighting and more stimulating surroundings will help our brains focus on the tasks in hand and process information quicker and more efficiently. But, how do we work smarter when work consumes us almost 24-7? Work follows us everywhere, it doesn't just stop after 5 pm, with technology allowing emails, phone calls and instant messages at any moment of the day it means we all always connected to our office, even when it is family time, gym time or bedtime. You

are just one email away from a happy mood to complete stressed out.

As simple as it sounds, the easiest way is to try to stick to strict working patterns, switch off your emails, or your phone when you finish work. Your body and brain both need time to relax and recover. You cannot be your best if you constantly clear emails until 9 pm every day. So ask yourself, does dealing with 10 emails after 7 pm really save you time the day after in work? The answer is not really, as there is always more work to fill those gaps. Resting is more important. When in work try to prioritise the tasks for the day ahead, so set clear targets and check emails only at certain times, otherwise one email could swallow up more time than you could imagine, this will make you behind on your daily tasks, more stressed, less productive and making you be less focused and productive, filling you with negative energy which can affect you and your colleagues.

> "Working hard is something we've all been taught since our childhood but the paradigms are evolving and ' working hard' isn't the way of the modern office. Working smart is very important, but working smartly can be quite hard if you don't know how."

So how do we become more focused on work? It's not just the mental approaches and clear time management that will benefit your daily work routine but also by embracing software which gives you little nudges throughout the day and encourages you to be more active both physically and mentally. Scientific research shows that the brain gets tired after just 40-50 minutes of continuous effort, this contributes to less speed and more mistakes. A simple three-minute pit-stop will allow your brain to recharge, re-align and you'll actually speed up after and make fewer mistakes. So, the three minutes isn't actually lost, you are just more efficient after.

Naturally, working smart is the only way forward, by embracing little changes your whole work and life balance could be vastly improved, showing health and mental benefits that you make you happier, freeing up time for some of the more important things in life. Evenings and weekends with family and friends. Embracing life is what we all want, so by learning to work smarter, we will naturally find more time to relax and enjoy the best things. ■

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Opportunities and challenges associated with Smart Working

Alison White of PLACEmaking asks: Are organisations focusing on the opportunities and challenges associated with Smart Working or too focused on the practical technology and property related aspects?

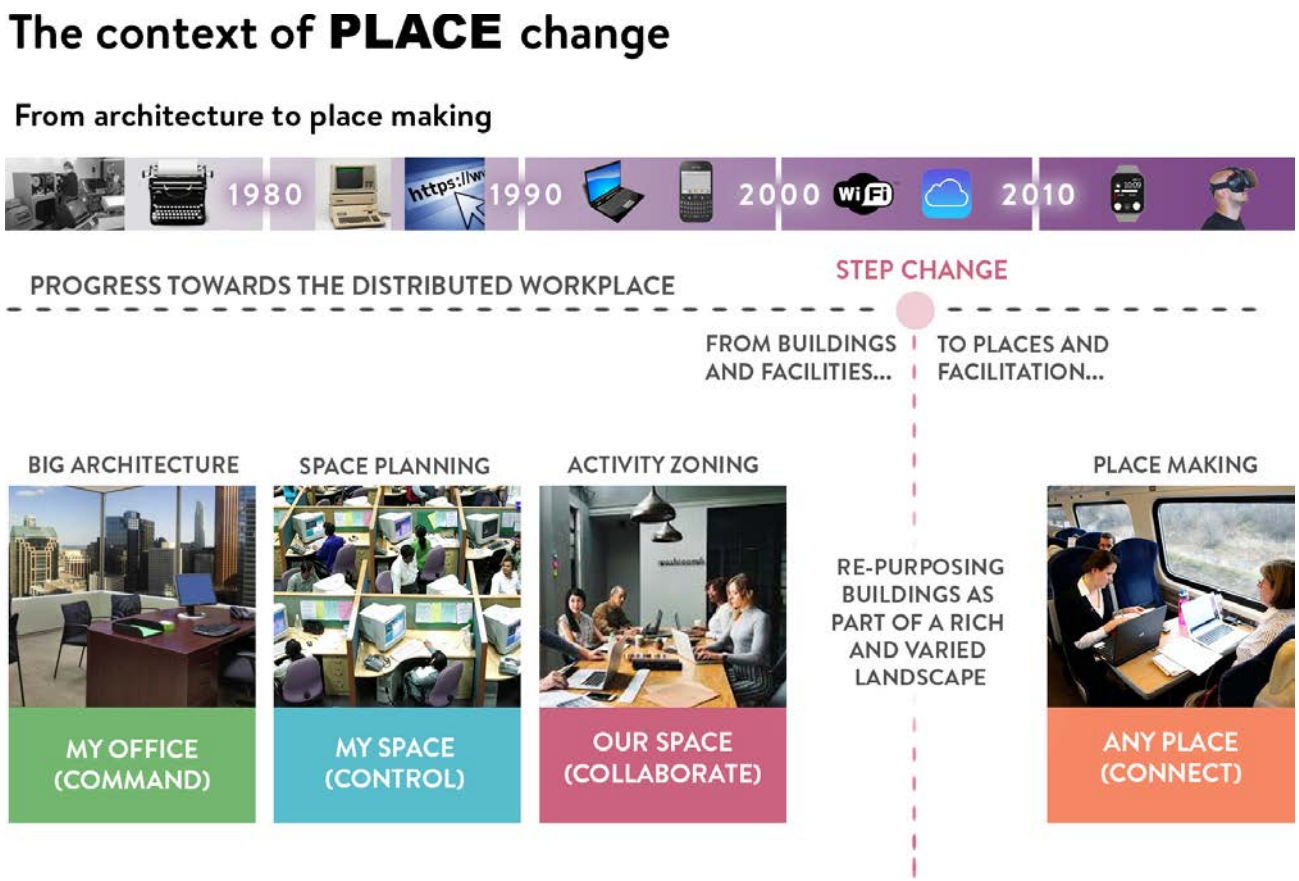
In my professional lifetime, the technology found in the average office workplace has evolved beyond recognition.

From the manual typewriters that were still knocking around even when the sophisticated 'golf ball' versions were the height of technology through to today's sophisticated 'work anywhere' cloud-powered smart devices, the transformations and evolutions of the last few decades have taken us on an unremitting roller-coaster ride of speed and, at each introduction of newness, wonderment.

Back in the day when technology was formed largely of mechanical devices that simply assisted traditional methods of processing information, things were predictable and change was slow. The landscape of the typical office reflected a hierarchical 'command and control' management approach with clear departmental boundaries reflecting core professional specialisms.

Over time, however, all of that has become blurred, and organisations now need a rethink on how they operate and how they facilitate smarter ways of working. With the option to work anywhere now a reality for many, new codes of behaviours, new expectations and new types of interaction between employee and employer are demanded.

For those of us professionally supporting organisations in preparing for the future – by adapting their working practices and making better use of work 'spaces' to reflect the step changes that technology advancements are facilitating – we see a pattern of behaviour which is common across many sectors, whether private or public. Somehow the consequence



of investment in technology on their tangible property assets is easier for them to comprehend and address than the intangible impact on their people and organisational culture.

Many regard allocating increasing proportions of their annual budgets to technology investment as something they simply have to do, often made more palatable by the promise that property rationalisation will contribute to such technology investment. Yet focusing on changing the way they implement changes of direction, changes in ways of working and changing expectations of what going to work actually means is often regarded as too complex and therefore given less (if any) attention.

More recently, the term Smart Working has been used to refer to the contributing factors that are changing how and where we work: the adoption of modern working practices made possible by advances in mobile technology, new contractual arrangements, more effective workplace environments and improved support service provision. When all of these elements are aligned, we are enabled to have more choice of where and when to work.

With the promotion of significant property rationalisation savings made possible by adopting Smart Working, it's easy to appreciate why leadership teams seize on the opportunity to activate lease breaks, sell off freeholds or develop parts of their property portfolio for commercial gain. The race to explore and exploit those opportunities though often obscures the need to consider and carefully plan for the impact that such changes have on long established ways of working. Too many organisations don't factor in at all the significant benefits available if quality attention is focused on what are often – erroneously in my view – referred to as the softer aspects of change. Indeed, not addressing people-related issues puts the desirable benefits promised from technology investment and property rationalisation at risk.

So why don't all Smart Working projects automatically include a balanced approach to change?

It may be that the tangible impact of change is simpler to articulate and the consequential benefits from investment decisions are far easier to measure and report than the intangible. And there appears to be nothing more tangible than property savings and technology investment.

What challenges this though is that many of the desired tangible benefits are dependent on the intangible interaction with people. Upgrading computing devices and software could be regarded as a tangible investment – but if people don't understand how to use them to improve their working experience and benefit their productivity performance, neither the tangible nor intangible benefits will be fully realised.

The same can be said about the physical workplace. We can be persuaded that the replacement of desktop computers and landline telephones with laptops and mobile phones means the amount of space needed to work has shrunk. But if what's retained is an unattractive, poorly equipped place that no one actually wants to spend anytime in at all, then the intangible value of 'event'-based social interaction with peers and colleagues is lost as everyone will find somewhere more welcoming to spend their working time.

We need to shift expectation away from going to an often 'joyless' office every day (simply because we have no other choice) to a different set of beliefs and behavioural patterns that regard the office as just one of many places where we go to work – but one that is desirable, welcoming, stimulating and adds value to make it a worthwhile visit.

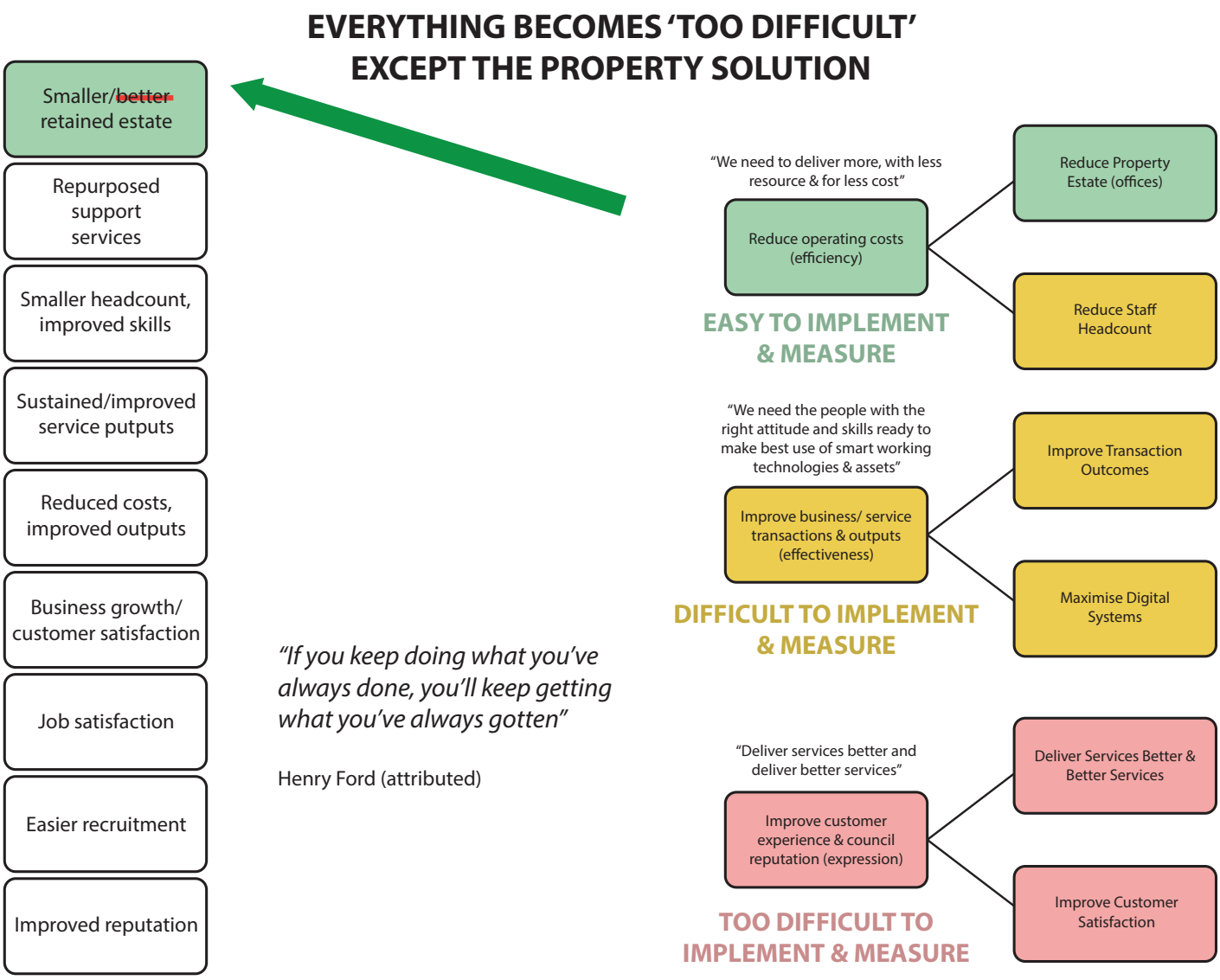
So what prevents an equal emphasis on intangible benefits as on tangible property and technology-focused benefits? Well, it appears that things often start going wrong just beyond the strategic vision stage.

Senior management is often clear on how adopting Smart Working will directly assist an organisation achieve its business objectives:

- Reduce operational costs (efficiency)
- Increase business transactions & productivity (effectiveness)
- Improve customer experience and business reputation (expression)

However, once this vision transfers to the implementation phase, the same old traditional siloed approach is all too often automatically adopted:

- Reducing operational costs and improving efficiency is assumed to be about rationalisation, and Property and HR lead on this.
- Increasing business transactions and productivity effectiveness is assumed to be about business improvement, so the PMO and ICT are assumed to lead on this



"If you keep doing what you've always done, you'll keep getting what you've always gotten"

Henry Ford (attributed)

- Improving customer satisfaction: PR and Communications are assumed to lead on this.

If there is no recognition that implementing Smart Working demands an approach that cuts across all of these silos, then the results will be predictable: objectives become diluted versions of what the blinkered leads interpret for themselves as being desirable and achievable. The most tangible and measurable aspects of Smart Working, namely property rationalisation and technology investment dominate, and the wider intangible objectives – the ones regarded as more difficult to define, measure and report – become side-lined.

The risk of this approach is that the outcomes not only fall well short of the original objectives, but what actually gets implemented in fact damages the organisation. Yes, the property portfolio overheads are reduced, releasing and redirecting investment to new technology solutions, but adaption to new business practices and the nurturing of a new working culture are absent.

If we are all to benefit from advancement of technology and newer, better and smarter ways of working, then people need to be at the heart of Smart Working – and not on the receiving end of diluted outcomes.

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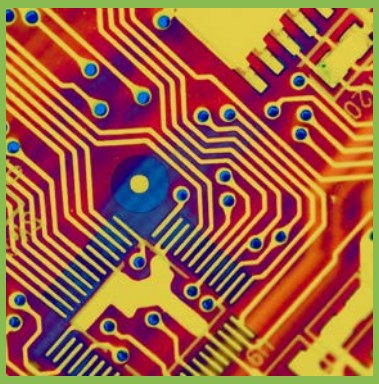





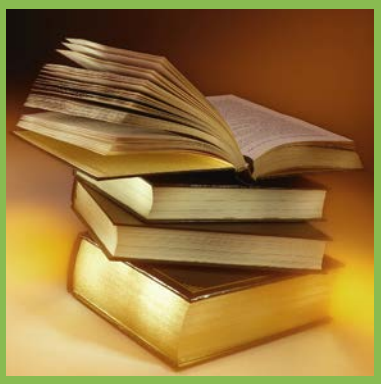

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The common law system: Why London is the jurisdiction of choice

Trevor Tayleur, Associate Professor and Head of Design and Assessment at The University of Law, provides his expert view on the common law system used in England and Wales and explains why London is the jurisdiction of choice

The common law system used in England and Wales has spread to many parts of the world. Most states in the U.S. use it, as do many Commonwealth countries. Although the jurisdictions that use common law have adapted it to meet their own needs, familiarity with the common law concepts of the Law of Contract and the use of English as the language of international commerce has helped to establish London as a major seat of international litigation.

Major corporations entering into international commercial contracts will often choose English law as the law governing their contracts and the English courts as the forum for hearing any disputes arising out of the contract. The global spread of common law has also meant that corporations from countries using other systems, such as the civil law system used in much of continental Europe, are willing to choose English law to govern their international commercial contracts. Accordingly, two-thirds of the cases that the Commercial Court in London hears involve non-UK litigants. It is no stranger to hearing litigation between, say, American and German corporations.

As well as global familiarity with common law concepts, there are other reasons why the English courts are a popular forum for international litigation. The English court system has an excellent reputation for dealing with commercial disputes fairly and efficiently. The judges are held in high regard, as are the lawyers involved. International corporations, therefore, have confidence that the English courts will deliver sound judgments. However, a debate has arisen about whether the UK's exit from the EU will jeopardise the position of English courts.

The EU Member States have signed up to the Recast Brussels Regulation, a piece of EU legislation agreed to by the Member States. This means that courts in all the EU Member States will uphold the jurisdiction of courts in the other the Member States. So, during the UK's membership of the EU, courts in the EU 27 Member States would recognise any clause in a contract giving the English courts jurisdiction to hear cases arising out of that contract. For example, if a contract between a French and Brazilian company gave the English courts jurisdiction to handle contractual disputes between them, a French court would refuse to hear the case. The Recast Brussels Regulation also requires courts in the EU Member States to recognise and enforce judgments issued by courts in other EU Member States.

A consequence of Brexit is that the UK will cease to benefit from the Recast Brussels Regulation. The EU 27 Member States are using the opportunity to try and attract some of the litigation that English courts handle. Thus, the Chief Justice of the Republic of Ireland, Frank Clarke, made a speech last September in New York extolling the advantages of Ireland as a common law English-language jurisdiction within the EU. Belgium France, Germany and the Netherlands have set up, or are in the process of setting up, specialist English language commercial courts with the aim of attracting business from London. To what extent do these developments threaten the pre-eminent position of English courts as the jurisdiction of choice?

The reality is that the effect on English courts is likely to be small. Internationally English commercial courts have a good reputation for the quality of procedures and judgments, so London as a favoured choice of jurisdiction does not especially depend on the UK's EU membership. Where all the parties to a contract are based outside the EU, there is little reason for them to move away from London. Even where one or more of the parties are based in the EU 27, London is unlikely

London, Inns of Court, Lincoln `s Inn, historic legal education and law office building

to lose out significantly. The Hague Convention is an international agreement governing the international enforceability of judgments, and the UK has signed up in its own right to cater for Brexit. Significantly, the EU is also a signatory. Although there may be some teething problems arising from the transition from the Recast Brussels Regulation to the Hague Convention, the latter will ensure that UK judgments remain enforceable in the EU Member States. There is accordingly unlikely to be a big exodus from London to Dublin or one of the new English-language commercial courts.

There are, though, some specialist areas that may be adversely affected, such as competition law. London is a popular forum for damages claims by victims of anti-competitive behaviour that has breached EU competition law. Suppose the European Commission has issued a formal decision that a corporation has broken EU competition law, for example by participating in a price-fixing cartel. That decision is conclusive proof in the courts of EU Member States that the corporation has breached EU competition law. Victims of the cartel do not have to prove there has been a cartel; they only have to show that they have suffered financial loss. In the UK, decisions of the European Commission will no longer be binding this way, so in this example the victims would have to prove the existence of the cartel to the satisfaction of the English courts. They are, therefore, likely to choose the courts of an EU 27 Member State instead.

In the long-term it is possible that the UK will conclude some form of a partnership agreement with the EU that will allow the UK to participate in the Recast Brussels Regulation. Pending such agreement, the reputation of the English courts and the Hague Convention are likely to safeguard London as a popular venue for international litigation. ■

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Legal affairs: Ensuring the consistent interpretation and application of EU law

The work of Koen Lenaerts, President of the Court of Justice of the European Union concerns directing the work of a unique, multilingual institution as it seeks to ensure the consistent interpretation and application of European Union (EU) law throughout its Member States, as this article uncovers

As President of the Court of Justice of the European Union, Koen Lenaerts is responsible for directing the work of a unique, multilingual institution as it seeks to ensure the consistent interpretation and application of European Union (EU) law throughout its Member States.

The Court of Justice of the European Union (CJEU) was founded in 1952 to ensure the law is observed in the interpretation and application of EU treaties.

Based in Luxembourg, it comprises two courts: the Court of Justice and the General Court, created in 1988. A Civil Service Tribunal operated between 2004 and 2016 when its jurisdiction was transferred to the General Court.

The CJEU is responsible for reviewing the legality of the acts of European institutions, ensuring that Member States comply with their obligations; and interpreting EU law at the request of national courts and tribunals.

Since 1952, over 37,000 judgements and orders have been delivered, helping to ensure the consistent application and interpretation of EU law across every Member State.

This is all the more remarkable because, as each Member State has its own language and specific legal system, the CJEU is a multilingual institution. Indeed, its language arrangements are unique to any other court in the world, as cases can be heard in any of the official languages of the European Union. The court observes the principle of multilingualism in full to both communicate with parties in the language of the proceedings and to ensure that case law is disseminated throughout the Member States. Indeed, some 43% of the institution's staff are dedicated to linguistic services.

The Court of Justice comprises 28 judges and 11 advocates general, with the General Court comprising 46 judges and one registrar. Judges are appointed by the agreement of Member States for a term of six years, which can be renewed.

The judges elect from within their number a President and Vice-President to serve for a term of three years, which can also be renewed. The President directs the work of the court and presides at hearings of the full court and the Grand Chamber, which brings together 15 judges at the request of a Member State or institution that is party to proceedings, and in particularly complex or important cases.

Koen Lenaerts has been President of the CJEU since October 2015. In his introduction to the CJEU's latest annual review, covering 2017, he noted that the Court of Justice and General Court had seen a record 1,656 cases brought before them.

These cases involved judgments on everything from wearing the Islamic headscarf at work and the rights of air passengers in the event of cancellation or long delays to flights to the UberPop ride-hailing service, immigration policy and the proof of defectiveness of a vaccine. All of which demonstrates that the case law of the CJEU is no longer limited solely to economic issues but covers ever-more diverse areas that relate to the daily lives of citizens.

In April 2017, as the EU marked the 60th anniversary of the signing of the Treaties of Rome, the CJEU

launched the Judicial Network of the European Union to reinforce cooperation with national courts and continue to improve the quality of European justice.

This multilingual platform seeks to promote mutual knowledge of the case law of the EU and that of Member States and to deepen dialogue between the Court of Justice and national courts.

In a speech to the Network of the Presidents of the Supreme Judicial Courts, Lenaerts said this type of informal cooperation, rather than the formal dialogue created by the preliminary ruling procedure guaranteeing uniform application of EU law, "allows for exchanges of views and of best practices that have beneficial effects on the quality of justice as a whole".

"In that regard, it is interesting to note that the most frequently consulted pages of the website of the Judicial Network of the European Union, which was created on the occasion of the 60th anniversary of the signing of the Treaties Rome, are the pages on which national decisions uploaded by the participating courts can be found. This clearly shows that there is a genuine interest in understanding our respective approaches to solving legal problems", he added.

"I am therefore confident in asserting that informal exchanges of information through networks – such as the Network of the Presidents of the Supreme Judicial Courts or the Judicial Network of the European Union – improve the quality of our decisions and ultimately the respect for the rule of law." ■

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Linguistic cultural compromises in EU Law

Dr Karen McAuliffe, PI on the European Research Council funded project 'Law and Language at the European Court of Justice', discusses her theory of linguistic cultural compromise in EU law

This article is the second in a five-part series focusing on the ERC-funded project 'Law and Language at the European Court of Justice' (the LLECJ project) – you can read the first article here. The LLECJ project is divided into three distinct yet interrelated sub-projects (see Figure 1), the first of which seeks to investigate the limitations of a multilingual legal system, by shining a light on processes and institutional culture within the Court of Justice of the European Union (CJEU). The research questions investigated in this sub-project included:

1. To what extent do language(s) and culture(s) affect the workings of the CJEU and the 'output' of that court (i.e. its jurisprudence)?

2. Can the judgments of the CJEU be considered 'hybrid texts'? What might that mean for their application/implementation throughout European Union (EU) member states?

3. Has the reshaping of institutional norms at the CJEU since the 'mega-enlargement' of 2004 impacted on the 'output' of that court?

To investigate those research questions, an interdisciplinary mixed-methods approach was taken. First, systematic literature reviews were carried out, focusing on the relationship between law, language, culture and translation in international organisations and the notion of hybridity across disciplines. Those literature reviews informed the research design for in-depth interviews with various actors at the CJEU as well as (corpus) linguistic analysis of CJEU judgments.

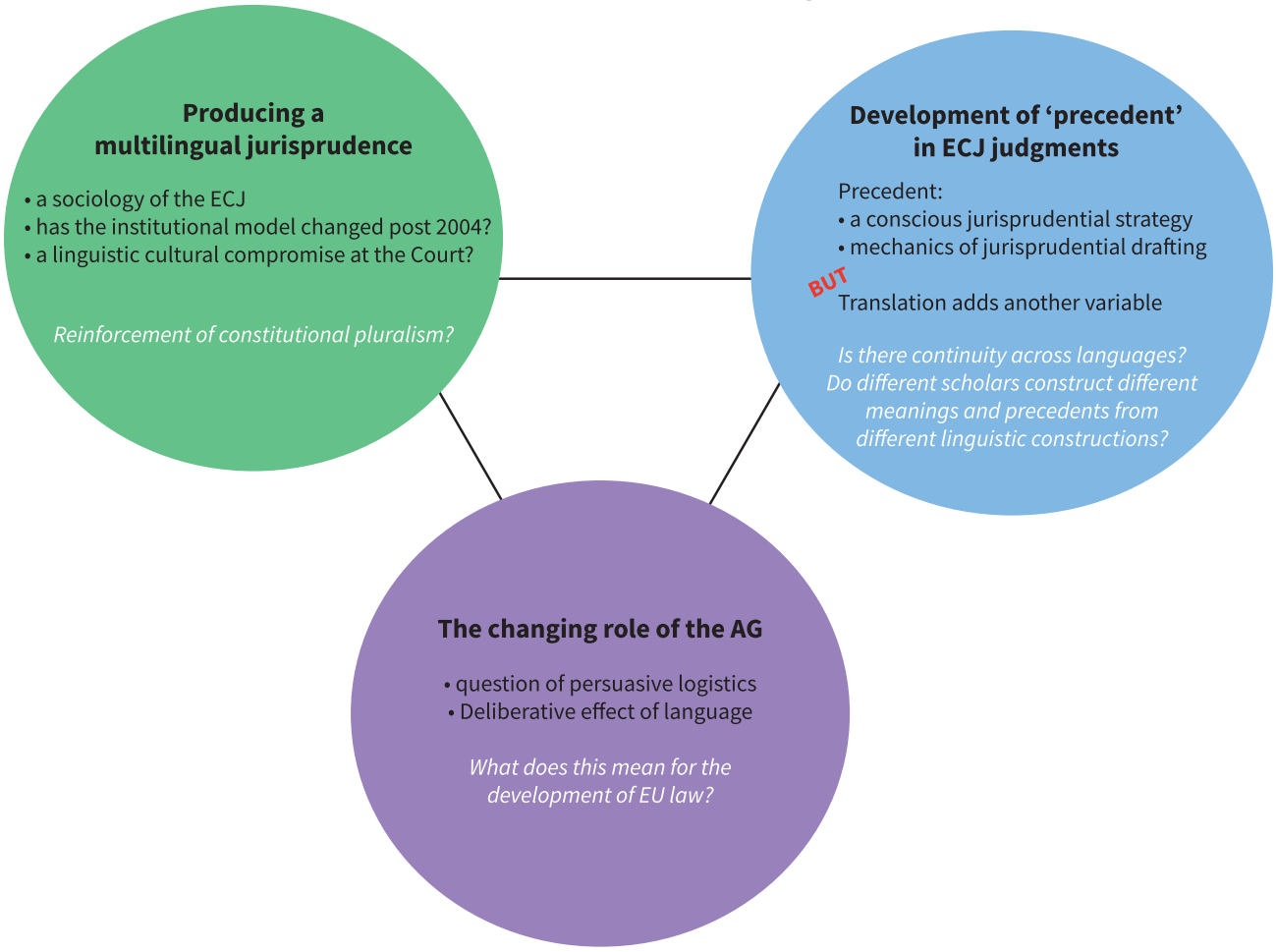
Analysis of the various data collected has demonstrated that the multilingual jurisprudence produced by the CJEU is necessarily shaped by the dynamics within that institution and by the 'cultural compromises' at play in the production process. The resultant texts, which make up that jurisprudence, are hybrid in nature, consisting of a blend of cultural and linguistic patterns, constrained by a rigid formalistic drafting style and put through many permutations of translation. They are, as a result, inherently approximate.

On the one hand, that approximation can lead to discrepancies between language versions of CJEU case law and thus jeopardise the uniform application of EU law. On the other hand, that approximation and hybridity define EU law as a distinct, supranational legal order. In the context of the LLECJ project, we build on scholarship on 'cultural compromises' in EU institutions first set out by Marc Abélès and Irène Bellier.[1] Going beyond their work, we put forward a theory of 'linguistic cultural compromises' in EU law. There are two main elements to such linguistic cultural compromises:

(a) The linguistic-cultural compromise by which the case law of the CJEU is created: the collegiate judgments of the CJEU are, by their very nature, compromise documents and, because the deliberations are secret, it is, in theory, impossible for anyone other than the judges involved to know where compromises lie in a text. This has implications both for the subsequent translation of such judgments and also for the drafting of future judgments. Furthermore, the case law of the CJEU is shaped by the language in which it is drafted – i.e. French. However, because French is rarely the mother tongue of those drafting that case law, there is a tendency to repeat expressions and to 'cut and paste' from previous case law or source documents. Together with the difficulties of manipulating a language that is not one's own, the result is often a stilted and awkward text. These, and other, factors have led to the development of a 'Court French' which necessarily shapes the case law produced and has implications for its development.

(b) The linguistic cultural compromise by which that law is filtered out to the wider EU through translation: The case law of the CJEU is 'filtered out' through linguistic cultural compromises involved in translation. Translation itself is a 'linguistic cultural compromise' and all translation, including legal translation, involves an element of approximation. Lawyer-linguists are responsible for translation at the

The LLECJ Project



CJEU. As well as dealing with the classic problems of translation such as ambiguity, translation of 'untranslatable' legal concepts, the effects of translated legal texts etc., lawyer-linguists' role perceptions also affect translation at the CJEU. The lawyer-linguists work at the interface of law and language, dealing with the relationship between those two concepts on a daily basis. The necessary compromise resulting from the struggle to reconcile the notions of 'law' and 'translation' is reflected in the process whereby CJEU case law is 'filtered' out to the wider EU.

The research carried out in the context of the LLECJ project makes explicit that which the majority of actors at the CJEU, and indeed at an EU level in general, already know – that EU law is a multicultural, multilingual construct which functions by way of approximation, and that its continued effectiveness is, in fact, dependent upon its hybrid nature.

This article series will continue in the next issue, which will focus on the development of 'linguistic precedent' in CJEU judgments. For more information on the LLECJ Project see www.llecj.karenmcauliffe.com

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The impact of apprenticeships on individuals, employers and the economy

Keith Smith, Director of Apprenticeships, Education & Skills Funding Agency in the UK explores the impact apprenticeships have on individuals, employers and the economy

There is a reason that the UK Government is backing apprenticeships and is committed to creating more quality career opportunities. Irrespective of age or background, apprenticeships give individuals superb opportunities to 'learn while they earn' – building transferable skills and confidence while being employed and gaining first-hand experience of the industry they're passionate about. For employers, apprentices are a valuable talent pipeline for businesses of all sizes, ensuring they have the right skills within the business to meet their needs and tackle productivity challenges, both now and in future

Two years ago, the government reinvigorated the apprenticeship system, following feedback from employers that apprenticeships were too short, with not enough off-the-job training and not focused on occupational competency. This meant that apprentices were not learning the skills needed by business.

The situation today is very different. New apprenticeship 'Standards', which are available from Level 2 (GCSE-equivalent) right up to Level 7 (Masters' degree equivalent), are designed by employers, to meet their business needs. The apprenticeship levy puts the

funding for apprenticeships firmly in employers' hands and encourages them to invest in high-quality training for their apprentices.

> "Research shows that employers who have hired apprentices report benefits including improved productivity, improved product or service or quality, as well as the new ideas apprentices bring to their organisation. It is encouraging to see that 83% would recommend the value of apprentices to other businesses."

The levy also means that the funding to support high-quality apprenticeship training across all businesses is increasing. By 2019-20 investment in apprenticeships in England will have risen to over £2.5 billion, double what was spent in 2010-11 in cash terms.

Research shows that employers who have hired apprentices report benefits including improved productivity, improved product or service or quality, as well as the new ideas apprentices bring to their organisation. It is encouraging to see that 83% would recommend the value of apprentices to other businesses.

We are proud of the progress we have made, but there is still more to do and challenges to overcome, particularly when it comes to changing perceptions around what apprenticeships can offer and whom they are suited for.

Our brilliant new campaign, 'Fire it Up', aims to breathe fresh energy into the conversation around apprenticeships – helping to raise awareness of the benefits, as well as highlight the huge variety of apprenticeship options available. In particular, we hope it will really start to challenge the outdated and snobbish attitudes that are stopping more people from considering apprenticeships and may be holding employers back from looking into how apprenticeships might work for their business.

Keith Smith

An important part of this is celebrating employers who have the first-hand experience of the benefit of employing apprentices, as well as showcasing the apprentices themselves and the significant contributions they have made to their workplace. That's why the annual National Apprenticeship Awards, now in its sixteenth year, are so important; they are uplifting examples of the impact, magnitude and benefits of apprenticeships. Boosted by the wider Fire It Up campaign, the 2019 Awards will seek to inspire top apprentices, employers and individuals across the country to step forward and show how apprenticeships have made a real difference to their organisation and careers.

They are a wonderful example to demonstrate how apprenticeships work so powerfully – for people, businesses and our country. ■

Keith Smith
Director
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Laying the foundations for a successful degree apprenticeship programme

Alasdair Poole, Apprenticeships Manager at Ashridge Executive Education details the importance of laying the foundations for a successful degree apprenticeship programme

The arrival of degree apprenticeships has revolutionised learning for public sector leaders – offering access to Masters-level qualifications that have been out of reach for many during times of austerity.

A growing number of organisations in government and across the health sector are now looking at how they can use their Apprenticeship Levy to fund these high-quality management development programmes, which are designed to build the skills and behaviours executives need to lead their people effectively in challenging times.

So, what are the key advantages of going down a degree apprenticeship route – and what do organisations need to do to set their programmes up for success?

A pragmatic approach

Ashridge Executive Education is a key player in the degree apprenticeship market and is leading the way with the development of three, highly pragmatic programmes which aim to raise standards of management practice and equip leaders with the agility and resilience needed to succeed in the new world of work.

The Level 6 Degree Apprenticeship is designed to boost the skills and performance of junior and emerging managers, by providing them with the tools and knowledge to make an immediate difference in the workplace. The three-and-a-half-year programme results in the award of a BA in Business and Management.

There are two Level 7 programmes. The Executive Masters in Leadership and Management is aimed at fast track, middle and established managers who want to stretch themselves using a flexible, self-directed learning approach. The two-year programme covers a range of subjects, from innovation to digital transformation, and places a strong emphasis throughout on personal impact and relational skills.

The more advanced Executive MBA is targeted at experienced managers and functional specialists who want to accelerate their progress into strategic management and leadership roles. This Level 7 qualification is part-funded by the levy, with the employer paying a top-up fee.

The appeal for organisations is the practical, grounded-in-reality approach taken during the programmes. Participants draw on live workplace scenarios as part of their learning, giving them the opportunity to develop fresh perspectives on some of the tough challenges they are facing.

There is also a major, supervised project at the end of programmes, which focuses on an area of organisational challenge, chosen together with the employer. This not only helps individuals deepen their understanding of the organisation they are working for, but also provides the employer with a valuable piece of internal consultancy it can build on.

> "On one recent programme, for example, Ashridge actually worked directly with learners to co-create content for a particular module, resulting in a fresh, stimulating learning experience that was directly relevant to the organisation."

Making sure the right foundations are in place is, however, fundamental to the success of any degree apprenticeship programme. Ashridge's experience in working with organisations going through the first tranche of apprenticeship programmes suggests the following issues are key:

Senior level endorsement

The employer is an important stakeholder in the degree apprenticeship process, championing participants through their studies and supporting them in applying their new-found knowledge and skills back in the workplace. This means that securing commitment to the programme at the highest level is critical. HR and L&D professionals will need to convince senior management of the potential for degree apprenticeships to help the organisation get future-fit – developing

the skills it will need to thrive in a constantly changing, digitally-driven environment and helping to attract and retain the best talent.

Clear communication

Misconceptions about apprenticeships still abound and organisations may find they have a certain amount of groundwork to do in explaining how they work at a higher level. A planned internal communications campaign can help to generate enthusiasm and address any concerns that may exist among potential participants. Ideas might include briefings for managers, placing articles on internal communication platforms or drawing up a list of FAQs. Ashridge has supported client organisations by running webinars for potential learners, explaining the degree apprenticeship process and giving participants the opportunity to ask questions.

Finding the right participants

It's important not to assume that degree apprenticeships will work for everyone. For some individuals, an open programme or being part of a customer group of senior executives can be a better solution. A clear 'recruitment' process will help to ensure the right people are being directed to the right kind of learning. Some organisations have tackled this by inviting expressions of interest from employees, backed up by a short personal statement about why they feel this particular study route will work for them. Offering one-to-one consultations for learners who are undecided or want more information can also be helpful. Ashridge supports organisations with this process, helping them to sift applications if required and advising on alternative options where appropriate.

Integrating degree apprenticeships

Degree apprenticeships work best when they are seen as part of the bigger L&D picture, rather than a stand-alone development intervention. Organisations need to think strategically about what skills they will need in the future and how a higher level apprenticeship can help to build them. They need to consider what kind of leadership roles will emerge in the new world of work and how degree apprenticeships could prepare employees to fill them. Organisations who take this wider, longer-term view are more likely to reap the benefits of the programme and get a return on their investment.

Working in partnership

Finding a provider who fits with the company culture and approach and is willing to develop a close working relationship is critical to the success of a degree apprenticeship programme. A good provider will take a collaborative, consultative approach, working closely with the organisation to design learning that is job specific and immediately transferrable back in the workplace.

On one recent programme, for example, Ashridge actually worked directly with learners to co-create content for a particular module, resulting in a fresh, stimulating learning experience that was directly relevant to the organisation. Finding a provider who is able to be flexible on delivery method is also key, to ensure that managers are able to successfully integrate their studies with demanding day jobs.

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Children with speech and language communication needs

Bob Reitemeier, Chief Executive of I CAN argues that empowering parents changes the conversation for children with speech and language communication needs

If your child was struggling to speak, what would be the first thing you'd do? Would you talk to your child's teacher or your local GP? Would you think of contacting a speech and language therapist, and if so, would you know where to look?

Because every child is unique and children's language development can vary according to the child's own development journey, it is important that parents and professionals are equipped to spot the signs of language and communication difficulties, so they can be addressed as soon as possible.

> "If we can reach children who struggle with speech and language at an early age and help them fully articulate their ideas and develop their skill sets, we can vastly improve the level of social mobility in disadvantaged areas, leading to much-improved life chances."

Some of these warning signs include exhibiting poor behaviour, struggling to make friends or their academic progress is hindered.[1] Unfortunately, there is a general lack of awareness across the UK from parents and teachers alike on how to spot these signs.

In our 'Bercow: 10 Years On' Report, an independent review of provision for children and young people with speech, language and communication needs in England, we outline how there is no assessment for spoken language in children above the age of five within the national curriculum. This makes the process of identifying speech and language communication needs (SLCN) for these children that much harder.

Across the country, communication needs can often remain hidden, untreated or not taken seriously. At I CAN, we know what the long-term consequences of ignoring this can be; just 15% of primary school pupils with an identified SLCN achieve the expected standards in reading, writing and mathematics when they reach the end of Year Six. Eighty-one percent of children with emotional and behavioural disorders have unidentified language difficulties and children with poor vocabulary skills are twice as likely to be unemployed when they reach adulthood.[2]

This problem is difficult enough for most parents. In areas of social disadvantage, up to 50% of children could have a communication need that is not being addressed.[3]

This remains a critical issue as children grow into adulthood, where communication skills are crucial in a challenging and evolving employment market. In a 2016 Survey Report by the Confederation of British Industry (CBI) and Pearson entitled 'The Right Combination', 38% of business leaders surveyed said there should be a focus on developing pupils' communication skills. In addition, 50% of the businesses surveyed were not satisfied with school leavers' communication skills when they entered the world of work.[4]

If we can reach children who struggle with speech and language at an early age and help them fully articulate their ideas and develop their skill sets, we can vastly improve the level of social mobility in disadvantaged areas, leading to much-improved life chances.

In December 2018, we announced a new project that we hope will help to combat this disparity directly and change the conversation about language for children and parents in these areas. Working in partnership with the Royal College of Speech and Language Therapists and the digital social enterprise EasyPeasy, I CAN aim to empower parents and families with very young children,

Bob Reitemeier

giving them information and skills about how to develop their children's speech and language skills.

There is growing evidence that the most effective route to parents is through local community practitioners with whom they have trusted relationships. This project will work in three metro mayoral areas, utilising a range of tools to support and develop children's speech and language, including I CAN's 'Tots Talking' programme and EasyPeasy's app for parents, both designed to support families with young children. The three areas are Bristol and South Gloucestershire, Peterborough and Cambridgeshire, and Liverpool City.

The goal of this project is to reach over 10,000 families with a range of interventions that will educate them on how they can best support their child's speech and language development.

Getting your child's SLCN identified and diagnosed early can open a whole range of options that can give them the support they need; ascertaining if they require a mainstream or specialist school, booking appointments with a speech and language therapist and giving parents great resources, they can use at home to improve their child's language development.

Empowering parents within their communities, giving them the knowledge and confidence to support their child's SLCN can radically change their perspective on the issue. This, in turn, can inspire them to be listening posts for other parents if they also have concerns over their child's speech, language and communication, creating a much more collaborative parental environment in the process.

If you are concerned about your child or child in your care's speech and language, you can contact our Enquiry Line on +44 (0)20 7843 2544 where you can speak to one of our dedicated speech and language therapists. Alternatively, you can email enquiries@ican.org.uk .

For more information, resources and tips on how you can boost your child's speech and language, check out our TalkingPoint website. ■

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1 Source: 9 Bidgood, A. (2016) What comes before words? The beginnings of early language LuCiD.

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Karlsruhe Institute of Technology

The Calorimeter Center – Advanced Materials and Batteries

Ensure your Lithium-ion cells perform well and are safe

With six Accelerating Rate Calorimeters of different sizes – from coin cell to large pouch or prismatic automotive format – and extremely sensible Tian-Calvet calorimeters the Calorimeter Center at the IAM-AWP of KIT offers the evaluation of thermodynamic, thermal and safety data for Lithium-ion and post-Lithium cells on material, cell and pack level. These data can be used on all levels of the value chain – from the safe materials design up to the optimization of the thermal management and the safety systems. Our fields of research and range of tests encompass both normal conditions and abuse conditions:

Normal condition tests include:

- Isoperibolic cycling, which provide constant environmental temperatures;
- Quasiadiabatic cycling, which ensure that there is almost no heat exchange between the cell and the surroundings

Each of these allows:

- Measurement of temperature curve and distribution for full cycles, or application-specific load profiles;
- Determination of generated heat;
- Separation of heat in reversible and irreversible parts; and
- Ageing studies.

Abuse condition tests include:

- Thermal abuse – heat-wait-seek, ramp heating and thermal propagation test;
- Electrical abuse – external short circuit, overcharge and overdischarge test; as well as
- Mechanical abuse – nail penetration test.

Each of these allows:

- Temperature measurement;
- External or internal pressure measurement;
- Gas collection;
- Post-mortem analysis; and
- Ageing studies – change of risk potential with increasing ageing degree.

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