



OPEN ACCESS GOVERNMENT

ISSN 2516-3817 • October 2018

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A “BLUE ENLIGHTENMENT” ERA IS DAWNING

THE ESTABLISHMENT OF THE EUROPEAN
MARINE BIOLOGICAL RESOURCE CENTRE
(EMBRC-ERIC) TO FURTHER THE GLOBAL
RELEVANCE OF MARINE BIORESOURCES



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CENTRE

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REINVENTING THE COMMUNITY

building on creativity

Creativity, innovation and a strong focus on social and cultural aspects of sustainability are at the very heart of developing the Municipality of Varberg to become the Swedish West Coast's Creative Hot Spot by 2025.

In our vision for the future, the municipality has unique opportunities. The city of Varberg is one of the most attractive cities in Sweden, ideally located with the city centre right next to the coastline. Our location is exceptional – right in between two of Sweden's fastest growing regions, The Greater Gothenburg region, and the Greater Copenhagen region.

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FOREWORD

Gunnar Hökmark MEP

Group of the European People's Party (Christian Democrats)

The economy of the European Union (EU) is currently doing quite well. We are most likely at the end of an expansionary phase of the business cycle, average incomes have risen above pre-crisis levels and the average unemployment rate of EU member states is down to 7% from almost 11% in 2013.

The doomsayers, who argued that budget discipline and structural reforms would not work and that the market economy was not delivering for ordinary Europeans, have been proven wrong. Again. What's more, new first-class research by Harvard economist Alberto Alesina and co-authors shows that the best austerity measure is cutting spending rather than raising taxes. And in reality, we can see that in the countries that started first, the development is the best.

However, we must not rest on our laurels, because there are challenges ahead and many necessary reforms are yet to be carried out. For example, the average EU debt-to-GDP ratio is 81.5% (Q1, 2018). Eight member states do not meet one of the most central requirements for economic success that we have set up ourselves. Further budget consolidation is necessary.

Also, even though structural reforms for enhanced competitiveness have been carried out, Europe is still lagging behind in a number of ways. Looking at the rankings of the World Economic Forum, Europe includes some of the world's most advanced economies, as well as some serious laggards. The Netherlands, Germany, Sweden, the UK and Finland are among top ten countries, whereas Greece is ranked 87th, Romania 68th, Latvia 54th, Italy 43rd and

Portugal 42nd, just to name a few countries from various parts of the continent.

The results of the Global Innovation Index are similar. Seven of the top ten countries are EU member states in the northwest of the continent, whereas countries like Romania, Greece, Bulgaria, Portugal and Italy are found much further down on the list.

We need cohesion in structural reforms in order to achieve a convergence of growth, where the new norm should be based upon the best performers. What is possible in one country is possible in other countries. Such a cohesion, focused on structural reforms, would in itself increase the average growth in EU dramatically.

And then there is the risk of a trade war, that together with Brexit present a clear and present danger to the economies of all countries involved. Not only do these two trends challenge the cohesion and global leadership of the Western world, something that may have dramatic long-term consequences also from an economic perspective. They also create economic problems in the short and medium term. Simulations that were done by the Bank of England estimate that a full-blown trade war could cost the world economy more than 2000 billion dollars. That is four times the size of the Swedish economy.

It is of paramount importance that European politicians do not give in to the worldview of the U.S. President. We know from economic theory dating back 250 years or so, as well as from extensive empirical evidence and hands-on historical experience, that autarky and economic nationalism are bad ideas. We have seen how economic integration at both regional and global levels have vitalised economies, raised incomes and defeated poverty worldwide. This is a battle we must not shy away from. When Donald Trump makes the U.S. smaller, we should make the EU taller. The EU must aim to be a centre for global trade, to be open and dynamic, in order to ensure prosperity and all the political benefits that ensue.

Another important economic challenge is to be taken on at home. We need to continue to combine stable public finances with increased growth. We have official

targets and policy instruments in place; we just need to take them seriously. EU countries must adhere to the budget constraints defined by themselves both as key to economic success and as rules to be followed. There is no shortcut. Only hard work will lead to long-term success. The overall aim must be to secure a potential growth in all member states of 3%.

Budget discipline needs the help of structural reforms, in order to be successful. Taxes, labour markets and rules and regulations have to be relaxed. Entrepreneurship should be encouraged. In its budget, the EU should devote more money to R&D and university research and less to hand-outs.

When looking around, an important point is that there is something to learn from most countries. The rest of Europe should not adopt Scandinavian tax levels, for example, but may very well learn something from the general business climate. We should be impressed by the German example when it comes to labour markets, but we should avoid the bureaucracy involved when starting a business. France has a well-functioning legal system, but registering property is cumbersome. The Baltic States have demonstrated that making it easy to start a company pays off, that digitalisation and budget discipline are combinations that lay the ground for success.

In Europe of today, we can see a lot of successful achievements, as well as the consequences of political failures. If we learn from both, we may avoid future failures and we will be able to secure stable high-level growth for the coming decades, making Europe not only more prosperous but also much stronger in the global economy, being a guardian of free economies and free trade. We are not there yet, but we can get there if we want to. That would be good for the free world, now that its former leader has abdicated. ■



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Electra Way
Crewe Business Park
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Registered in England & Wales.
Company Reg No. 8667479.
VAT Registration No. 169 9152 64.



INTRODUCTION

A very warm welcome to the October 2018 edition of Open Access Government. My personal highlights of working on this edition are the many interesting policy-focussed interviews I have been honoured to conduct with politicians and other eminent senior figures across the globe.

One example is an interview with a public health specialist, Dr Wilfred Alexander Chalamira Nkhoma from the World Health Organization (WHO) Office for the Africa Region, who spoke to me about the priorities for tackling infectious diseases in Africa, with a particular focus on Tuberculosis (TB). Another is an interview with Jan Wörner, Director General of The European Space Agency (ESA) who discusses his exciting priorities for enhancing the competitiveness of the European space sector.

Heading up the environment section, Kimmo Tiilikainen, Minister of the Environment, Energy and Housing speaks to Open Access Government about his government's priorities for energy efficiency and climate change in Finland and beyond. Also, Brian Berridge, Associate Director of the National Toxicology Program (NTP) in the U.S. reveals how NTP studies the health impacts of chemicals and other factors in a compelling interview.

At the time of writing, you will be aware of the news around the devastating impact of Hurricane Florence in America. Before this took place, we were fortu-

nate to speak with Dr Michael Brennan, Branch Chief at the Hurricane Specialist Unit within the National Hurricane Center (NHC). In this interview, we find out about NHC's vital work in issuing the best watches, warnings, forecasts and analyses of hazardous tropical weather including, of course, hurricanes.

Finally, I must say that it was a hugely enjoyable experience for me to speak with Maroš Šefčovič, Vice-President, Energy Union at European Commission who shared his thoughts on establishing a European Energy Union and the importance of all Europeans having access to secure, affordable and climate-friendly energy.

On this note of optimism, I hope that you enjoy reading this bumper edition of Open Access Government. Do feel free to get in touch with me if you would like to contribute an opinion piece for future editions of the publication in 2019. ■

Jonathan Miles
Editor



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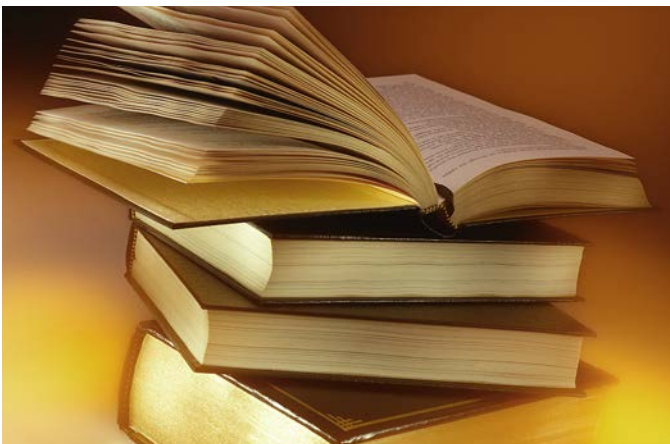
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Discovery and health at the intersection of data science and open science

Michael F. Huerta from the National Library of Medicine at the U.S.'s National Institutes of Health explores how discovery and health benefit from the intersection of data science and open science

The promise of biomedical science to save and improve lives has never been realised so quickly and spectacularly as it is today. And yet, the nearly universal digitisation of research and healthcare is starting to unlock the power of data and more open paradigms, making possible faster progress and changes in the very nature of discovery. The National Library of Medicine (NLM) lives at the intersection of these forces and is poised to catalyse this transformation.

NLM is an institute of the National Institutes of Health (NIH) with a research and training focus on biomedical information science, informatics and data science. NLM is at the forefront of innovation in computational biology, computing in context, extracting insight from electronic health records and using artificial intelligence (AI) and data science approaches to answer key biomedical questions. This scientific leadership is reflected in NLM's support of extramural research across the country, as well as a robust intramural research programme and internal information engineering efforts aimed at innovating and improving its products and processes.

NLM is also the world's largest biomedical library, creating and hosting major resources, tools and services for biomedical literature, data, standards and more. Every day, NLM sends over 1,000 terabytes of data to nearly five million users and receives over 100 terabytes from more than 3000 users. As a library, NLM has fostered and advanced open science and scholarship by making digital research objects – whether a digital literature citation, dataset, or data standard definition – findable, accessible, interoperable and reusable (i.e., FAIR), as well as attributable and sustainable. Resources like GenBank, PubMed, Medline Plus, PubChem, PubMed Central and ClinicalTrials.gov make data and information findable and accessible and their

implementation makes data and information reusable, attributable and sustainable.

NLM facilitates interoperability of digital data by promoting, developing and hosting a range of standards products, such as terminologies like UMLS and LOINC, as well as standards platforms such as the NIH Clinical Data Elements (CDE) Repository and the Value Set Authority Center. NLM also shares its standards expertise, acting as the coordinating body of the Department of Health and Human Services for clinical terminology and of NIH through its leadership of the NIH Clinical CDE Task Force.

The recently released [NLM Strategic Plan](#) envisions NLM building on its experience to become a platform for biomedical discovery and data-powered health by achieving three goals.

The first is to provide tools for data-driven research, which includes enhancing innovation by expanding NLM's biomedical informatics and data science research activities. NLM will also work to connect resources, tools and services as the basis of a sustainable, open and trusted digital ecosystem for biomedical and health information, scholarship and science. Emphasis will be placed on ensuring digital research objects such as scientific papers, datasets, models, analytic pipelines and others, are FAIR and appropriately associated with each other – minding appropriate considerations for privacy and confidentiality.

In pursuit of the second goal, to reach more people in more ways, NLM will optimise users' experience with – and use of – its resources, tools and services, to better serve its many different users. The final goal is to expand NLM's training support and activities to: (1) produce experts who will develop next-generation



innovations in biomedical informatics and data science; (2) make sure that biomedical scientists are adept in the use of these advanced approaches; (3) instill an understanding of the opportunities, limits and requirements of data science across the entire biomedical workforce and; (4) assure the public is data-ready to make the best use of health information in the 21st Century.

Maximising the scientific opportunities that sit at the intersection of data science and open science will require addressing some basic issues, but solutions do not seem far off. Non-traditional practices needed for open science, such as sharing data, must be encouraged; this might be addressed by strategically aligning incentives across the biomedical enterprise. And, as digital research objects and their links to each other multiply, at-scale curation solutions will be needed; this might be addressed by using AI to infer the nature of an object based on its location in the network of interconnected objects, with provenance tracked using blockchain.

Finally, the sustainability of an open digital ecosystem is crucial; this will be helped by making sure that

decisions about investing in the ecosystem are based on empirical evidence about the value of those investments to the science.

Achieving the goals of the NLM Strategic Plan, especially in the context of the NIH Strategic Plan for [Data Science](#), will usher in a new era of data-driven research and data-powered health – one that is certain to offer more hope to more people more rapidly. ■

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Biology research: The state of health of the gut microbiome

Hannah M. Wexler, Professor at the Greater Los Angeles VA Health Care System and UCLA School of Medicine gives a fascinating glimpse into biology research that focuses on the state of health of the gut microbiome

More than two millennia have passed since Hippocrates declared: “Bad digestion is the root of all evil.” In 2018, the importance of the gut flora in human health is at the forefront of scientific and public awareness and the gut microbiome is the new microbial frontier. The state of health of the gut microbiome is associated with GI diseases such as Crohn’s disease and irritable bowel disorders. More surprisingly, the state of the gut microbiome is implicated in obesity, diabetes, heart disease, autism and even psychological disorders such as obsessive-compulsive disorder and depression.

Recently, specific bacteria in the gut microbiota were associated with certain food preferences! Now, virtually every health condition seems to be linked in some way to the gut microbiome. The number of journal articles published per year has skyrocketed. A growing public awareness of the importance of a healthy gut microbiome is the foundation for several very profitable industries that we could not have imagined a decade ago!

Bacteroides fragilis (BF), the organism that we have studied for >30 years, is the most important anaerobic gut pathobiont and the most concentrated reservoir of resistance genes in the human gut microbiome¹. In its normal niche, BF is a commensal and has even been implicated in maintaining

immune health by stimulating different arms of the T-cell response. Outside its colonic niche, it is an aggressive pathogen. BF is the most common anaerobic isolate in surgical site infections (SSIs) following colorectal surgery², in wound isolates from combat casualties³, in intraabdominal abscesses and in extra-intestinal infections of intestinal origin. It is the main cause of anaerobic bacteremia and implicated in other serious infections (e.g., brain abscess, soft tissue infections and peritonitis⁴).

Our group studies *Bacteroides fragilis* strains that are responsible for serious, multidrug-resistant clinical infections around the world. We are primarily interested in the transition from benign commensal to an aggressive pathogen. Our questions include: Are certain BF more likely to transition from commensal to pathogen and do specific genes facilitate this transition? Are there genes carried by all BF that are regulated differently when BF is in “virulent” mode? What triggers changes that allow BF to persist in the more aerobic environment of abscesses and the even more, aerobic environment of the blood?

Bacteremia is more common for BF than for any other anaerobe⁵ (it is the most common anaerobic pathogen identified⁶) and these infections are responsible for a significant burden of disease in general populations. The BF

enterotoxin is a known virulence factor⁷ but strains enterotoxin-bearing BF do not necessarily cause disease nor do all virulent BF produce enterotoxin.

At this stage, we believe that certain subgroups of BF are more innately virulent than others. We found that BF blood isolates cluster in a highly specific phylogenetic subgroup within the BF species. These strains have never been studied as a distinct group in terms of how they differ from other BF strains. We found that they have unique virulence genes, differentially transcribed genes common to other BF and CRISPR-Cas systems that differ from other BF isolates. CRISPR-Cas systems are considered innate immunity systems in prokaryotes and are important in controlling horizontal gene transfer (HGT), host interactions and can even be involved in cell regulation. Thus, the distinct nature of the BF blood isolates CRISPR-Cas is another indication that BF blood isolates are a group apart.

We also study whether these factors are transferable between strains. Often, a group of genes that contribute to pathogenicity, such as resistance genes and virulence factors, are shared together on large mobile genetic elements. We have identified numerous types of these mobile pathogenicity packages that *Bacteroides fragilis* has acquired, which contribute to its opportunistic pathogenicity^{8,9}.

We believe that tolerance and persistence, currently recognised as an alternative mode of evading antimicrobial action¹⁰, are important factors in the tenacity of BF. Persisters constitute a serious clinical problem and are thought to be responsible for the recalcitrance of chronic infections¹¹. Data from decades of studying and MIC testing of BF isolates suggests to us that tolerance and/or persistence are important mechanisms that BF uses to survive an antibiotic challenge. Susceptibility studies are not designed to measure tolerance, so this data is almost never published.

In fact, the protocols for susceptibility testing published by the Clinical Laboratory Standards Institute (that, ironically, we helped co-author) specifically instruct the microbiologist reading the test to ignore hazes for MIC determination¹². On the other hand, we have noted and written about this problem for decades¹³. We noted that MICs of BF are often indistinct; sometimes hazes and sometimes small colonies appear beyond the MIC “end-point”. To estimate just how frequent this phenomenon occurs, we reviewed lab notes from susceptibility studies published over the course of two decades and found that between five and 15% of *B. fragilis* isolates yielded hazes that persisted well beyond the “MIC endpoint” and we think it likely that most of those hazes represent tolerance or persistence behaviour.

We found that the endpoints of growth isolated from these areas often have indistinct endpoints as well¹⁴. This type of growth is presumed to be an indication of tolerant or persistent cells according to recent studies by Balaban¹⁵. Almost thirty years ago, we investigated these hazes with two other gram-negative anaerobic bacteria, *Fusobacterium* and *Bilophila wadsworthia* and found that they were

cell wall deficient forms that would revert to the normal form after two or three passages on drug-free medium. We believe that these phenomena may be responsible for the chronic nature of BF infections, as well as the clinical non-response in some patients to “appropriate” antibiotic therapy.

We know that antimicrobial therapy brings with it a host of unwelcome side effects, including disruption of the healthy gut microbiome and subsequent opportunistic infections such as *Clostridium difficile* overgrowth. We believe that the proper approach to treating BF infections would be a narrower one that would target specific virulence factors or antimicrobial evasive mechanisms. Our work is designed to identify precise gene targets that will then inform the emerging targeted therapies so that serious BF infections can be treated while preserving the beneficial gut microbiome.

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Non-radioactive, non-ionising radiation for safe paediatric imaging

E.M. Sevick and J.C. Rasmussen from The University of Texas Health Science Center, The Brown Foundation Institute of Molecular Medicine discuss non-radioactive, non-ionising radiation for safe, paediatric imaging

Medical imaging has transformed the entire spectrum of healthcare, from enabling discoveries in medical science and directing the development of therapeutic interventions, to providing the most optimal and efficient management of diseases in individuals. Yet conventional medical imaging modalities have particular limitations, especially when it comes to the paediatric populations in whom diagnosis and treatment arguably may have the greatest long-term benefit.

Whether it be the ionising radiation of computed tomography (CT) or x-ray imaging; the radioactivity of radionuclide-based imaging agents in nuclear imaging; the long scanning times of magnetic resonance imaging (MRI); or the need to administer substantial amounts of iodinated or gadolinium-based contrast agents whose long-term effects are questionable in adults, much less in infants and children; conventional medical imaging does not advance discoveries in paediatric medicine in the same manner it does in adult medicine.

Under development in our laboratories, near-infrared fluorescence (NIRF) imaging may uniquely meet the requirements for paediatric medical imaging. The technique depends upon administering a trace dose of non-radioactive dye that fluoresces in the near-infrared wavelength range

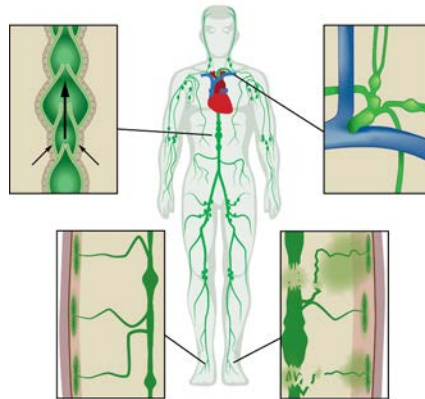


Figure 1: A schematic of the open and unidirectional lymphatic system which begins at the initial lymphatics (lower left panel) that line all organs and carries lymph through lymph nodes and the thoracic duct before emptying into the supraclavicular vein (upper right panel). The system includes series of lymphangions or "lymph hearts" which propel lymph unidirectionally through the lymphatics (upper left panel). The abnormal lymphatic function may be a result of lack of pumping and/or the degradation or malformation of lymphatic vessels (lower right panel). Figure reproduced from O'Donnell, et al., J Vasc Surg Venous Lymphat Disord, 2017.

and illuminating tissue surfaces with dim near-infrared (NIR) light that penetrates several centimetres to excite the dye, causing it to fluoresce. The resulting fluorescence is emitted from the tissues and is captured by an imaging system, consisting of military-grade night vision technology coupled to a digital image capture device.

Because of the superior sensitivity offered by the coupling of these two technologies, trace doses of fluorescent dye can be rapidly imaged with sub-second exposures at tissue depths as great as 3-4 centimetres. This unprecedented performance enables NIRF imaging to be used as a point-of-care diagnostic and removes the need for sedation otherwise needed for paediatric patients. Future developments include extending this depth and generating 3-D imaging, similar to CT or MR angiography.

Owing to its 60 year-record of safe use in humans at much larger doses, we currently employ indocyanine green

(ICG) as the NIRF contrast agent, but other far brighter and more useful dyes remain to be translated into humans. ICG strongly associates with plasma proteins, making it an excellent hemovascular contrast agent and in our work, an excellent lymphovascular contrast agent that, when coupled with the NIRF imaging devices, has allowed some of the first glimpses of lymphatic vascular function in disorders of adults and children.

The lymphatic vascular system has largely escaped routine medical imaging and as a result, comparatively little is known about its role in health and disease. The open and unidirectional lymphatic system begins with the initial lymphatics that lie beneath the epidermis and line all organs. Waste products, immune cells and excess fluid (capillary filtrate) that enter the initial lymphatics are actively pumped through series of "lymph hearts" or contractile lymphangions that transit lymph through lymph nodes to the subclavian vein where the fluid

returns to the blood vasculature (Figure 1).

There are few procedures to image the lymphatics: (i) lymphoscintigraphy, in which a radioactive colloid is injected to image lymphatic transport over several minutes to hours using nuclear imaging and (ii) lymphangiography, in which several millilitres of an iodinated or gadolinium-based contrast agent is injected into lymph nodes or into surgically isolated lymphatic vessels for MR or x-ray imaging, provide invasive and cumbersome diagnostic techniques. As a result, there is little understanding of how the lymphatic vasculature mediates immune response and returns fluid and lipids absorbed from the gut back into the hemovascular system.

Today, despite the paucity in procedures to image the lymphatics, it is generally accepted that it plays a critical role in several chronic conditions in adults, including autoimmune diseases, such as rheumatoid arthritis, cancer metastasis, peripheral vascular disease and neurodegenerative diseases. In children, lymphatic dysfunction has been hypothesized to accompany neurological diseases, such as specific forms of Autism, vascular malformations and cardiovascular deformities.

In translational studies funded in part by the National Institutes of Health and conducted under investigational new drug applications from the FDA, we have used the NIRF technology to dynamically image the lymphatics of over 400 subjects, including 30 infants and children. The imaging begins with an intradermal injection of 0.05- 0.1 mL of saline containing microgram amounts of ICG into the region of interest. ICG administration on the top of the foot results in immediate uptake into the main conducting vessels (Figure 2A) that proximally “pumps”

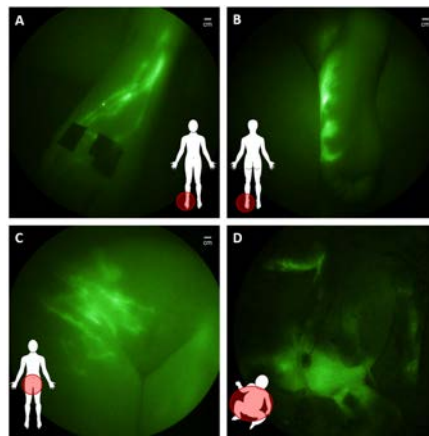


Figure 2: Conducting lymphatics on the top (A) of the right foot and (B) abnormal drainage on the bottom of the left foot of a 17-year girl with congenital lymphedema; Lymphatic congestion in the pelvis of (C) a 16-year girl with congenital lymphedema and (D) a 23-day old male infant with surgery-induced chylothorax.

ICG-laden lymph into the inguinal nodes before entering the central lymph channel that collects mesenteric and peripherally generated lymph for its return to the hemovascular system.

In children and adults with suspected lymphatic dysfunction, we have observed abnormal lymph drainage to the bottom of feet (Figure 2B), as well as pelvic, lymphatic congestion which in adolescents and young adults is associated with lower extremity lymphedema (Figure 2C) and, in some infants, with surgery-induced chylothorax (Figure 2D).

In other studies, concerning infants, we have uncovered impaired lymphatic pumping and imaged retrograde lymphatic drainage into the pleural cavity to ascertain the nature of impaired lymphatic return. These imaging observations, when coupled with genetic and immune profiling, could provide critical clues to develop effective treatments for the paediatric population suffering immune or cardiovascular disorders.

While we have used NIRF to interrogate lymphatic function in children

and adults, it also has the unfulfilled potential to interrogate hemovascular function as well as cerebral spinal fluid production and drainage to address some of our most challenging problems in paediatric patients. In addition, the development of molecularly targeted NIRF agents expands the repertoire of imaging diagnostics in the paediatric population to advance therapeutic discoveries.

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Steering Europe towards a healthy future

Karin Kadenbach MEP (S&D, AT), Vice-President of the European Health Forum Gastein details her priorities to steer Europe towards a healthy future

The urgent need for health system transformation in Europe is undisputed, and the only way to make this happen is by pursuing a bold approach.

Over the past decades, European societies have significantly changed, and on many different fronts. We are faced with an unforeseen spectrum of opportunities and challenges, brought about by globalisation, innovation, and a digital revolution. Not surprisingly, the lifestyles of Europeans have changed with these developments and, in consequence, so has the burden of disease. The rise of non-communicable diseases (NCDs) is an example of how different societies are compared to what they were a few decades ago, illustrating also the extent to which the budget-constrained health systems in Europe today are under pressure to keep up and transform.

NCDs have replaced infectious diseases as the number one killer, in Europe and worldwide. According to the European Commission, NCDs now account for 555,000 premature deaths in Europe each year. Money alone is not enough to realise an effective response to this threat. We need to think outside the box, and to not be afraid to overhaul current structures, to develop systems and processes focused on prevention, that offer timely access to care and treatment, and that are resilient enough to respond to people's continuously evolving needs.

We also need systems that are able to respond to the challenges of the future, challenges we cannot even imagine today. This is why this year's edition of the [European Health Forum Gastein](#) (EHFG), which will take place during the Austrian Presidency of the European

Union from 3rd to 5th October 2018, focuses on health and sustainable development, highlighting the urgency to make bold political choices for Agenda 2030. I very much welcome this call for audacity. The current political climate in European countries is tempestuous as well, to say the least, and should be met with a similar approach. With the European elections taking place in May 2019 and with the deadline to reach the Sustainable Development Goals (SDGs) getting closer, now is the right time to push for change.

“The rise of non-communicable diseases (NCDs) is an example of how different societies are compared to what they were a few decades ago, illustrating also the extent to which the budget-constrained health systems in Europe today are under pressure to keep up and transform.”

The Sustainable Development Goals (SDGs) reflect the understanding that the world is continuously changing. Furthermore, the SDGs recognise the need to be ambitious, to integrate health in all policies and in discussions at all political levels. For instance, the threat of antimicrobial resistance (AMR) cannot be addressed without involving policymakers from other fields, like agriculture. And without effectively tackling AMR, which accounts for approximately 25,000 deaths per year in the European Union alone (European Centre for Disease Prevention and Control), achieving the SDGs will be difficult, especially because of the significant social and economic burden AMR inflicts.

Healthy people, and especially a healthy force of medical professionals, have a key role to play in managing the threat of AMR. As is also pointed out in the motion for a European Parliament resolution on a European



Medical professionals often have to make important decisions in dynamic environments

One Health action plan against AMR, for which I am the rapporteur in the European Parliament's Committee on the Environment, Public Health and Food Safety, there is a strong urgency to establish training facilities that offer guidance to medical professionals on the use of antibiotics. Moreover, medical professionals often have to make important decisions in dynamic environments, which is why the report calls for the development of rapid diagnostic tests. If anything, being bold means being efficient and practical.

But the challenge around medical professionals is broader. Many European countries are confronted with different problems around human resources for health, from staff shortages to a lack of skills. Overall, skilled health professionals are essential to provide the adequate care needed to tackle AMR and NCDs, as well as to reach the Sustainable Development Goals. Realising access to quality care stands or falls with the availability of properly trained and equipped medical professionals, that moreover heed evidence-based practice.

This important issue, as well as many other health matters, will be discussed by the 500 European health policy experts that will come together in Bad Hofgastein this October. ■

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Simulation in health and social care at the University of Salford

Amanda Miller, Course Leader, outlines the PgCert Simulation in Health and Social Care course available at the University of Salford

This unique course is aimed at innovative, creative health and social care practitioners and education workers who have the ambition to advance practice. This course is applicable for (but not limited to) nurses, midwives, doctors, physiotherapists, radiographers, occupational therapists, social workers and technicians who want to develop their knowledge and skills in simulation-based education.

The PgCert Simulation in Health and Social Care will equip you with the contemporary knowledge and skills required to develop and advance simulation practice or education in your specific area of work.

Facilities

The University of Salford was the first higher education institution to be accredited by North West Simulation Education Network (NWSEN) for the simulation suite which consists of replica hospital wards and community care facilities.

Mark Hellaby from NHS Health Education England endorsed the simulation suite as a centre of excellence and stated that: "The use of the simulation facilities at the University of Salford will in no doubt catalyse a caring, efficient and safe workforce." To learn more about healthcare simulation suites, please visit: <https://vimeo.com/205076379>.

Course details

This course is designed to give you the confidence to develop and advance simulation in your area of practice or education and is tailored specifically to your needs.

"Simulation has made me feel better prepared for practice and has contributed massively to my confidence as a soon to be a qualified midwife."

This course runs part-time over nine months and encompasses two Level 7 modules:

- Theoretical perspectives of simulation-based education and;



- Practical application of simulation-based education.

By undertaking this postgraduate course, you will be able to:

- Demonstrate a systematic understanding of the knowledge and skills related to simulation-based education (SBE);
- Develop the knowledge and skills required to design, develop and facilitate SBE;
- Master a comprehensive understanding of how SBE can be applied to own individual practice discipline;
- Show originality in the application of how simulation is essential to advancing practice and;
- Share and explore the diverse perspectives of discipline-specific SBE that is encountered globally, that could inform professional practice in own local practice setting.

For more information on this, please visit: <http://www.salford.ac.uk/pgt-courses/simulation-in-health-and-social-care>

What do people say about the simulation facilities at the University of Salford?

“I was extremely impressed with the talking manikin and the ability to perform a clinical assessment with all the information available – pulses, heart sounds, breath sounds etc.”

Christopher Jones, MSc Advanced Clinical Practice.

“Simulation has made me feel better prepared for practice and has contributed massively to my confidence as a soon to be a qualified midwife.”

Savannah Dallas-Cross, third-year midwifery student.

Course leader, Amanda Miller
Amanda Miller is the Simulation Lead in the School of Health and Society.

Amanda is research active and her areas of interest include service user involvement in simulation, enhancing outcomes for children and young people through simulation and the emergency care of children.

“The use of the simulation facilities at the University of Salford will in no doubt catalyse a caring, efficient and safe workforce.”

Amanda is a registered children’s nurse and a member of the North West Simulation Education Network (NWSEN) and the Association of Simulated Practice in Healthcare (ASPIH). For further information, you can contact her at A.Miller@salford.ac.uk or you can follow her on Twitter at www.twitter.com/susimulation.



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<http://www.salford.ac.uk/pgt-courses/simulation-in-health-and-social-care>
www.twitter.com/susimulation

How can healthcare systems boost innovation and facilitate the adoption of digital interventions?

An example of a UK based regional model created to drive the adoption of digital innovation is one that Yinka Makinde, Programme Director at DigitalHealth.London outlines

NHS England is the executive non-departmental public body that oversees the budget, planning, delivery and day-to-day operation of the commissioning side of the National Health Service (NHS) in England for the Department of Health and Social Care.

Following previous failed attempts to modernise the NHS through mandated large-scale national IT programmes, the NHS in recent years has committed through the [Five Year Forward View Plan](#), a number of targeted work programmes designed to leverage the potential of technology and innovation, enabling patients to take a more active role in their own health and care while also enabling NHS staff and their care colleagues to do their jobs. This approach includes the nomination and rewarding of [Global Digital Exemplar](#) healthcare organisations operating at an advanced level of digital maturity. The [NHS Digital Academy](#) builds transformation capability amongst the CIO and CCIO professionals in the health system, whilst the [NHS Digital Tools library](#) lists 70 digital health 'apps' that have gone through an evaluation process by NHS England.

Funding pots are being created and ringfenced by NHS England to incentivise the implementation and adoption of digital tools across provider

organisations such as the [GP Online Consultation Fund](#) and the more recently announced [£487 million technology fund](#) for STPs (Sustainability Transformation Partnerships).

A regional example of where digital innovation is being assisted is in London. Funding from NHS England, the [UK Office for Life Sciences](#), the London based [Academic Health Science Networks](#), [MedCity](#) and the European Regional Development Fund has been aggregated to create and run a digital health hub – [DigitalHealth.London](#) – bringing together connected health solutions that radically improve the delivery of healthcare, to patients living in London.

For the supplier

[DigitalHealth.London](#) (DH.L) acts as the 'front door' to assist high potential digital health companies, often at minimal cost, to navigate the complex London health care system and its customer base, increasing their ability to forge the right partnerships that lead to new contracts and pilot opportunities with healthcare provider and commissioner organisations. The companies selected for close support have the potential to solve the real problems faced by the [health] system. The 'hub' provides a market place for exchange and exploration between the buyers and sellers, often

brokered through DH.L, which is seen as a trusted and impartial broker. Companies engaging with DH.L can access services and resources to boost their knowledge about how the health system works and are given a much sought after platform in front of potential customers and investors. To date, DH.L has closely supported an estimated 600 digital health companies with face to face contact over the last two or more years.

For the buyer

DH.L also works closely with the 'buyer' – the health care providers and commissioners that are scouting for potential solutions and need support in driving up the adoption of the innovations being deployed within their organisations and across their communities. NHS decision makers and change makers are increasingly working with DH.L to facilitate the right connections and sharing of knowledge. To date, DH.L has engaged directly with circa 460 healthcare professionals/ clinicians through its initiatives over the last two or more years. Notably, the agency focuses much of its time and resources on helping to drive forward adoption where multiple NHS organisations are working on a similar project.

One recent example is Digital Outpatients. With more than 100 million

outpatient appointments every year, the NHS has a major opportunity to introduce more efficient and patient-focused digital outpatient services. Across the country, there are many examples of GPs, hospital trusts and community services innovating with the latest digital technology to reduce pressure on outpatient services, improve patient experience and save resources.

In London, more than 20 London trusts opted to form two new digital outpatient collaboratives focusing on virtual consultations and streamlining outpatient processes. Facilitating the collaboratives, DigitalHealth.London has linked the collaboratives to the expertise and resources they need to implement solutions in their health-care organisations; whether it's managing change, planning and evaluating projects or sharing results and learning. Each 'forum' providing opportunities for networking and shared learning between the NHS providers. This model also starts to offer the NHS stakeholders:

- The skills to be more effective at enrolling (vital for achieving adoption): through better influencing, storytelling, developing stronger business cases, improved benefits articulation.
- The skills and awareness to develop a basic level of commercial literacy in the context of working more effectively with suppliers.

Building an environment supporting validated solutions

The key to all of this is, of course, a landscape that is built to provide the 'plumbing' so to speak, that creates the foundations for validated innovation, which is repeatable and scalable across a region. Seeded in London as a result

of a number of exploratory pieces of work in the preceding two to three years, to which DigitalHealth.London has contributed, a working group led by NHS England and including MedCity, National Institute for Health and Care Excellence (NICE), Public Health England and DigitalHealth.London is developing guidance and standards to address and streamline support on this issue. This has been convened against a backdrop of increasing pressure for therapeutic digital health tools being considered for commission and adoption to demonstrate safety, effectiveness and offer economic value.

"DigitalHealth.London (DH.L) acts as the 'front door' to assist high potential digital health companies, often at minimal cost, to navigate the complex London health care system and its customer base, increasing their ability to forge the right partnerships that lead to new contracts and pilot opportunities with healthcare provider and commissioner organisations."

The project, titled 'Evidence for Effectiveness' (EfE), aims to make it easier for innovators and commissioners to understand what 'good' evidence for digital tools looks like, whilst meeting the needs of the NHS and patients.

Developing technologies is a collaborative process and this project is bringing key parties together, including innovators, commissioners and other stakeholders to understand their needs and experiences. The goal is to develop a digital health tool which will advise on appropriate evidence generation and a set of standards for generating evidence of effectiveness and economic impact.

The framework will include clear requirements for data standards, information governance and technical

safety standards, as well as guidelines on how the effectiveness of digital therapeutic products are evidenced and evaluated.

Creating these standards and a regulatory framework will:

- Enable better NHS commissioning, with commissioners being better equipped to know what to ask developers and what to expect back;
- Provide guidelines for digital health innovators and clinical innovators on how to work with the NHS and the standards expected of them and;
- Facilitate a functioning market, leading to a minimum standard of higher quality health products and tools with a clear pathway for procurements.

Digitalhealth.london as an example of a model for driving the adoption of digital innovation, now in its third year, is starting to see the impact of its multi-pronged interventions at the supplier, buyer, policymaker and regulatory levels.



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The value-based public procurement nurse in Europe

Paul De Raeve, Secretary General of the European Federation of Nurses Associations (EFN) places the value-based public procurement nurse under the spotlight in Europe

Nurses have a key role in addressing the financial and sustainability challenges of the health and social care ecosystem, therefore, they should be involved in the procurement co-design from an early stage, working with procurement officers, to secure funding and successful outcomes. Creating an inclusive relationship between clinical and procurement staff is a crucial first step to ensure that both financial and clinical benefits are considered from the outset.

My personal account

Materials and services designed without engaging nurses in a systematic way compromise safety and quality, as tools could become 'engineering products tested in labs', but not 'fit for purpose' for end-users.

As a former senior procurement nurse, my focus was on translating nurses/doctors/patients' needs related to materials for public procurement into technical requirements, as well as proactively co-designing devices with the industry to achieve better patient outcomes and lowering down nurses' workload. A good example was the neonatal ICN incubators, where, instead of the total price, €20 million for 15 high intensive care incubators, the research focussed, together with a National Aeronautics and Space Administration (NASA) expert, on developing high-quality foam for mattresses, so neonates' skin, comfort, struggle for life, became the first criterion in public procurement.

The innovative and provocative approach was welcomed by neonatal units in Europe and procurement officers capturing the clinical perspective covering safety and quality indicators linked to procurement. Public procurement and its selection criteria, need to be transparent, including its scores, as the motivation for not selecting a specific material/tool/service becomes key in the value-based procurement process.

In this context, the frontline nurses' voice is crucial, with the analysis of the material/tools testing and finally, the frontline continuous professional development to facilitate deployment is driving 'small changes into big differences.

Nurses engagement with procurement

Frontline nurses, using a vast range of clinical products, are uniquely qualified to offer a detailed insight into what items do and do not work. But the industry needs to understand 'codesign' better, to make procurement less intensive for the nurses' frontline. The implementation of the EU Directive on the prevention of sharps injuries within healthcare settings, from May 2013, is a case in point. Healthcare facilities identified the existing sharps products used and, where appropriate, to find replacements that complied with the Directive's requirements. Nursing staff were responsible for defining the technical specifications of the products – a central part of the procurement process and one in which their clinical expertise was crucial.

The development of a procurement nurse has become more common across the EU. This nurse acts as a bridge between clinical activity and the contracting/commercial requirements of a care organisation. The role requires a wide range of clinical experience, the ability to understand complex clinical treatments and excellent communication and interpersonal skills. Clinical procurement nurses (CPN) can come from a range of clinical backgrounds including theatre, critical care, ward managers or other roles that require engagement across all levels of the multidisciplinary team. The CPN role can cover:

- Liaising between procurement and clinical teams to agree and control standardised products and devices across an organisation;



- Support and coordinating complex clinical procurement exercises where critical appraisal or formal clinical evaluation is required;
- Ensuring that legislative and regulative procurement laws and guidelines associated with medical devices and patient care are considered and communicated correctly;
- Developing multidisciplinary input into a clinical products and devices review process through clear protocols, policies and product groups;
- Actively promoting research activity to identify new innovations or technologies that advance safety and quality;
- Observing product utilisation in practice, collecting staff feedback, identifying training needs.

However, the entire process of selecting and purchasing material and services are often managed by procurement departments. Often by health economists,

resulting in the prioritising of financial considerations over product usability and clinical suitability in the selection process.

EU mechanisms - bring innovation into the market

In 2014, the European Parliament passed the [Directive 2014/24/EU](#)¹ which aims to improve procurement by promoting quality and innovation while considering longer-term costs, as well as environmental and social factors. The Directive provides more freedom to contracting authorities supporting the use of flexible procedures and allows a greater interaction with the market, as it introduces negotiation and competitive dialogue formats. Also, the Directive encourages industries selling to public authorities to define the best price-quality ratio, equivalent to value for money and it allows public authorities to consider full life-cycle costs rather than just the up-front purchase cost.

The European Commission, through DG Connect, has given an initial drive to value-based procurement (VBP), seen as a useful mechanism to bring innovation

into the market. Under Horizon 2020², the EU increases support for groups of public procurers who work together on innovation procurement through two approaches: Pre-Commercial Procurement³, that offers public procurers to share risks and benefits of procuring R&D and to address challenges of public interest for which no satisfactory technological solution is not yet available on the market; Public Procurement of Innovative Solutions⁴, in which public procurers act as launching customers of innovative goods or services which are not yet available on a large-scale basis and may require conformance testing. This is applicable when contracting authorities/entities, possibly in cooperation with additional private buyers, acting as a lead customer for the procurement of existing “innovative” solutions (not the R&D services to develop them) that are not yet available on large-scale commercial basis due to a lack of market commitment to deploy.

“Nurses have a key role in addressing the financial and sustainability challenges of the health and social care ecosystem, therefore, they should be involved in the procurement co-design from an early stage, working with procurement officers, to secure funding and successful outcomes.”

Although several initiatives started in the healthcare sector, it remains uncertain how the end-user, in particular nurses and patients, drive this process to guarantee access and outcomes.

Conclusions

Making the right choices about which equipment and supplies the hospital, community care practices or even research centres buys can make a huge difference to the quality of care, patient safety and outcomes. To foster a shift to a value-based procurement using a multi-disciplinary approach and resulting in the most economically advantageous tendering, nurses become frontline drivers of choosing the materials co-designed with and for the end-user. Nurses using clinical products every day can indicate the best and easiest solution to achieve the best results. The EFN believes that:

- Every local procurement team should have relevant clinical expertise at the appropriate time to support effective procurement decision making;

- Healthcare organisation, including primary care centres, boards should include procurement nurses to make sure investments turn into better outcomes;
- The procurement process must include identifying the needs of the frontline for a product/service;
- Procurement strategies and decisions should be transparent and quality/patient safety should take priority over quantity and costs;
- Procurement processes should be proportionate to the value, complexity and risk of the services contracted, but should not be overly bureaucratic and;
- Member States should be in line with EU Directives and explore procurement collaboration between Member States in order to reduce costs with suppliers.

The position of nurses on the frontline of patient care, using a vast range of clinical products on a daily basis, including IT equipment, leaves them uniquely qualified to offer detailed insight to make the public procurement process a success. ■

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YOUR OPINION MATTERS

Whether you agree, disagree, or have another viewpoint with any news and features on our website, we want to hear from you.

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Ethical Healthcare asks: Is the market ready for a novel approach to consulting?

Here, Ethical Healthcare Consulting explains how they look to shake up existing consulting models with a unique blend of quality combined with not-for-profit status

Ethical Healthcare Consulting (EHC) was set up after the founders saw how the NHS was paying so much in fees for quite often very little return – not in every case of course, but all too often. Simply put, the ultimate and overarching objective of any private enterprise is to deliver profits for shareholders which means prioritising profit over patient care, frequently compromising on quality to protect profit margins.

EHC hopes to change this and shake things up a little. The solution was to create a not for profit community interest company with a primary focus on supporting NHS staff and patients, whilst offering the same expertise to compete with the big consultancies. In essence, doing the right thing really well without a financial agenda. EHC is the only not-for-profit health informatics consultancy in the UK with one goal in mind, to do the best for patients and healthcare providers whilst offering unrivalled value for money.

Ethical Healthcare values

EHC believes that true partnership with the NHS can only be achieved through trust and alignment of values; a consultancy that places patients over profit, aligned with the values of the NHS. With no focus on profit margins, values are at the core of EHC's behaviours, engagement and the improvements and changes delivered to the NHS.

How Ethical Healthcare works

EHC would rather do a small number of things really well than dilute expertise across a wide range of services and use contractors that are not bought into the organisation's values.



“EHC services focus on developing and leading programmes that will actually be delivered and sustained and that will make a difference.”

With this in mind, the team has been created with like-minded experts in their field. There is no competitor that can provide more expertise and a better service at a lower cost. EHC also spends considerable time transferring knowledge to staff within partner organisations so that they continue to maintain and grow once the expertise leaves. Additionally, an integral part of EHC's core offerings is cultural baselining, ensuring staff have the tools, capability and core culture to be successful. It's a holistic approach.

Ethical Healthcare services

EHC services focus on developing and leading programmes that will actually be delivered and sustained and that will make a difference. Purely technical transformation is a waste of time if people don't understand the 'why' behind it. EHC's approach is one of inclusiveness and co-production. Staff

must feel that they own transformation initiatives, but also be provided with the right strategic framework in which to deliver lasting change.

Whether it's enterprise imaging or a replacement EPR system, EHC employs a range of techniques from value chain mapping, novel benefits management approaches and cultural base-lining to offer a service that is a cut above the transformation initiatives offered by other consultancies.



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Can current suppliers survive the coming revolution?

Ethical Healthcare Consulting asks if current suppliers can survive the coming revolution as the company looks to the future of the Electronic Patient Record (EPR)

Apple has recently announced that they are making their health records platform open. This is a big deal for the whole Electronic Patient Record (EPR) space. The key is the wording; Apple are building a platform but they're absolutely not trying to build a monolithic EPR. This is intentional.

They are building a platform that will contain millions of health records, in a standardised, normalised and consented way. In doing so, they are removing pretty much all barriers to entry into the healthcare software market, creating a potential explosion in digital health innovation.

But why would they do this? It is down to the platform business model – in providing a large-scale platform they are essentially creating their own innovation playground. Amazon, Apple et al. (in other words platform providers) will all have a helicopter view of what is doing well on their platform and will simply buy whatever that is, absorb it and let it make money for them. It is a simple and very successful business model. They get to buy their future competitors before they actually become the competition without creating the innovation themselves. Look at Google buying Deepmind, or Facebook buying Whatsapp, they become even more dominant in that sector and so the vicious circle continues.

EHC hopes to change this and shake

things up a little. Our solution was to create a not for profit, community interest company with a primary focus on supporting NHS staff and patients whilst offering the same expertise to compete with the big consultancies. In essence, doing the right thing really well without a financial agenda. EHC is the only not for profit health informatics consultancy in the UK with one goal in mind, to do the best for patients and healthcare providers whilst offering unrivalled value for money. We like to call it 'value-driven expertise'.

The future

So, what will happen next? We predict that:

- Apple, Google, Microsoft and Amazon (amongst others) will continue to create their healthcare data platforms, catalysing a whole new generation of innovation of patient/citizen facing healthcare software;
- The NHS will mandate interoperability but... Apple etc. will become the dominant voices in interoperability instead, setting data and messaging standards just by the sheer popularity of their platforms and the apps sat on them. Users will expect the systems in their providers to access these health clouds, so the NHS bureaucracy will have to keep up with these standards (which of course it won't be able to, but Simon Eccles' intentions are to be lauded nonetheless);

- The current monopoly of the existing supplier community will be broken and come under attack from pretty much anyone that wants to have a go at writing a better system than those that exist right now without the worry of building a proprietary data model. Clinicians will, directly or indirectly, build their own systems and they will be far better.
- As proven by the suite of globally dominant uber-applications such as Facebook, people's data is the new currency. These apps are not free, we all pay for them with our data. Those who control the data have all the power. What we see happening in the next 10 years will be the gold rush and marketisation of health and care data. It will be interesting to see who comes out on top, but we very much doubt it will be the current crop of suppliers with systems built around data intransigence. For them, it is already too late.



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Speeding up health technology innovation in Wales

Swansea University Medical School is contributing valuable work to help speed up health technology innovation in Wales

Swansea University Medical School is proud to be a partner in the new £24 million Accelerate programme.

Accelerate, which is supported by the Welsh Government and European funding, will speed up innovation in health technology in Wales. The programme is led by the Life Sciences Hub Wales and is drawing on the expertise and capabilities of Swansea University, Cardiff University and University of Wales Trinity St David to develop new, innovative healthcare products and services, which will help boost the economy and create hundreds of new high-quality jobs.

The Accelerate programme, which will run over three years, brings together clinical, academic and industry expertise to develop and roll out new, innovative products and services within the Welsh health and care system.

Professor Keith Lloyd, Head of the Medical School at Swansea University, explains that Accelerate will help build on the already strong life science sector – which is worth around £2 billion to the Welsh economy.

Professor Lloyd says: *“We are delighted to be part of this exciting new Accelerate programme. The Medical School has contributed significantly to the growing life science sector through its Institute of Life Science (ILS) at Singleton campus.*

“And as a top three UK Medical School, we are committed to ensuring the research, innovation and expertise within our Medical School is used to prevent ill health, develop better treatments and be at the forefront of new technologies which can be used to improve care in the NHS.

“Through the Accelerate programme, we will also be able to ensure we can improve – not only the health of people in Wales – but the wealth of the people in Wales. We will be able to take our ideas and research out of the lab and into the marketplace – helping create new firms and new high-value jobs.”

Swansea University is will create a Healthcare Technology Centre (HTC) on its Singleton Campus, the project is being led by Dr Naomi Joyce. Dr Joyce says the programme will speed up the translation of ideas from the healthcare system into new technology, products and services to create lasting economic values in Wales.

Dr Joyce notes: *“Swansea University is leading the Healthcare Technology Centre (HTC). HTC completes the Technology Development & Adoption Pipeline by supporting Research and Enterprise & Innovation and associated Skills Development. HTC provides a platform for companies and researchers which builds on our research strengths in biosensors and devices, bioinformatics, bio analytics and biobanking. Opportunities which require technol-*

ogy development/exploitation will be progressed in partnership with the private sector, academia, the NHS and other stakeholders.

“We have a team dedicated to HTC and Accelerate based in the Medical School, this will create 16 new jobs at the School.

“The team is made up of post-doctoral, technologists, innovation specialists, technicians and project managers who will support the development of technology and innovation in the life sciences & health sectors in collaboration with industry. We are looking forward to bringing together the NHS, businesses with the world-class researchers here in Swansea.”

Cardiff University is leading the Clinical Innovation Accelerator (CIA). CIA supports the translation of medical innovation by identifying and addressing the unmet clinical need through facilitating the application of specialist research/clinical expertise and facilities. While the University of Wales Trinity Saint David is leading the Assistive Technologies Innovation Centre (ATIC). ATIC delivers devices for improved standards of living. ATIC focusses on assistive, adaptive and rehabilitative devices to improve the prevention of illness and support self-management of long-term conditions, leading to improved standards of living and maintaining active independent living.



Dr Joyce adds: *“An example of how the HTC will work in practice is the development of a non-animal drug-testing model. Accelerate will assess the baseline, needs and analyse the project before recommending and agreeing on a detailed plan with HTC and project partners.*”

“HTC then provides dedicated resource and expertise including the provision of a research technologist to work alongside the industrial partner building on research strengths within Swansea University Medical School, to develop and test a non-animal, 3D clinically relevant model.”

“The industrial partner can then use this model to assess the drug toxicology, safety and penetration. The results will inform the commercial viability of proceeding to Phase I Clinical Trials. The project will then be reviewed by Accelerate to assess the impact of the project, which may include the creation of new intellectual property (IP) and the leverage of funding to further develop the innovation.”

Welsh Government Health Secretary, Vaughan Gething adds: *“Developing innovative new ways to prevent, treat and cure illness and disease is a vital part of the Welsh Government’s vision for the future of the NHS in Wales. The Accelerate programme and new health innovation centres fund will help develop new ideas for health products and services more quickly for use in our NHS and across the world.”*

***Accelerate will be showcased at Swansea University’s Collaborate 2018 event. This free life science and health conference will be held on October 17, 2018, at the University’s Singleton Campus – to register visit: <https://www.eventbrite.co.uk/e/collaborate-2018-tickets-48022755354?aff=es2>*

If you would like to get involved as a sponsor, exhibitor or event collaborator – please email the Medical School at medevents@swansea.ac.uk

For more information about the Accelerate Programme please email:

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To find out more about Swansea University Medical School visit:

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New Medical Pharmacology degree “could help reduce the NHS financial burden”

Dr Lisa Wallace, Course Director from Swansea University Medical School explains their exciting new Medical Pharmacology degree which “could help reduce the NHS financial burden”

A new Medical Pharmacology course at Swansea University Medical School could help reduce prescribing error costs incurred by the NHS.

A recent report commissioned by The British Pharmacological Society and produced by PWC has estimated the financial costs incurred from inappropriate and inefficient medicines use and prescribing error as £826million.

The report title “*Clinical Pharmacology and Therapeutics: The case for savings in the NHS December*” reveals that if the NHS recruited more clinical pharmacologists the cost of human prescribing error could be significantly reduced.

Dr Lisa Wallace, course director of the new Medical Pharmacology at Swansea University Medical School and a Vice-President of The British Pharmacological Society (BPS), said the new Pharmacology degree at Swansea will ensure students gain a solid pharmacology understanding – before they pursue a career in medicine – which will help create an upskilled NHS workforce and in turn help reduce prescribing errors.

Dr Wallace explains: “*We believe that by giving our students – who are potentially our future clinicians – a really strong grounding in medical pharmacology this can work towards significantly reducing the cost currently incurred by the NHS.*”

“The BPS report states that for every £1 spent to hire additional clinical pharmacologists has the potential to reduce NHS costs by almost £6.”

“This new degree is the first step in a career as a clinical pharmacologist. Clinical pharmacologists are trained doctors who focus on the safe and effective use of medicines. They have a multi-faceted role within the NHS which includes treating patients, training other clinicians in prescribing best practice, and the development of innovative new medicines.”

Clinical pharmacologists are specialists in the detection and management of poisoning. They lead specialist poison centres and provide advice to other clinicians. The BPS evidence shows that poisoning costs the NHS up to £226 million and that an additional 78 clinical pharmacologists recruited to the NHS could unlock £6 million of savings.

Helping to reduce financial costs of prescribing errors

Dr Wallace adds: “*The BPS report states there is clear evidence that over a long period of time the recruitment of clinical pharmacologists could make significant savings to the NHS.*”

“Clinical pharmacologists can help reduce the incidence and treatment of Adverse Drug Reactions (ADRs), the detection and management of poisoning, reduce prescription errors, help boost clinical R&D. And as they have

an in-depth knowledge of drugs and their interactions, they are also able to improve adherence – which means ensuring that people take their medicines in the appropriate way.”

Medical Pharmacology lecturer Aidan Seeley, who has recently joined the teaching team at Swansea, adds that their new Medical Pharmacology degree will give those students who want to pursue a career in medicine a brilliant understanding of how these errors can be reduced.

He notes: “*Our new Medical Pharmacology course provides students with an exceptional level of training and specialist knowledge. This is particularly important for those who want to pursue a future career in medicine.*”

“It is vital that our future NHS workforce have a strong knowledge and understanding of how drugs work, how they act on the body and how the body metabolises these drugs – this increased knowledge will hopefully reduce prescribing errors and could help reduce the overall financial costs to the NHS in the long term.”

Prescription errors are estimated to be present in 7%-15% of all hospital prescriptions. Many of these errors result from clinicians with insufficient training in prescribing drugs to patients. Clinical pharmacologists spend approximately 10% of their time teaching other clinicians about medicines management and usage.



Dr Lisa Wallace and Aidan Seeley, from Swansea University Medical School's Medical Pharmacology department

Based on the BPS evidence clinical pharmacologists could potentially unlock up to £18.5 million in savings from fewer prescription errors.

“A recent report commissioned by The British Pharmacological Society and produced by PWC has estimated the financial costs incurred from inappropriate and inefficient medicines use and prescribing error as £826million.”

The next big thing in healthcare:

Swansea University Medical School has also launched a new Population Health and Medical Sciences degree programme for September 2018. Population Health has been described as “the next big thing in healthcare” by Monster Jobs.co.uk.

Population Health aims to address health inequalities by understanding the health needs of groups of people and transforming traditional health-care models to meet those needs.

Professor Phil Newton, Director of Learning and Teaching, says it is a very exciting time for Wales’s number one Medical School. He says: “*Swansea University Medical School has once again been named as the UK’s number 3 Medical School – only beaten by Oxford and Cambridge (The Guardian University Guide 2019) – is continuing to expand with the recruitment of new academic staff, the launch of new courses and an expansion of its teaching space across the South West Wales region.*

“*Our two new undergraduate courses – Medical Pharmacology and our new Population Health & Medical Sciences – are part of our very successful Pathways to Medicine. Our Pathways courses give our undergraduate students the opportunity to progress to our flagship Graduate Entry Medicine programme.*

“*We are delighted to be able to offer so many courses for undergraduate students which has now allowed us to recruit new academic staff.*”



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The priorities for health and social care policy in Germany

The priorities for health and social care policy in Germany are placed under the spotlight here by Open Access Government, including the Federal Minister of Health's ambitions for the elderly care sector

Jens Spahn has held the position of Federal Minister of Health in Germany since March 2018, but he has been a member of the German Bundestag since 2002. After training as a banker, he took on the role Parliamentary State Secretary to the Federal Minister of Finance between 2013 and 2018. This article will look at his recent efforts to boost the quality of care in Germany, including improving the daily lives of caregivers through better staffing and better working conditions in the elderly care sector.

In recent news from the Ministry, we learn about the introduction of the appointment service and supply law (TSVG), which ensures that patients in Germany can get medical appointments faster. Under this law, more consultation hours are expected to be offered. Commenting on this important policy development, Minister Spahn says: "We ensure that insured persons in the future get a doctor's appointment faster. Doctors who help us to improve care should be paid higher and outside the budget."⁽¹⁾

In other news, we learn that the bill to strengthen nursing staff was approved by the German Cabinet on 1st

August 2018. The aim of this policy is to achieve improvements in the daily lives of caregivers through better staffing and better working conditions in the elderly care sector. Minister Spahn provides his detailed thoughts on this important healthcare development in Germany: "As of January 2019, 13,000 nurses can be hired in inpatient care facilities. And: any additional or increased nursing job in hospitals will be fully funded by health insurance. Collective pay increases in hospital care will also be fully covered by the payers, retroactively from 2018. The immediate care programme is a first important step towards improving care. We are thus taking care of the care directly and noticeably under the arms. Something is happening in nursing - with this signal we want to support nurses in their daily work, to gain new nurses and to further improve the nursing care of the patients. And further steps will follow soon."⁽²⁾

On the subject of care, we find out that the federal government in Germany wants to inspire more people to work in the care sector. Minister Spahn along with Minister for Family Affairs, Senior Citizens, Women and Youth, Dr. med. Franziska Giffey and Minister of Labor



Jens Spahn, Federal Minister of Health in Germany

and Social Affairs, Hubertus Heil are making a joint effort in this vein. The intention here is to significantly improve the day-to-day work and working conditions of caregivers and to relieve the burden on nurses and strengthen training in the nursing sector. Together with the leading minds of the social system and the relevant actors of care, the three Ministers agreed that concrete measures must be developed in the very near future.

Providing his own perspective on this important health and social care policy step forward, Minister Spahn stresses that good care means affection, but this takes time and staff hours as well. "That's why we start the Concerted Action Care. We want to get more people to take up this responsible job. We want to encourage caregivers to get back into work or to work full-time again. The nurses in our country are doing great things for our society every day. For this, they deserve more appreciation in the job, good working conditions and fair pay", he adds. ⁽³⁾

To further reduce new infections with the HIV virus in Germany, Minister Spahn submitted a bill in July 2018

by which statutory health insurance funds will take on preventive medicine (PREP) for high-risk patients, including the associated medical advice and medical examinations that take place. Commenting on this aspect of care, the Minister comments: "Germany is one of the countries with the lowest HIV infection rates in Europe. But we want to further reduce the number of new infections. People with an increased risk of infection should receive a legal claim to medical consultation, examination and drugs for pre-exposure prophylaxis." ⁽⁴⁾

Finally, in June this year, Federal Health Minister Jens Spahn invited five start-ups for a dialogue with the Federal Ministry of Health. Together, they discussed visions and ideas on how digitisation can noticeably improve health care. At the time, the Minister said: "For me, it's important for us to shape the processes of digitisation in health care and not simply accept what has already started in other parts of the world. That is why we promote the exchange between the founder scene and politics with 'Innovation Meets Politics'". ⁽⁵⁾ ■

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Antiviral and antitumor therapies

Prof Dr Chris Meier at the University of Hamburg, Faculty of Sciences, Department of Chemistry explores antiviral and antitumor therapies. He discusses the intracellular delivery of antivirally active nucleoside triphosphates and argues that the ultimate challenge is applying these as chemotherapeutics

Nucleosides are the components of nucleic acids and play an essential role in the synthesis of RNA or DNA and in many other biological events. Synthetic nucleoside analogues are used in antiviral and anticancer chemotherapy and they are the backbone to combat virus infections nowadays, for example, the HAART approach against AIDS/HIV.

However, nucleoside analogues need to be intracellularly stepwise phosphorylated into the ultimately active nucleoside analogue triphosphate (NTP) by host cell kinases or, in rare cases, by virus-encoded kinases. Due to the substrate specificities of the kinases, the activation of nucleoside analogues often proceeds insufficiently.

Furthermore, the clinical efficacy is hampered by limitations such as low biological half-lives due to catabolic transformation. Often, the first phosphorylation catalysed by a nucleoside kinase to give the monophosphate metabolite (NMP) has been identified as the limiting step, for example, for the anti-HIV drug 3'-deoxy-2',3'-dideohydrothymidine (d4T).

However, for 3'-azido-3'-deoxythymidine (AZT) the bottleneck is not the NMP formation but the metabolism to the corresponding diphosphate (NDP)

and recently, we showed that two uridine nucleoside diphosphates were very poor substrates for NDP-kinase. The latter proved that even the last conversion to NTPs can be rate-limiting.

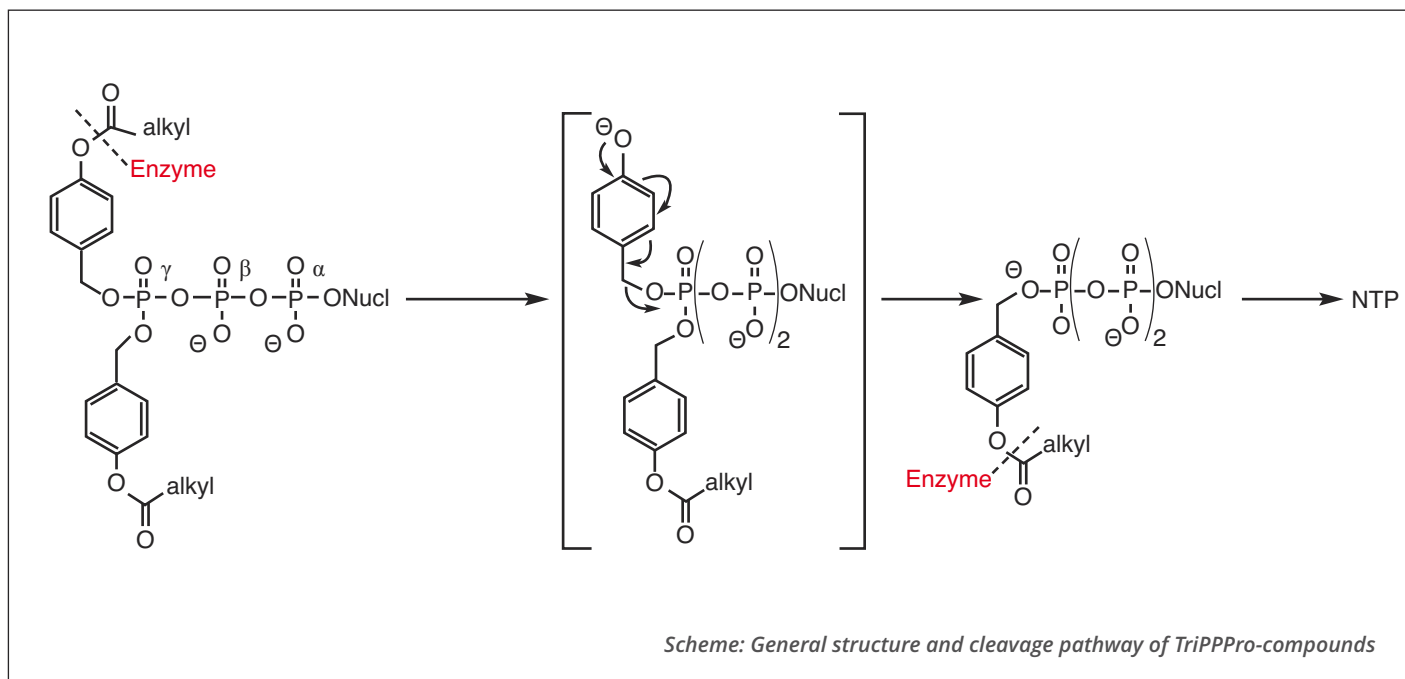
However, for most of the synthetic nucleoside analogues, the detailed metabolism to yield the NTP has not been studied yet because they were biologically inactive and therefore were discarded. The main reason for a lack of (bio)activity is often an inefficient phosphorylation. To overcome the phosphorylation bottleneck, the design of prodrugs of the phosphorylated metabolites can be an option to restore antiviral or antitumor activity. This concept has been successfully used for monophosphorylated nucleosides. Examples of such NMP-prodrugs are the enzyme triggered McGuigan Protide-strategy, which is used successfully in HCV chemotherapy (Sofosbuvir) and the chemically driven *cycloSal*-technology introduced by us. Interestingly, previously to our own work, delivery approaches for the higher phosphorylated metabolites were published in only a very few reports and all of them failed.

Despite the success of NMP prodrugs, such as the anti-HCV agent Sofosbuvir and the successful intracellular delivery of NDPs, the final goal in the field

of pronucleotide development is the intracellular delivery of NTPs. The advantages are obvious. Firstly, the complete phosphorylation is by-passed because the ultimately active NTP is delivered and secondly, catabolic processes which normally only take place at the nucleoside or the NMP level can be avoided. Despite these obvious advantages, almost no reports were published on the development of NTP prodrugs.

There are important challenges to be solved in NTP prodrug development. Firstly, the inherent lability of the triphosphate unit because of reactive phosphate anhydride linkages and secondly, the high negative charge that has to be compensated by lipophilic masking groups. Thirdly, a possible unselective cleavage of these masking groups and fourthly, the potential low stability of the delivered NTP towards kinases/phosphatases. Hence, the common opinion in the field was that it is almost impossible to develop prodrugs of NDPs or NTPs.

However, in 2008 we published on the first NDP prodrugs, the so-called DiPPro-approach to bypass the second phosphorylation step.¹ These prodrugs showed very good antiviral activity in HIV-infected human T-lymphocyte cell cultures and clearly



formed the nucleoside diphosphates in cell extracts.

In 2015, we disclosed the intracellular delivery of nucleoside triphosphates through a prodrug technology (TriPPPPro-approach, Scheme).^{2,3} In contrast to the *cycloSal*-approach, as in the DiPPPPro-approach, in the TriPPPPro-approach the delivery of the NTP is triggered by an enzymatic activation within the masking group. In our work, we have used two different synthesis routes towards the TriPPPPro-derivatives. One route is based on the phosphoramidite chemistry and needed an oxidation in the final reaction step, while the second route involves H-phosphonate chemistry.

Using the second route, nucleoside analogues or masking groups sensitive for oxidation can also be used. Additionally, we reported on the biophysical properties of the TriPPPPro-derivatives, a PCR assay, the antiviral activity of a variety of approved, as well as so-far non-active nucleoside analogues, plus cellular uptake study and the intracellular delivery of the NTP using a fluorescent nucleoside. Recently we proved

the in-vivo efficacy of a TriPPPPro-compound against HCV in mice. These studies demonstrated the general applicability and potential of the approach.

In conclusion, our work on the design of pronucleotides led to the first example of a nucleoside triphosphate prodrug. The key to this approach was that the reactive phosphate anhydride linkages of the TriPPPPro-compounds were stabilised by the presence of negative charges. However, by keeping the charges the polarity has to be compensated by the lipophilicity of the two masking groups connected to the terminal phosphate group. The second important feature was to use an enzyme-catalysed cleavage within the masking group which avoided almost all possible side reactions associated with the triphosphate moiety.

So, the results obtained proved that the TriPPPPro-approach enables the intracellular delivery of bioactive NTPs. Thus, the TriPPPPro-strategy offers a high potential to be used in antiviral and antitumor therapies. The approach can be used for all those

nucleoside analogues that lack efficient conversion into the triphosphate form. Also, compounds that are quickly catabolised may be rescued by this approach. Moreover, the approach might be also suitable to address chemical biology questions by delivering triphosphorylated nucleotide probes into cells.

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Health research: The challenge of cleaving proteins in the membrane

Regina Fluhrer from the LMU & DZNE in Munich explains an aspect of health research that concerns how proteases embedded in cellular membranes hydrolyse other proteins and the challenges they must overcome

The concept of proteolysis was first discovered in 1836, when Theodor Schwann, a German researcher, purified pepsin as an enzyme capable of fragmenting nutrient proteins in the intestine. Peptide bonds, the chemical bonds that connect amino acids within a protein, are very stable and hydrolysis, the breakage with water, is not easy. This is important because it allows, for instance, that we can shower in the morning without our skin dissolving. However, it is a hurdle if it comes to degradation and, thus, cleavage of these bonds, since energy, the so-called activation energy, needs to be invested. Here, proteases come into play: with their special active site, also known as the catalytic centre, they interact with their substrates forcing them into a special confirmation that reduces the activation energy allowing hydrolysis of peptide bonds within milliseconds that without this catalysis would take hundreds of years and life wouldn't be possible.

To date, more than 500 human proteases, with specificity for an even greater number of substrates are known. However, the vast majority of these proteases are soluble proteins that are active in an aqueous environment within cells and tissues or in body fluids like blood.

In 1997, more than 150 years after the discovery of the first protease, it became evident that proteolysis also

occurs within cellular membranes. Membranes of cells are composed of lipids that arrange as bilayer to separate the inner of a cell from its surroundings, but also allowing a limited and very selective permeability, particularly for small molecules. To allow passage of larger or charged molecules, like glucose and certain ions and to enable cells to communicate with their environment, various proteins are integrated into cellular membranes.

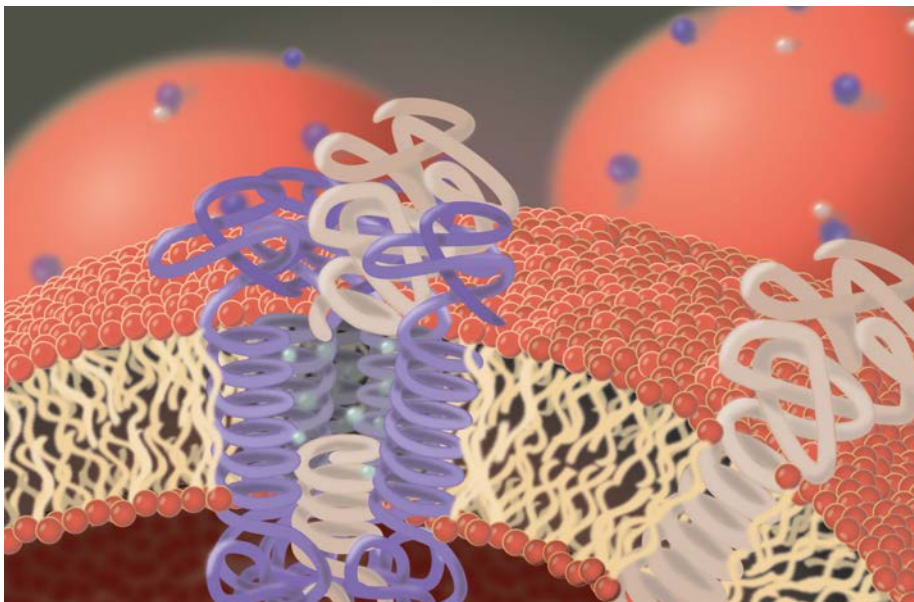
Many of these proteins span the membrane with domains that are mainly composed of amino acids that allow interaction with lipids. These proteins are termed integral membrane proteins. Like all cellular proteins, integral membrane proteins are subject to a permanent turnover that requires de novo synthesis and subsequent degradation. Protein degradation requires proteases since they are the only players in a cell capable of hydrolysing peptide bonds.

Proteases capable of cleaving peptide bonds in membrane-embedded protein domains, face specific difficulties compared to proteases cleaving soluble proteins: i) the peptide bonds in their substrates are embedded in lipids and thus access of the protease to its substrate is much more difficult than in solution. ii) lipid-embedded protein domains tend to form ordered helical structures, which again

aggravates cleavage. iii) water, critical for hydrolysis, is much less abundant in membranes. iv) diffusion rates in lipid environment differ from that in solution.

Remarkably, despite these additional challenges, intramembrane proteases apply similar catalytic strategies as their soluble cousins. Based on the amino acids or co-factors critical for catalysis in their active centre four major classes of intramembrane proteases have been identified: metallo, serine, glutamyl and aspartyl intramembrane proteases.

The peculiarity of these proteases is that their active site, like the cleavage site in their substrates, localises to domains embedded in the cellular membrane. In addition, intramembrane proteases comprise further membrane-spanning domains that allow the formation of a pore-like structure in the lipid environment. Thus, intramembrane proteases combine protease features with that of transporters and channels as they are, for instance, used to carry glucose or sodium ions over membranes. Their membrane-spanning domains allow contact with the integral membrane domains of their substrates and most likely by a lateral opening of the pore-like structure the substrate gains access to the protease active site. This structural layout also allows access of water molecules so that proteolysis



Intramembrane Proteolysis illustrated by Charlotte Spitz

can take place. Although the mechanism of the actual peptide bond hydrolysis is similar to that observed for soluble proteases, kinetics of substrate recognition and cleavage by intramembrane proteases seems to be fundamentally different and are far from being completely understood.

“Remarkably, despite these additional challenges, intramembrane proteases apply similar catalytic strategies as their soluble cousins. Based on the amino acids or co-factors critical for catalysis in their active centre four major classes of intramembrane proteases have been identified: metallo, serine, glutamyl and aspartyl intramembrane proteases.”

Cleavage of integral membrane proteins by intramembrane proteases liberates protein fragments on both sides of the membrane. Thus, intramembrane proteases not only initiate degradation of membrane proteins but also produce protein fragments that are capable of transmitting signals across membranes. In that context, S2P, a metallo intramembrane protease, has been linked to the regulation of cholesterol synthesis, SPPL3, an aspartyl intramembrane

protease to the regulation of protein glycosylation and various intramembrane proteases contribute to cell differentiation (read more in the January 2019 edition of Open Access Government).

Moreover, intramembrane proteases contribute to the proper function of the immune system (read more in the April 2019 edition of Open Access Government) and are implicated in the development of neurodegenerative diseases (read more in the July 2019 edition of Open Access Government), cancer and infectious diseases (read more in the October 2019 edition of Open Access Government).

Compared to soluble proteases, which have become important and valuable targets for treatment and prevention of human diseases, like HIV infections, high blood pressure or stroke, intramembrane proteases are only known for a short period of time. To utilise intramembrane proteases in the future as targets to treat or even cure diseases, it is indispensable to understand their cleavage mechanisms, substrate repertoires and physiological function in depth. Therefore, much more basic research on these



Prof Dr Regina Fluhrer

fascinating enzymes will be required to raise this treasure.

Further Reading

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BROThER: A network for digitalisation in biobanking to promote personalised medicine

Christoph Brochhausen¹, Judita Kinkorova², Karl-Friedrich Becker³, Dalibor Valik⁴, Ondrej Topolcan² detail the marvellous work of BROThER, a network for digitalisation in biobanking to promote the use of personalised medicine

BROThER is a Bavarian-Czech project funded by the Bavarian-Czech Research Agency to optimise the cooperation between biobanks via digitalisation. To reach this goal, a student exchange programme was established to bring knowledge about new developments in the various hard- and software components dealing with tissue and liquid biobanking. In workshops and symposia, new methods are addressed to combine aspects of digitalised workflows to connect biobanks and facilitate common biobank projects.

Personalised medicine is one of the leading concepts in modern medicine and represents a fast-growing field of modern patient care. In this context, biobanking plays a crucial role to promote further applications in personalised medicine. Digitalisation represents great chances to optimise patient care and research but holds also some relevant risks. The chances of digitalisation are given in the harmonisation and consolidation of clinical data from different resources. With that, double documentations and errors during the documentation steps could be minimised.

Since research in personalised medicine needs highly specific and entirely characterised cohorts, the interaction of biobanks with further databases for clinical, laboratory and imaging data will become increasingly

important. Good data integration from these different data sources represents a crucial prerequisite to build-up relevant collectives for basic and translational research. This is especially true when it comes to rare diseases, but also with a view to creating highly specialised and characterised cohorts a multicentre approach is mandatory, to ensure the inclusion of significant numbers of biobank specimens at the appropriate time.

Therefore, the interconnection of biobanks and network building is an important issue for the future development of biobanking. For biobanks in the clinical context, digitalisation to share information and knowledge automatically represents an important parameter. To admit modern technologies in hardware and software solutions in the existing biobank structure will be an important aim for the coming years. In this vein, the interaction and cooperation of biobanks from different countries have to overcome special challenges even if these countries are located within the European Union (EU).

BROThER (Biobank Research on Telemedical Approaches for Human Biobanks in a European Region) is an interconnecting project aimed to analyse the obstacles, which have to be overcome if clinically related biobanks from two national health care systems plan to work together.

Beneath the aim to identify these obstacles, an important issue is to find solutions to enable the set-up of common biobank projects. BROThER will check how digitalisation could help to overcome obstacles and to improve inter-biobank project management.

A further important aim of BROThER is to disseminate the idea of biobanking and the idea of the relevant role of digitalisation of biobanking to young academics and to a broader public. BROThER is a project within a consortium of four biobanks, two in Bavaria and two in the Czech Republic. These are namely the biobanks of the University Regensburg, that of the Technical University in Munich, that of the Faculty Hospital of Pilsen and last but not least that of the University of Brno. This project is supported by a grant of the Bavarian-Czech University Agency (BTHA) with funding coming from the Bavarian State Ministry of Finance. The aim of funding is to promote the cooperation in a border region of two different healthcare systems with different healthcare and research infrastructures. Therefore, the project partners have the understanding to give a relevant example of inter-systemic cooperation.

BROThER is an acronym standing for: "Biobank Research on Telemedical Approaches for Human Biobanks in a European Region" addressing the digital approach for the optimisation of

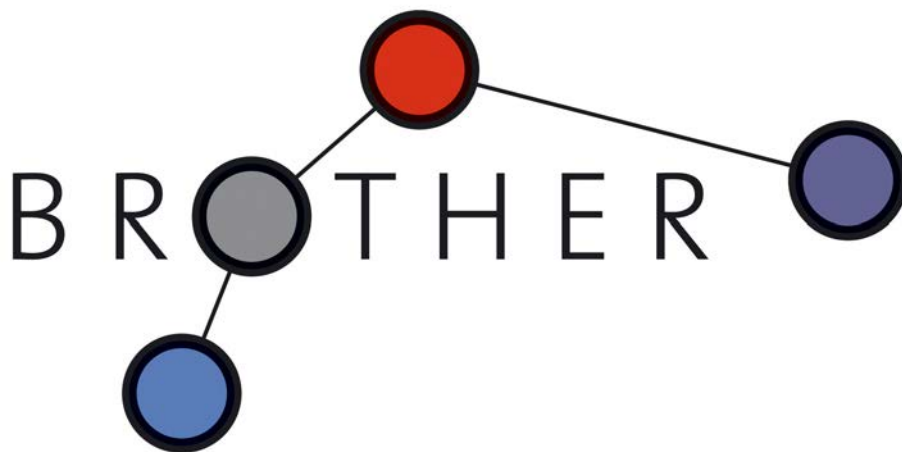


Fig. 1 The BRoTHER logo: The acronym BRoTHER stands for Biobank Research on Telemedical Approaches for Human Biobanks in a European Region. The round, dot-like figures represent the geographical locations of the project partners. The colours are that of the corporate identity of the related universities (blue for Munich, grey for Regensburg, red for the Faculty Hospital Pilsen and dark blue for Brno). The lines symbolised the interconnectivity between the partners without creating a closed network to demonstrate the openness for further partners (logo Design: "Grüne Kommunikationsdesign", www.gruene-kd.de)

biobank cooperation. Furthermore, our acronym is dedicated to the phrase "Every man became a brother" in the European anthem; this should illustrate the strong commitment of the project partners to the European spirit.

Finally, BRoTHER clearly conveys the close relationship between the network partners, which comprise a very open and trustful way of interaction. To illustrate the vision of a closely related network a logo was designed by a professional communication design agency (<http://www.gruene-kd.de/>). The philosophy behind the brand development was to symbolise both the close connectivity of the partners and the openness of the network for potential new partners (fig.1).

One important tool to reach the goal of BRoTHER is a set-up of different interdisciplinary events. The backbone is a student exchange programme with site visits of students in all partner biobanks to make them familiar with different techniques in biobanking and related research.

Furthermore, we have established a summer school, which will be held every two years at one of the partner sites. The summer school addresses the tremendous technical developments in sample preparation, storage techniques and IT-infrastructure, which will influence the field within the next years rapidly. Actually, the recent EU data protection regulation provides a new legal framework for using biobank data and leads to challenges in worldwide biobank cooperation and sample exchange which was an important issue during the first summer school held in Regensburg end of September 2018.

In hands-on courses about the latest technical developments in biobanking, the participants had the opportunity to learn and discuss the huge progress in biobanking with international experts in the field and learn how to implement the new data protection regulation in international projects both within and outside of the EU. To the best of our knowledge, that is a unique format in the field which

brings undergraduate and graduate students together with post-docs, researcher and clinicians to learn together how digitalisation could be integrated with the infrastructure of biobanking.

One last thought is that digitalisation in health care and biobanking will be the challenge of the coming decades. BRoTHER aims to seize this challenge to make students and researchers fit for digitalisation in biobanking.

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Precision medicine and biobanking: Future directions

A group of experts from the International Society for Biological and Environmental Repositories, (ISBER) shed light on the science of biobanking and its role in delivering modern and precision medicine

Biobanking is increasingly recognised as an essential activity underpinning scientific breakthrough in precision medicine and leading to new treatments¹. Biobanking is a collective term which describes the process by which 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 last two decades have seen sustained growth in the creation of biobanks and as such, biobanks now exist in almost every country, university and medical research institute/hospital.

Precision medicine research is based on the analysis of samples with clinical data – and, because the associations are often weak, we need these samples in large quantities. The implication is clear: if more, well-characterised, high-quality samples are available through biobanks, the faster research will advance and impact upon the faster delivery of precision healthcare today. The systematic collection of human samples of high quality is a key element to the success of future treatments. Biobanks are now being relied upon to standardise tissue collection for improved science quality and to actually drive research.

Biospecimen research: Where biobanking becomes science

A new line of thinking is emerging in biobanking: the need to identify and develop indicators (biomarkers) to show if a given sample has the quality to be used with a certain technique. Before using the sample, a simple test can show its quality and usability and if during the lifetime of the sample, it was kept in the appropriate conditions.^{2,3} Such biomarkers should allow researchers to compare analytical results from biologically identical samples, processed in different ways or stored for different periods of time. Biospeci-

men research is a new concept and often scientific journal editors refuse to consider such manuscripts for review, stating that the subject is not considered to be a priority. However, sample quality underpins the accuracy of all subsequent research done with those samples and can impact on the reproducibility and robustness of the results.

“Precision medicine research is based on the analysis of samples with clinical data – and, because the associations are often weak, we need of these samples in large quantities. The implication is clear: if more, well-characterised, high-quality samples are available through biobanks, the faster research will advance and impact upon the faster delivery of precision healthcare today.”

A number of governments globally, including the U.S. and the EU, are increasingly interested in this area on account of the lack of reproducibility in scientific research. ISBER is leading global discussions aimed at the identification of such biomarkers. ISBER has organised a number of Biospecimen Research Symposia (Luxembourg, February 2018; Berlin, February 2019) with global leaders in the field. As the technology in medical research develops at a fast pace, biobanks need to provide the evidence of the shelf-life or the fitness-for-purpose of the samples they supply.

Harmonisation of standards leads to scalability

The two most important aspects of a biobank are consistency and quality. The validity of the data generated by biobanked samples depends on their quality, which is, in turn, is dependent on the use of stringent standards in collecting these samples and delineating patient characteristics. A number of best practices and guidelines have been published over the last few years,

such as the ISBER Best Practices 4th edition;⁴ while at the end of 2018, the International Biobanking standards are expected to be published by the ISO TC276.⁵ For the first time, these documents will be aligned, indeed, this development is expected to introduce a new level of harmonisation across the entire field. The expectation is that the introduction of these standards will allow for the scaling of the biobanking operations and the support of major research projects, both in academia and the pharmaceutical industry.

Innovative digital technologies

Biobanking is not only the collection of biological samples but also of related data which would allow the meaningful study of the collected tissue. The added-value for the collected samples is created by annotation, analysis and transformation of samples to other derivatives, such as genetic information. All these technological advancements will need to remain aligned with proper data governance and donor privacy protection. The management of human tissue in research, therefore, inevitably leads to a requirement to manage the data generated from laboratory investigations and linked clinical sources.

Aided by a continuous level of standardisation, new methods such as predictive analytics and artificial intelligence (AI) are slowly making inroads into biobanking. The interrogation of vast quantities of data from a large biobank can now be completed within a few weeks (even remotely) as opposed to months or years previously. The large size of many biobanks, coupled with the enormous potential of health records and other electronic health data, place this type of research in the forefront of making significant contributions to health care.

New capacities requiring new support mechanisms

This aspect of biobanking sustainability is critical for precision medicine research. The increased demands on the types of samples and processing provided by biobanks create increasing operating and financial pressures. Success cannot be gauged any longer by simple supply and demand principles and judged on the efficiency of the ability to move samples.⁶ Instead, if we accept the fundamental truth that banked samples are sources of information, biobanks should be judged on their ability to generate knowledge, the

discovery of clinical innovations and implementation of new practices that will ultimately lead to improved health outcomes for patients. ■

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Indoor air pollution: A neglected yet important risk to public health

Stephen T Holgate, Special Advisor to the Royal College of Physicians (RCP) on Air Quality and MRC Clinical Professor of Immunopharmacology, University of Southampton takes the stance that indoor air pollution is a neglected yet important risk to public health

The Lancet Commission on Pollution and Health has declared pollution as the greatest health risk to the world population of which air pollution is by far the greatest contributor⁽¹⁾. The principle outdoor pollutants are particulates (PM₁₀, PM_{2.5} and ultrafine particles), both primary from exhaust and tyre/brake wear and secondary from atmospheric chemical interactions of pollutants.

In the developed world, most air pollution is traffic related, although emissions from intensive agriculture, through the formation of secondary particles, is becoming increasingly problematic. Modern-day toxic pollutants comprise oxides of nitrogen (NO_x, including NO₂), ozone (a secondary pollutant produced by the action of sunlight on atmospheric pollutant mixtures) and volatile organic chemicals (VOCs, including poly-aromatic hydrocarbons from incomplete combustion) and ammonia from agriculture.

“Other major indoor sources of pollutants include cooking (particles and NO₂), the burning of fossil fuels and wood (especially if damp) for heating, household aerosol sprays, polishes and cleaning products.”

In 2016, the Royal College of Physicians (RCP) and Royal College of Pediatrics and Child Health (RCPH) published a ground-breaking report highlighting the serious health issues being created by air pollution in the UK with an estimated 40,000 deaths from cardiovascular and lung disease brought forward and substantially greater effects on morbidity from a wide range of diseases⁽²⁾. An important conclusion from this report was that air pollution acts across the entire life course

from conception to old age; exposure to pollutants in early childhood, contributing to excess morbidity and mortality in later years⁽³⁾.

While there has been the most emphasis on pollution exposure outdoors, the average person in Britain spends just 8% of their time outside on a weekday, meaning less than two hours a day out of doors. Approximately 80% of outdoor pollution penetrates the built environment including homes, transport, schools and the workplace⁽⁴⁾. The indoor environment is clearly where most exposure to outdoor pollutants occurs. The ingress of outdoor pollutants will be worse in buildings close to busy roads and junctions as encountered more frequently in the more socioeconomically deprived communities in whom there are other drivers of adverse health⁽⁵⁾. This has recently become a major issue for urban schools and especially the presence of idling vehicles on the school drop-off and pick-up.

The indoor setting is also the source of a wide range of additional pollutants, both chemical and biological. Carbon monoxide is the most widely known indoor pollutant for which there are tight regulations. Another well-known pollutant, second-hand tobacco smoke, is highly toxic both through direct effects when inhaled, but also when chemically reacting with other indoor pollutants (third-hand tobacco smoke)⁽⁶⁾. Other major indoor sources of pollutants include cooking (particles and NO₂), the burning of fossil fuels and wood (especially if damp) for heating, household aerosol sprays, polishes and cleaning products. In the average house, concentrations of VOCs indoors are 7-times higher than in ambient air⁽⁷⁾. These derive from a wide range

of sources including cooking fats and oils, polishes, lacquers and paints as well as aerosols, pesticides, personal care products, open fireplaces, scented candles and air fresheners. The use of personal and home products indoors is now contributing significantly to outdoor VOC pollution ⁽⁷⁾.

Recent work has highlighted the many chemical transformations of pollutants that can occur indoors ⁽⁸⁾. Such chemistry is associated with three of the top 10 risk factors for negative health outcomes globally: household air pollution from solid fuels, tobacco smoking and ambient particulate matter pollution. Highly oxidised organic compounds arise from auto-oxidation mechanisms initiated by either ozone or active radical attack. Reaction of an airborne organic chemical with a single oxidant molecule can lead to the formation of multiple oxygenated functional groups within seconds. This changes the organic reactant from a gas to a molecule that will condense to form secondary organic aerosol (SOA) particles. One such example is nicotine's reaction with ozone to form carcinogenic nitrosamines.

Although much less is known about the additional effects of indoor air pollutant exposure on health, there is increasing evidence that this may contribute to a chemical burden on the developing fetus. This increases the risks of incident asthma and allergies, impaired cognition, lung and cardiovascular development, somatic gene mutations and endocrine pathways (endocrine disrupting chemicals) in cancers, a decline in male and female fertility and chronic diseases associated with ageing such as chronic obstructive pulmonary disease (COPD), dementia, Type 2 diabetes, metabolic syndrome, Parkinson's disease. Indoor pollutants are acting in combination with other disease risk factors. For example, for asthma, chemical pollutants interact with biological pollutants such as fungi in damp homes and dust mite allergens found in carpets, beds and furnishings to increase the chances of developing asthma. In this respect, water and excess heat should be regarded as adjuvants which enhance the adverse effects of pollution.

Consumer product chemicals also accumulate in indoor dust that becomes re-suspended from carpets

and furnishings ⁽⁹⁾. The levels of phthalates (endocrine disruptors found in shampoos and plastics), phenols (cleaning, paints and polishing products), furniture flame retardants, fragrances and perfluoro-alkyl sulphonates (PFAS' in synthetic materials) ⁽¹⁰⁾. Some flame retardants used in many home products such as decabromodiphenyl ether (BDE-209), the most heavily used PBDE and to a lesser degree, tris(2-chloroethyl) phosphate (TCEP), appear to be associated with the most common type of thyroid cancer, papillary thyroid cancer (PTC) whose prevalence, especially in women, is increasing.

“Approximately 80% of outdoor pollution penetrates the built environment including homes, transport, schools and the workplace ⁽⁴⁾. The indoor environment is clearly where most exposure to outdoor pollutants occurs. The ingress of outdoor pollutants will be worse in buildings close to busy roads and junctions as encountered more frequently in the more socioeconomically deprived communities in whom there are other drivers of adverse health.”

In one study ⁽¹¹⁾, participants whose BDE-209 levels in their dust were high, were more than two times as likely to have thyroid cancer as those individuals with low BDE-209 concentrations. Another recent example is a clear link between cleaning at home and at work in relation to lung function decline and development of airways obstruction, including asthma in which both cleaning sprays and other cleaning agents were associated with accelerated lung function decline ⁽¹²⁾.

In her Annual Report of 2017 ⁽¹³⁾, The Health Impacts of All Pollution, Professor Dame Sally Davies, Chief Medical Officer of England, stated: “We must further expand this focus (on air pollution) to indoor air. Work to gather evidence of health impacts, raise awareness of any harm and highlight actions to address this is needed...”. In April 2017, the RCPCH hosted a workshop, “Better homes, better air, better health”, bringing together professionals across research, industry and the third sector ⁽¹⁴⁾.

The workshop highlighted the need to strengthen understanding of the relationship between indoor air pollution exposure and health impacts, identify solutions

to help tackle and reduce indoor-generated air pollution and communicate this information clearly to the public. Because infants and children were a particular concern the RCPCH and RCP were approached to give serious consideration to these issues. As a consequence, the RCPCH/RCP have established a Working Party to investigate Impact of Indoor Air Quality on Children's and Young People's Health across the Life Course. Using an evidence base derived from systematic reviews linking children's adverse health to indoor pollution exposure and linking this to sources and levels of indoor exposures, ventilation and other factors influencing indoor pollutant levels, recommendations will be made along with guidance for stakeholders and the wider public⁽¹⁵⁾. The working group will be inviting calls for evidence later in 2018 which we hope stakeholders will respond to. This is the first time that a serious attempt is being made to identify how indoor pollution is affecting the health of our children and what we can all do about it. ■

Note

The author of this article is Co-Chair of a working party on indoor air pollution which is led by the Royal College of Paediatrics and Child Health in collaboration with the Royal College of Physicians.

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Partnership with patients: The way forward to better and sustainable health services

Astri Arnesen, President of the European Huntington Association argues that building a partnership with patients is the best way forward to promote better and sustainable health services

As the health sector is growing and spending is rocketing, we need to implement both new technology and new knowledge into practice to secure a sustainable health system for the future. As a patient advocate and an Huntington's Disease (HD) family representative for many years, I have experienced a growing interest in the patient perspective from health care providers and authorities. But despite a growing interest and request for our opinion, I don't see patients being really involved in their own treatment. It's still a silent contract between the parties that the doctor or health professional delivers treatment or services to a more or less passive patient.

New knowledge from psychology is emphasising the importance of thoughts, emotions and actions in our wellbeing and health. Nevertheless, health professionals in general, rarely take this knowledge into account by involving the patient actively as a full member of the multidisciplinary team in charge of the treatment. A multidisciplinary team is regarded to be of great importance to treat complex and chronic conditions in order to cover all aspects of the condition or disease. Nevertheless the patient is rarely involved as a team member.

Generally, the patient comes to a consultation and explains how things are going, and the doctor/health professional provides some kind of treatment or tells the patient what to do. This makes the patient a more or less passive receiver of the treatment offered. If we manage to have the patient actively involved in the decision making, I think we could generate higher quality and a much higher compliance to treatment. It's simple common sense: if you have been taking part in making decisions about your own health and you fully understand the rationale behind the treatment, you tend to be loyal and follow up whatever it is you need to do.

As head of the European Huntington Association, I meet a lot of people affected by HD all over Europe. What strikes me is that despite the enormous challenges and burdens, people have a lot of resources and a unique expertise in how life with HD is for them and their family. I am convinced that taking the patients resources and expertise into use in multi-disciplinary teams would improve the patient's condition and increase both quality and efficiency in the offered treatment. I witness far too many being subjected to treatment and interventions they don't really understand and sometimes don't want. The effect is usually negative. This can be avoided by having the patient involved in the decision-making and evaluation of what to treat and how.

Far too often, I hear health professionals talking about how they think people affected by HD should go and do gene-testing or not, should treat involuntary movement or not, and so on. My point is that health services need to be individualised and we need to have the patient actively involved in decision-making, because – what matters to some people, is maybe not important to this actual patient and should, therefore, not be addressed, while other factors cause a great impact and need to be treated. Healthcare is not just about offering a cure, in HD there is still no cure, treatment is about reducing burdensome symptoms and improving the quality of life, whatever that is for each individual patient. ■

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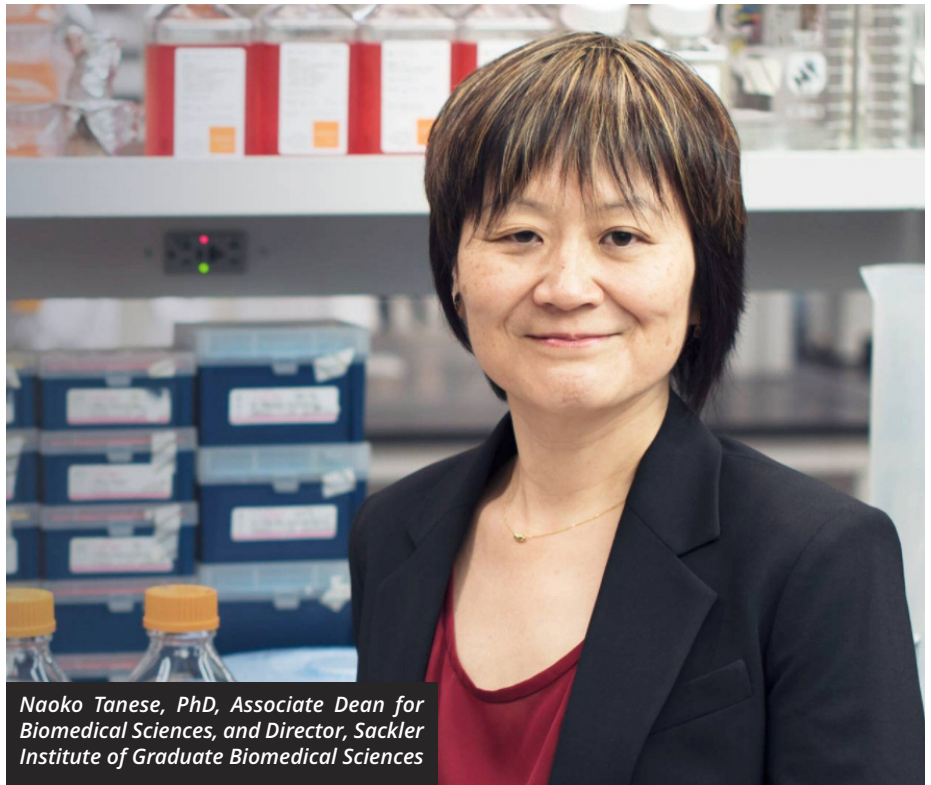
What's in an aggregate? Therapeutic intervention in Huntington's

Naoko Tanese from New York University School of Medicine outlines their work around Huntington's disease (HD) and effective new targets for therapeutic intervention

Huntington's disease (HD) is a rare hereditary neurodegenerative disease that strikes patients in mid-life. American physician George Huntington first described the disease in 1872 after seeing affected residents in East Hampton, New York. Patients generally experience a progressive decline in cognitive, psychiatric, and motor functions. The disease is fatal. In 1993 an international team of scientists discovered the gene that causes the disease. Despite years of intense research, no cures or treatments to delay the onset or prevent the progression of the disease are available.

HD is caused by an inherited dominant mutation in the Huntingtin gene, HTT. This means an offspring of a parent who carries a mutant HTT gene has a 50% chance of inheriting the mutant gene. The mutation results in an increased number of repeats (greater than 40) of the amino acid glutamine in the encoded Huntingtin protein (HTT).

A normal HTT protein has between 7 and 35 glutamines. Increased number of glutamine repeats changes the property of the protein and renders it toxic to cells. The HTT protein is present throughout the body and throughout life. However, mutant HTT is toxic to select cells. Postmortem examination of the brains of affected individuals shows massive cell loss in certain parts of the brain, leaving



Naoko Tanese, PhD, Associate Dean for Biomedical Sciences, and Director, Sackler Institute of Graduate Biomedical Sciences

other cells and tissues intact. This indicates that some neurons are particularly sensitive to the toxic effects of mutant HTT.

The normal HTT protein has been implicated in many cellular functions. However, we have an incomplete understanding of how mutant HTT causes the disease. A better understanding of the functions of the normal and mutant HTT protein is paramount, if effective therapies or cures are to be developed.

Proteins made in cells maintain certain structures dictated by their biochemical and biophysical properties. This is

referred to as protein folding. When proteins misfold, they often lose their normal functions. Cells have developed elaborate mechanisms to remove such aberrant, misfolded proteins. This protects the cells from potential harmful effects of misfolded proteins.

However, misfolded proteins can accumulate over time and form irreversible aggregates that impair cellular homeostasis. These aggregates are a hallmark of many neurodegenerative diseases. They are found in postmortem brain tissues of affected individuals. Age-associated diseases such as Alzheimer's disease, are linked to protein misfolding. HD is

also considered a protein misfolding disease although many other mechanisms are thought to play a role in the disease pathogenesis.

Decades of research have uncovered intriguing properties of different types of protein aggregates, some of which are RNA-protein granules found in normal cells. Each granule appears to have distinct properties and its formation is driven by specific sets of proteins and RNA. Some granules are formed in response to stress. This mechanism serves to halt energy-consuming cellular activities, by sequestering proteins involved in key biochemical processes. Upon removal of the stress, granules disassemble and the released proteins resume their normal functions.

Interestingly, mutant proteins linked to several neurodegenerative diseases have been located within these types of granules. They include mutant RNA binding proteins associated with amyotrophic lateral sclerosis, spinal muscular atrophy, and fragile X syndrome. These RNA binding proteins normally play a role in RNA transport, translation of RNA to make proteins, and formation of RNA-protein complexes.

Mutant RNA binding proteins, however, show altered biophysical properties. They have increased propensity to interact with one another and affect the formation and function of granules. There is increasing evidence that over time mutant RNA binding proteins in these granules steadily accumulate and become converted to irreversible aggregates that are toxic to cells. Neurons are vulnerable to aberrant proteins that accumulate because neurons do not divide. Ultimately the machinery in the cell fails to remove toxic proteins, causing cell death.

Since the functions of normal HTT and the mechanisms by which its mutant counterpart contributes to HD remain unclear, my lab began investigating the role of HTT in RNA metabolism. New imaging techniques have helped us determine the location of the normal HTT protein inside neurons.

Strikingly, we discovered that HTT could be found near neuronal RNA granules. RNA granules are large RNA-protein assemblies responsible for transporting RNA to specific locations in the neuron. To determine whether HTT influences RNA localisation, we reduced the level of normal HTT in neurons grown in a culture dish and examined its effect on transport of RNA. We found that the reduction of HTT in cells disrupts RNA localisation. The result points to HTT contributing to the integrity of RNA granules during RNA transport.

New experiments in HTT

To further investigate cellular processes that HTT is involved in and how they might differ in mutant HTT, we designed experiments to purify normal and mutant HTT proteins from cells and tissues. We next identified proteins that interacted with each form of HTT. By identifying the functions of the proteins that co-purified with HTT, we uncovered new functions for HTT. Analysis of the binding partners of HTT proteins revealed that both normal and mutant HTT interact with proteins involved in RNA metabolism and protein synthesis.

We have thus uncovered new roles for normal and mutant HTT in RNA metabolism. The findings have several implications for the development of HD. We have located mutant HTT in neuronal granules, similar to those associated with aforementioned RNA

binding proteins linked to neurodegenerative diseases. Our results suggest HTT has a role in the formation of RNA-protein granules.

Unlike normal HTT, mutant HTT has a propensity to interact with one another through the increased repeat sequence. At high concentrations, mutant HTT alters biophysical properties of RNA-protein assemblies and shifts the equilibrium in favour of forming aggregates.

Furthermore, a recent study reported stable formation of RNA aggregates containing repeat sequences. Collectively, the findings suggest that mutant HTT together with repeat sequence-containing RNA forms granules that become converted to irreversible toxic aggregates over time. The development of chemical agents that prevent aggregation or disrupt aggregates may serve to reverse the toxicity associated with the mutant protein and RNA. Through understanding of how HTT supports neurons with these functions, we hope to reveal effective new targets for therapeutic intervention.



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People living with atopic eczema

Bernd Arents, Patient Advocate from the European Federation of Allergies and Airways Diseases Patients' Associations (EFA) Dutch Member VMCE, discusses the importance of raising awareness when it comes to people living with atopic eczema (atopic dermatitis)

Why is being aware of people living with eczema so important? I, Bernd Arents (54) have severe atopic eczema and am a patient advocate from the Netherlands.

This year, for the first time, an awareness day for people living with atopic eczema was held on September 14th. It's truly a new chapter for those who have this patchy, itching and difficult-to-live-with chronic skin disease (which is not contagious, just to be clear).

Over one in ten children in industrialised countries get atopic eczema. By the age of 12, three-quarters of them have outgrown it. Yet, some people have eczema in a more severe form, sometimes all over the body which is more difficult to treat. For those – and in the case of children, also their parents and siblings – living with atopic eczema is truly a challenge.

A recent survey on almost 1,200 adults living with severe atopic eczema in nine EU-countries, to which I contributed as a patient advisor, shows that participants found it important that other people are aware of how it is to live with eczema.⁽¹⁾ Having eczema, myself from top-till-toe since I was five, I completely understand. September 14th, 2018 is, therefore, a sympathetic day a year to realise what it is like to live with itchy and disfigured skin.

Atopic eczema patients are masters of disguise

'We', the people with eczema including myself, also need to be honest: we are masters of disguise. Rarely do I encounter in public others who experience eczema the way I have. Why is this the case? They do the same thing as I do: we cover it up. I did that when I was in my teens, wearing long-sleeved shirts and full-length trousers to school and I still do that today.

So, how could the general public notice you live with eczema? They can't.

The point of hiding eczema is that no-one wants to be different; we all want to fit in. People with eczema want to stand out for their positive features, not to be noticed for just the flaws of their skin. And there are downsides to showing your eczema in public. Either people ask, 'what is the matter with your skin?' as if you need to explain yourself; or you receive unsolicited advice: 'Is that eczema? Well, have you tried this and that, because...' and so on. I do not know which one is most bothersome, but you surely want to avoid both.

"A recent survey on almost 1,200 adults living with severe atopic eczema in nine EU-countries, to which I contributed as a patient advisor, shows that participants found it important that other people are aware of how it is to live with eczema."

Patients hide the deep extent atopic eczema has

There are some people who are surely aware of our eczema because they know us well: our loved ones, friends, roommates and colleagues. Since eczema usually starts in early childhood, family and childhood friends were already aware of it. During adulthood, at some point, we had to 'disclose' it to others because you cannot keep hiding it.

Those people who are close to us surely look beyond our eczema, as for them it is just another part of who we are. But, we also have to be honest that we do not show them how it is to live with eczema, truly. Or at least not all the time. We don't want to be a burden, now do we? This implies that even those who are closest to us eventually become 'aware, yet unaware'. That makes life easier, yet it also can make us feel alone.



Bernd Arents (54) has severe atopic eczema and is a patient advocate from the Netherlands

Even doctors might be 'aware, yet unaware', as they see people with eczema all the time. Depending on the setting, the severity of eczema can be judged differently: what is considered very severe for a general practitioner might be moderate for a dermatologist who has seen worse. But the key question is: are they aware of how it impacts the lives of their patients? In my experience: not always. And are the treatments working well enough? Not always.

The extent of the emotional impact of having eczema is crystal clear from our survey. Here are just a couple of the 28 statements and what those 1,200 people with more severe eczema felt at the time of taking the survey:

- **72%** envied people with normal skin;
- **50%** felt sad about having eczema;
- **43%** were angry about having eczema;
- **40%** felt embarrassed about their skin;
- **39%** felt guilty about scratching;
- **39%** struggled with their appearance and;
- **34%** tried to avoid physical contact.

One of the most distressing findings of the study is that 88% of the people who at the time of the survey experienced severe eczema symptoms, stated that their eczema at least partly compromised their ability to face life.

The European Atopic Eczema Awareness Day: September 14th

This quality of life study shows that adults with a more severe form of eczema are suffering from the condition and this is more than anybody can bear. Fortunately, the people close to us know that, at least when we let them know. But the general public, health care professionals, policymakers and health insurers should be made more aware of this suffering. There should be more efforts to develop effective treatments and access to better and affordable health care should be available to us all, to relieve the physical, psychological and emotional burden of eczema.

That's why the European Eczema Awareness Day is not just a sympathetic gesture, as I suggested at the beginning of this article, but of great importance, even if it is for just one day. ■

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ECZEMA
Atopical Lives

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Rebuilding tissues inside the human body

The creation of living tissues to replace or repair damaged tissues or organs in the human body has defied clinicians and researchers for centuries. Yet, only by the end of the last century, scientific progress and systematic approaches to grow or culture new tissues outside the human body led to the first market approvals of living tissue-engineered implants.

In its most fundamental paradigm tissue engineering entails the seeding of living cells, harvested from a donor, onto a pre-shaped biodegradable support material, or scaffold, of synthetic or natural origin. This cell-scaffold construct is generally cultured in a so-called bioreactor under conditions that favor cell expansion, tissue growth and tissue function. When the tissue has reached targeted functional properties, it can be implanted (Fig. 1A). Key to the success of this approach is the synthesis of substantial new tissue by the cells to take over the function of the degrading scaffold.

Compared to other approaches for tissue regeneration, like stem cell therapies, *in vitro* tissue engineering emerged as a promising therapy to replace tissues with a predominantly mechanical function that should withstand high dynamic loads immediately upon implantation. As such, research in our group concentrated on the creation of structurally organized load-bearing tissues for the cardio-

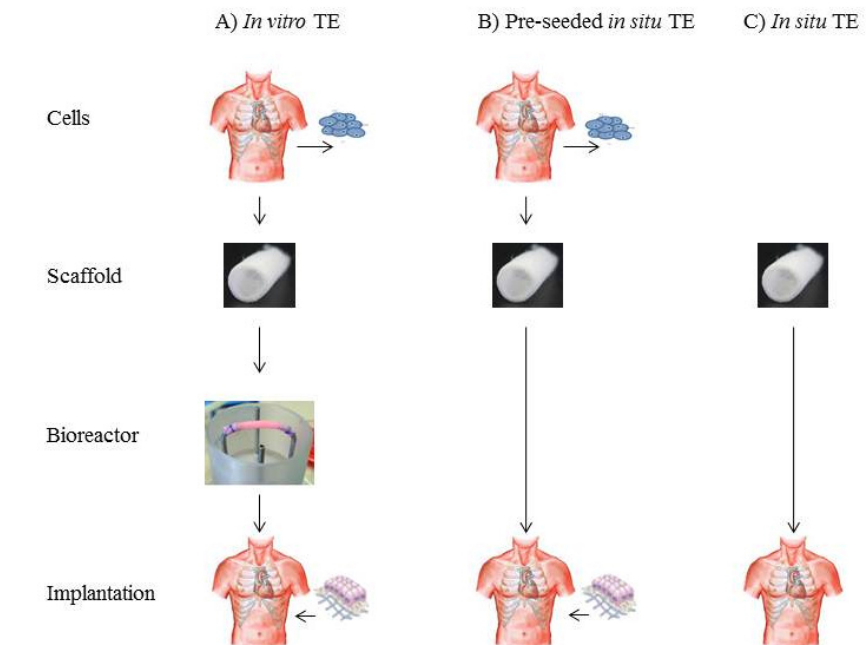


Fig 1. Paradigms of tissue engineering: A: *in vitro* tissue engineering (TE), where cells are harvested from a donor and seeded and cultured on temporary scaffolds inside a bioreactor. B and C: *In situ* tissue engineering, where tissues are created inside the human body at the site of destination using slow-degrading scaffolds. The example shown here aims at the creation of blood vessels from scaffolds that are either pre-seeded with cells harvested on the fly during the surgical procedure (B) or implanted as pristine materials (C).

vascular system: functional blood vessels, load-bearing heart valves, and supportive cardiac muscle tissues.

Heart valves

A prominent example is the heart valve. Heart valves control unidirectional flow through the heart and their damage or malfunction often leads to serious medical conditions. End-stage heart valve disease is commonly treated by replacement of the valve with a mechanical or bioprosthetic device. While these prostheses generally improve survival and quality of life, they have technical drawbacks that limit their long-term efficacy. These include thrombo-embolic complications requiring lifelong anticoagulation therapy in case of mechanical

valves, and limited durability due to calcification and structural failure in case of bioprostheses. Most importantly, prosthetic valves, including donor valves, are non-living structures that do not grow, repair or adapt. As a consequence, the life expectancy of patients after heart valve replacement is substantially lower than that of age-matched healthy individuals. The creation of a living, tissue engineered heart valve could circumvent many prostheses-related complications and would be particularly beneficial to paediatric patients.

By merging insights from engineering, life sciences and medicine, our group, in collaboration with partners from the University of Zurich, was the first

Fig 2. A tissue engineered heart valve

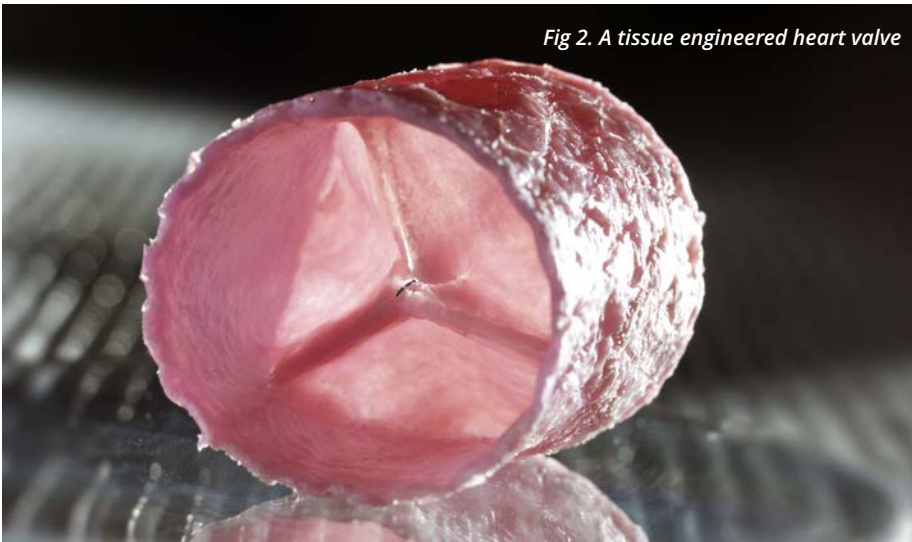


Image: © Bart van Overbeeke

to develop a living tissue engineered heart valve that could withstand systemic loading and hence could function as an aortic heart valve¹ (Fig. 2). Translation of this technology to the clinic, however, was hampered by sub-optimal long-term in-vivo performance of these valves and valves from other labs – the biggest issue being valve leaflet retraction and consequent valvular leakage due to traction of the used cells. In addition, clinical introduction is hindered by the costly and laborious cell and tissue culture, associated high risks of infection, and the complex logistics and regulation of applying a living medical product.

***In situ* tissue engineering**

Recently, *in situ* tissue engineering was proposed as a route to create living heart valves inside the body (Fig. 1 B, C). In this innovative approach costly and complex tissue culture is omitted and the body itself is used as bioreactor. Cell-free valvular shaped scaffolds are implanted at the site of destination where they gradually transform into living heart valves by recruiting cells from the bloodstream. Both synthetic and biological scaffolds can be used, provided that they can function as a load-bearing heart valve upon implantation and adequately guide and control neo-tissue formation.

Contrary to *in vitro* tissue engineering, the technology is compatible with current regulation for medical devices and offers off-the-shelf availability at substantially reduced costs.

Collaboration

While this technology would constitute a simple and clinically attractive procedure, starting with the implantation of a non-living device, it requires the design of slow-degrading scaffolds that provide meticulous control over (selective) cell recruitment, cell fate, and load-bearing tissue formation. We propose the use of supramolecular polymers that can be fine-tuned with respect to degradation and mechanical properties, and functionalized with bioactive moieties to communicate with host cells in the course of tissue development^{2,3}. It is hypothesized that neo-tissue formation follows the pathways of wound healing and to align this process interaction with inflammatory and immune cells, as well as balanced tissue formation in pace with scaffold degradation in the beating heart, is critical. To achieve the essential deep understanding of these interactions, multidisciplinary consortia of material scientists, engineers, clinicians and biologists have been established. Within larger (inter)national frameworks they

collaborate with industrial partners and patient organizations to translate the technology to the clinic⁴⁻⁷.

Outlook

In situ tissue engineering holds great promise for the regeneration of damaged tissues and is foreseen to be valid for a broad range of applications. It provides the opportunity to create living tissue replacements that improve quality of life of many patients and that can outrange existing replacement therapies in terms of effectiveness, durability, availability, and costs. When successful, its simplicity and compliance with current regulatory protocols may favor a relatively smooth route to clinic.

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Aplastic anaemia and other rare bone marrow failures

Grazina Berry from Aplastic Anaemia Trust argues that young patients diagnosed with aplastic anaemia (AA) and other rare bone marrow failures need more help and support

Life with a rare illness is tough. It is even harder when you're a child, an adolescent or a young person trying to get to grips with growing up and finding your place in the world. A rare illness like aplastic anaemia (AA) turns people's lives upside down.

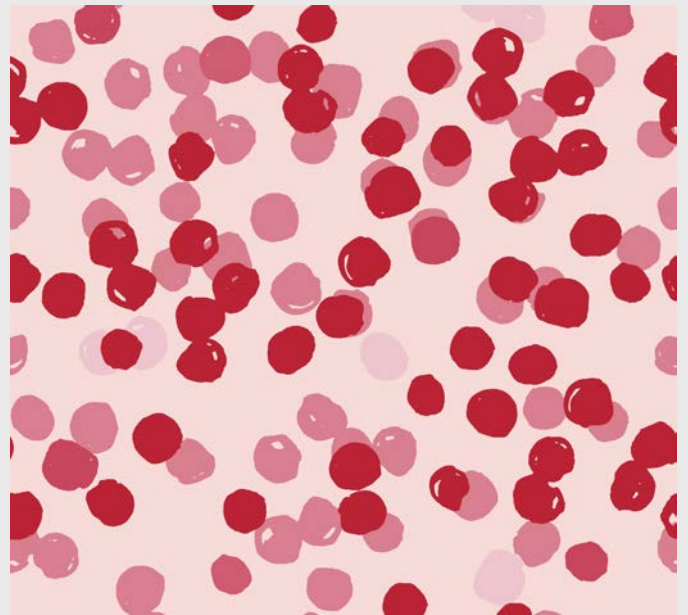
"I felt we were entering unknown territory and all the doctors kept telling me was that it was something they had never seen in their whole career." (Mum of a 14-year old aplastic anaemia patient).

It is an ultra-rare illness of the immune system, whereby the bone marrow fails, wiping out stem cells, thus halting the production of vital red, white blood cells and platelets. This affects people's ability to function – they may bleed simultaneously, bruise, attract life-threatening infections and be haunted by extreme fatigue. Treatment will be prolonged, costly and with severe side effects in a lot of patients. The only curative treatment currently is a stem cell transplant; however, this will not be a suitable treatment option for a large proportion of patients.

"The Aplastic Anaemia Trust is passionate about addressing this inequality across all local communities, in which the young patients live and is working hard, alongside patients and their families, to secure the necessary funds."

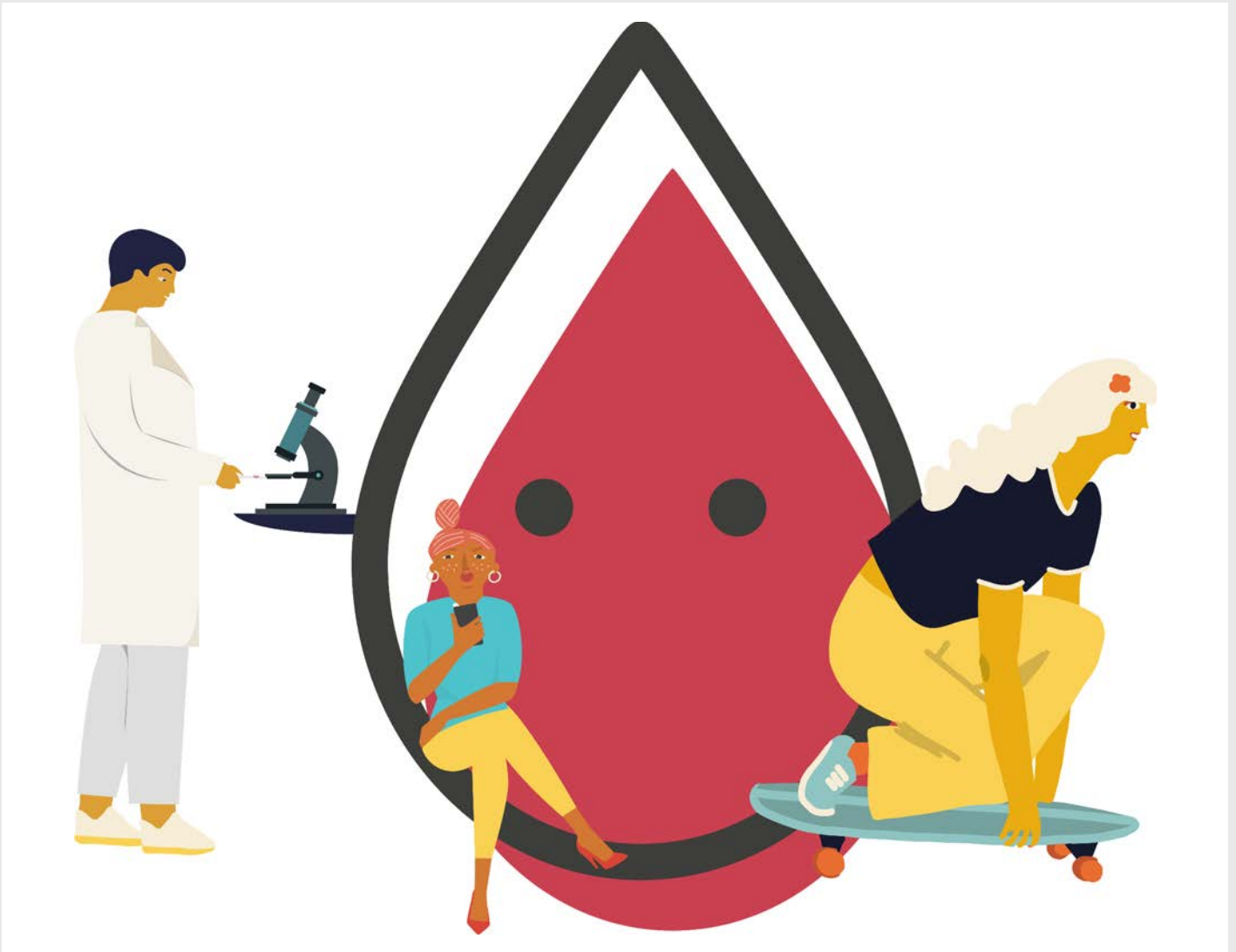
Aplastic anaemia will affect around 100-150 people annually in England, making it an extremely rare disease. It can affect anyone of any age and gender, but it peaks in the most vulnerable – 0-22-year-olds and the elderly (60+).

It is estimated that inherited and acquired rare bone marrow failures will affect between 30-50 children and young people across England every year. Treatment is



closely similar to that of patients suffering from cancer. Once a diagnosis is established (and even this can take a long time) treatment is lengthy, costly, extremely isolating and entails multiple blood transfusions, chemotherapy in preparation for a bone marrow transplant if a direct match bone marrow donor is found. Patients and their families may need to travel frequently and great distances to access specialist treatment that is often not available locally due to the nature of the rare disease. The level, quality and access to co-ordinated support currently available to a young cancer patient is not available to a child suffering from aplastic anaemia. Yet the effects of the disease can be equally devastating.

The impact on young patients' mental health is also significant. The lack of available support and information can lead to anxiety, in some cases, post-traumatic stress disorder, undue worry and concern, feelings of exclusion and can add to the already significant emotional trauma experienced by everyone affected. Young



patients, whilst undergoing intensive treatment, will miss school, sometimes for an entire year. This can have an additional traumatic effect of missing out in forming those key relationships and friendships in the formative years.

“Aplastic anaemia (AA) will affect around 100-150 people annually in England, making it an extremely rare disease. It can affect anyone of any age and gender, but it peaks in the most vulnerable – 0-22-year-olds and the elderly (60+).”

The Aplastic Anaemia Trust is passionate about addressing this inequality across all local communities, in which the young patients live and is working hard, alongside patients and their families, to secure the necessary funds.

This is an area of support where there’s no government funding available and the not-for-profit sector and charities like ours exist to plug the gap.

Encouragingly, The UK Strategy for Rare Diseases published in 2013 now has an implementation plan for England, published in February 2018. Let’s hope all commitments outlined across five areas of empowering those affected by rare diseases, identifying and preventing rare diseases, diagnosis and early intervention, coordination of care and the role of research are met. ■

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Neocytolysis: When young red blood cells die first

International researchers are investigating the molecular processes involved in premature clearance from the circulation of young blood cells formed at high altitude after a descent

Two million red blood cells are removed from the circulation each second in each healthy human living at sea level. These millions of cells are replaced by the same amount of newly formed cells that leave the bone marrow as reticulocytes, which share the features of precursor cells and mature red blood cells and are vulnerable and unstable. It takes several days for reticulocytes to undergo transformations and become mature red blood cells, stable and ready to function as gas carriers for the following 100 days.

Spending days to weeks at high altitude, we initiate an adaptation sequence to help cope with low ambient oxygen levels. Urgent stimulation of production of more oxygen-carrying red blood cells is a part of this adaptation. These cells provide oxygen supply of our tissue – the more cells, the better oxygen delivery.

However, expansion of red blood cell mass is associated with the rise in blood viscosity and higher mechanical load for the heart and blood vessels. Compromised blood perfusion of extremities is a cause of freezing of fingers and toes in mountaineers.

As soon as we descend back to the sea level, the number of red blood cells in our blood sinks back to the normal level due to the selective destruction of young cells that were produced at high altitude.

Today we understand the mechanisms triggering stimulation of red blood cell production in response to low oxygen levels fairly well. They include the production of a hormone, erythropoietin (Epo), by our kidneys and its release into the bloodstream.

As soon as Epo reaches stem cells in our bone marrow, it binds to the receptors at their membrane and signals them to start dividing and to choose to become red blood cells. As a result, the number of newly formed cells (neocytes) released into the circulation may grow up to 10-fold, giving rise to more circulating red blood cells that transport more oxygen from the lungs to all the organs in our body.

Dissection of this signalling mechanism helped us to harness it, produce recombinant erythropoietin and help people that cannot produce this hormone. Athletes also made illegal use of this knowledge, applying Epo to improve performance.

The molecular processes involved in premature clearance from the circulation of neocytes formed at high altitude after descent remains much less clear.

Currently, standing hypotheses suggest that the cells formed at high altitude stem from precursors that are immature and overexposed to high levels of erythropoietin in the bone marrow, making them expose signals that render them more attractive to

the macrophages and experiencing oxidative stress. These two factors make these prematurely released young cells more susceptible to fast clearance, whereas more stable mature cells survive the stress.

In order to discriminate between red blood cells produced at sea level and at the high altitude, they should be labelled and then the fate of labelled cells may be followed over time to monitor their longevity.

The labelling procedure involves using stable isotopes of carbon, or nitrogen, that incorporate into hemoglobin. Cells carrying labelled hemoglobin may be detected and their elimination monitored.

Discovering the age of a tree involves counting the growth-rings. Similar to that, the age of red blood cells may be estimated by the gradual transformation of one of the membrane proteins, historically known as protein 4.1, from native to a deamidated state, making this protein a “molecular-clock” intrinsic in all circulating red blood cells.

This “clock” may be used to assess selective removal of young cells providing direct evidence for the existence of neocytolysis.

In order to dissect the molecular mechanisms of neocytolysis, the causes of selective clearance of cells produced at high altitude have to be revealed.

Tagging young cells for premature removal implies that the cells are getting unstable, possess some 'eat me' signals, or have lost some 'don't eat me' signals. These tags are usually recognised by the macrophages that take care of damaged old cells, engulfing them and preventing the spill of free hemoglobin into plasma.

In patients suffering from pathological uncontrolled over-production of red blood cells (polycythemia), a compensatory increase in turnover rate was observed and the circulating red blood cells shared the properties common for young and old cells.

Red blood cells of polycythemic individuals are more flexible, less dense and their band 4.1 protein is less deamidated than that in a healthy test subject: a feature characteristic of young cells. At the same time, these cells are more oxidized, and oxidation is one of the key factors making red blood cells attractive for macrophages.

A decrease in oxygen levels in the atmosphere (eg at high altitude) was suggested as a cause for the weakening of antioxidative defence in stem cells giving rise to red blood cells. However, this hypothesis has never been tested for human cells. To do so, stem cells circulating in peripheral blood have to be collected before, during and after the stay of test subjects at high altitude. These cells will be then placed into the liquids resembling plasma in composition, but additionally supplemented with growth factors and hormones supporting their transformation into young red blood cells. This procedure is established in a number of research labs and is now being scaled up to produce red blood cells of rare blood groups for transfusion.

Properties of stem cells at different stages of transformation of red blood cells should be compared for these three batches of cells obtained from the same individual exposed to the changing environmental conditions. Parameters of importance will indicate any delay in maturation, impaired function of antioxidative defence proteins, membrane stability and ability to resist mechanical shear and maintain intracellular ion and water homeostasis.

This exciting programme will be fulfilled by an international research team headed by Prof. Heimo Mairbäurl (University of Heidelberg) and partners from Saarland University (both Germany), University of Zürich (Switzerland) and the University of Pavia (Italy) within a joint project funded by the German Research Foundation (DFG) and the Swiss National Science Foundation (SNSF) during the coming year.

The project will also become a training platform for the early stage researchers of the RELEVANCE Innovative Training Network consortium.

Healthy young volunteers will receive a label tagging red blood cells that were produced at sea level four months prior to the ascent to 3,450 m. One more red blood cell labelling round will be performed in one week after ascent to the Jungfraujoeh research station in Switzerland, where the study participants will stay for three weeks in total.

Monitoring the disappearance of the labelled cells, along with detection of deamination state of protein 4.1, will provide information on the premature removal of neocytes. Collection of blood samples at sea level before the

ascent and after the descent and at high altitude will provide red blood cells and stem cells for investigation of the impact of hypobaric hypoxia on erythropoiesis.

Why is understanding of the underlying principles of neocytolysis so important? Similar mechanisms are most likely implicated in the development of anaemia in patients on chronic erythropoietin treatment, as well as in the course of space flights.

*RELEVANCE ITN consortium receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 675115 — RELEVANCE — H2020-MSCA-ITN-2015/H2020-MSCA-ITN-2015. <http://relevance.arivis.com/>

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Modernising and simplifying EU food safety policy

The work of European Commissioner for Health & Food Safety Vytenis Andriukaitis around modernising and simplifying EU food safety policy is investigated here by Open Access Government

As the European Commissioner for Health & Food Safety Vytenis Andriukaitis, one of the important areas he is responsible for concerns modernising and simplifying European Union (EU) food safety policy. At the same time, he is mindful of keeping the present high level of safety in this area and making sure that existing policies have nothing but the maximum impact.

In a speech he delivered on 20th June at Agricultural and Rural Development Committee Annual Dialogue in Brussels, the Commissioner comments that the EU has stringent, effective food safety and animal and plant health legislation in place. While this system is regularly tested by animal diseases and plant pests, he argues that the EU's response should be rapid, coordinated and strategic.

One of the many points Commissioner Andriukaitis addresses in this speech concerns the EU food safety system, which underpinned by a comprehensive body of food law, is by no means flawless. As such, the European Commission is not resting on their laurels, indeed they are seeking to perfect such a process. The Commissioner develops this notion by outlining concrete action that has taken place to improve food safety legislation, as he explains in his own words.

“In April, the Commission adopted its proposal on the transparency and sustainability of the EU risk assessment in the food chain with this goal in mind.

“The proposal is not an overhaul of the EU's risk assessment system, but rather a targeted revision of the General Food Law and some sectoral legislation –

to improve the transparency and sustainability of the process.”

The Commissioner underlines that he has presented a proposal to the EU Member States in the context of the AGRIFISH Council and to the ENVI Committee of the European Parliament earlier this year. The Commissioner stresses that a series of public consultations will follow but he explains that the proposal is based on four main pillars, which he details. Firstly, it would increase transparency, as we have already discussed in this article. Secondly, it will increase the reliability and the quality of scientific studies used in risk assessment, he explains.

“Thirdly, the proposal aims to increase Member State involvement in EFSA’s governance structure and Scientific Panels, without impeding EFSA’s independence. This will strengthen the long-term scientific capacity of EFSA.

“Finally, it would strengthen risk communication between the Commission, EFSA, the Member States, stakeholders and the public.

We aim to have the proposal adopted through the legislative procedure by spring 2019. The support of the European Parliament and of this Committee is crucial if we are to reach this target.”⁽¹⁾

On the subject of food safety, it is worth highlighting more of the Commissioner’s thoughts on this vital area of policy. Let me take you to his Presentation of the Commission proposal on “General Food Law” to the PEST Committee, at European Parliament, Brussels on 19th June this year. Here, he stresses that it is right and proper that European citizens should expect safe food but adds that they are also concerned with the sustainability of the food system, environmental protection and how their food is produced.

“The governance of our food safety system is also becoming more open and inclusive, with a call for greater transparency in risk analysis as well as greater engagement of citizens in the decision-making process, facilitated by digital innovation and social media.

“Let me stress one point – this Committee and I share the same goal – to maintain food safety, protect citizens’ and animals’ health, and safeguard the environment.”

The “Fitness Check” of the General Food Law and the recent European Citizens Initiative on glyphosate both called for more transparency when it comes to the reinforcement of the system’s sustainability and the EU risk assessments in the food chain. On the revision of the Regulation on General Food Law, in summary, this seeks to:

- Increase transparency of the risk assessment so that scientists and citizens have access to key information at an early stage, except where confidential matters are concerned;
- Ensure specific measures to improve the quality and reliability of the scientific studies;
- Strengthen the involvement of EU Member States, EP and NGOs in EFSA’s governance structure, without impeding the independence of the EFSA and;
- Make risk communication between the European Commission, EFSA, the Member States, stakeholders and the public stronger.

Commissioner Andriukaitis concludes that this proposal will result in significant benefits and will improve European citizens’ trust and confidence in the legislative process. He calls for support around this initiative so that the legislative process can be completed within the current legislative term.⁽²⁾ ■

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Regenerative medicine to trump cancer

A group of academic experts from the U.S. and the UK share their views on effective regenerative medicine-based strategies against cancer

Among vertebrates, adult urodele amphibians retain the capability to regenerate complex structures such as limbs, tail, jaws, eyes and a variety of internal organs following an insult¹. Similarly, but with a more limited potential, reptiles possess the capability to regrow a fraction of their tail dropped as a self-defence mechanism to elude a predator's grasp. The strategies used by these highly regenerative organisms to restore organ function typically involve the crucial role of connective tissue-associated fibroblasts that undergo de-differentiation².

The undifferentiated phenotype acquired by resident fibroblasts is the source of a complex embryonic structure called blastema, where the correct pattern for tissue growth is ensured by the positional identity of every single cell and by the continuous interplay between neighbouring cells³. This means that a precise recapitulation of specific embryonic developmental steps is required for successful tissue regeneration. Pro- and anti-inflammatory signals are timely induced following an insult, for instance, axolotl limb amputation and sustained throughout the process of regeneration, due to the transient presence of macrophages⁴.

This precise process is perpetuated until tissue restoration is completed and most interestingly, without incurring abnormalities or genetic aberrations. Rather, it has been observed that

such a regeneration-permissive environment can reverse tumorigenicity by reprogramming tumour cells⁵. As an example, the administration of chemical carcinogens induces cancer in regeneration-incompetent tissues (i.e. the newt dorsal iris), but not in those capable of regeneration (i.e. the newt ventral iris)⁶. Specifically, despite a low frequency, malignant transformations can be observed together with the formation of invasive epithelial tumours, this phenomenon is generally followed by spontaneous remission as tumour cells are induced to reorganise into non-cancerous tissues⁷.

We thus hypothesise that the adult mammal's susceptibility to cancer development has been determined by the loss of an advanced regenerative capability during the course of evolution, with the consequent lack of an associated control system. A better understanding of this evolutionary process can help conceive effective regenerative medicine-based strategies against cancer.

In adult mammals, only a rudimentary regenerative potential is evident in the form of quiescent cells, known as endogenous stem cells, because this feature is not sufficient to spontaneously regenerate a whole functional organ following an injury. On the other hand, we think that mammalian embryos keep the memory of the ancestors, as the controlled series of processes that resemble blastema

formation described in amphibians are identified during embryonic tissue development as well. To state some common characteristics, embryos harbour an enormous number of undifferentiated cells, with a great proliferation rate, specific differentiative potential and a proper identity leading to morphogenesis (see Figure 1)⁸.

Similar to the blastemal environment of urodeles, the mammalian embryonic environment critically supports normal tissue development and precludes malignant transformations. In fact, besides the more efficient and frequent DNA repair mechanisms active in embryonic cells, other processes including apoptosis and senescence have also been reported as recurrent tumour suppressive systems acting to functionally remove cells at a risk of aberrant growth during embryogenesis⁹.

The above mentioned transient mechanisms, with characteristics that disappear at birth, have also been associated with the recruitment of macrophages for the clearance of suppressed cells¹⁰. The latter aspect is of particular interest because the presence of such inflammatory cells to the site of action is essential for the final outcome, whether during tissue regeneration, cancer progression, or morphogenesis.

Like a wound that never heals, neoplastic transformation has been associated with persistent inflammation and abnormal macrophage differentiation¹¹. The reactive species produced by these cells (i.e. reactive oxygen and nitrogen species) have been directly linked to an altered DNA repair, apoptosis and/or cell cycle checkpoint control¹². As a consequence of an impaired wound healing process, chronic inflammation leads to fibrotic scar formation,

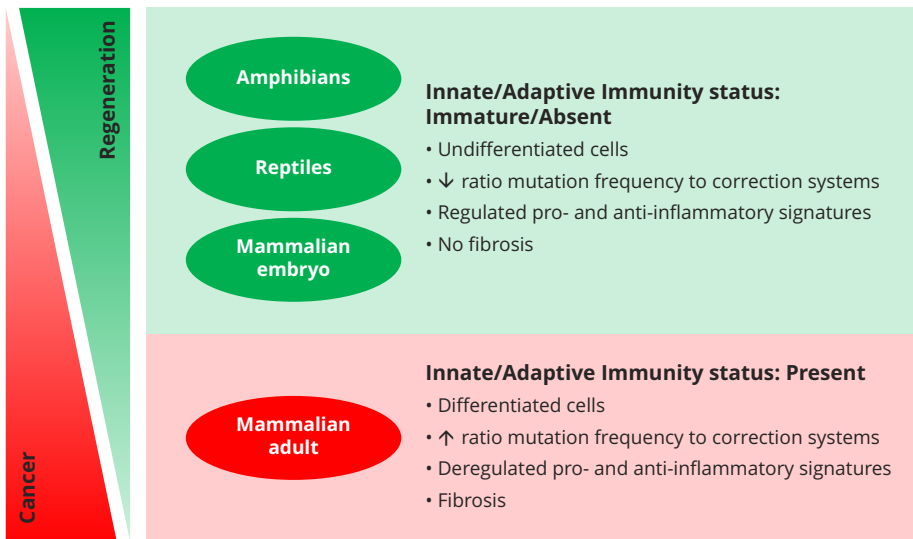


Figure 1: An overview of inter- and intra-specific differences pertinent to tissue regeneration and cancer among regenerative organisms, mammalian embryos and adult tissues. Correction systems include DNA repair, apoptotic processes and senescence.

whose role in tumorigenesis is still under debate. Some researchers consider fibrosis responsible for disruption of the anatomical polarity of a regenerating tissue and consequently for tumorigenesis following an injury, while others contemplate it as an alternative to cancer, thus protecting undifferentiated cells from uncontrolled proliferation that could represent a danger in case of chronic inflammation.

Based on these pieces of evidence, several approaches have been developed in the field of tissue engineering, which aim to reduce inflammation while avoiding scar formation and consequently to improve regeneration¹³⁻¹⁵. Our group recently demonstrated that the implantation of a finely functionalised collagen-based immunomodulatory material was capable of recruiting and modulating macrophage phenotype towards an anti-inflammatory status, therefore, recreating in mammals the pro-regenerative environment described in highly regenerative organisms¹⁶.

On the other hand, conventional tumour-associated macrophages displaying an anti-inflammatory phenotype are potent suppressors of anti-tumour immunity, whereas appro-

priately activated macrophages have been reported to lead to cancer-related inflammation and kill tumour cells¹⁷.

It becomes clear that within their dual role and multiple functions, macrophages hide the secret behind the uncontrolled tumorigenic condition frequently reported in adult mammals, as well as in the controlled cascade of events leading to embryogenesis. Surprisingly, embryos and highly regenerative organisms lack an established innate and adaptive immunity that is rather observed in animals with a more limited regenerative potential, including mammals, birds and reptiles¹⁸. The regenerating limb of newts suggests that similar to the role they play in embryogenesis and contrarily in tumorigenesis: macrophages are mainly required to mediate immunosurveillance and the clearance of senescent cells generated during blastema formation¹⁹ and to prevent the lysis of dedifferentiating cells induced by NK cells²⁰.

In a nutshell, embryonal macrophages know how to create and support the microenvironment needed to guarantee tissue homeostasis and morphogenesis, while keeping it onco-suppressive. Understanding the inter-

actions occurring at a microscopic level in the blastemal and embryonic tissues and keeping in mind the phylogenetically conserved properties between amphibians and mammals, we will be able to develop effective regenerative medicine-based strategies to fight cancer.

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Working together to treat and prevent Alzheimer's disease and related dementias

Dr Richard Hodes, Director of the National Institute on Aging within the U.S. National Institutes of Health, explores the importance of working together to treat and prevent Alzheimer's disease and related dementias

For some time, scientists have understood that Alzheimer's disease develops by way of a complex cascade of events taking place over time inside the brain. These events, influenced by both genetic and non-genetic factors, contribute to changes in the brain that disrupt functioning and are at the centre of the notorious devastation caused by this mind-robbing disease.

Driven by the growing ageing population at risk for Alzheimer's and related dementias (including Lewy body dementia and frontotemporal dementia) and the staggering costs they impose on individuals, families and society, the sense of urgency to develop an effective treatment has never been greater. Estimates indicate that some 46.8 million people age 60 and

older lived with dementia worldwide in 2015, a number expected to grow to 74.7 million people in 2030 and to 131.5 million in 2050 (Prince et al., 2013).

The National Institute on Aging (NIA) at the National Institutes of Health (NIH), which leads the U.S. biomedical research effort on Alzheimer's and related dementias, is spearheading an ambitious research agenda to better understand, diagnose, prevent and treat these diseases, with a goal of finding effective treatments by 2025. Thanks to extraordinary boosts in Congressional appropriations for Federal research in recent years, we can now pursue the answers to many fundamental questions – as well as test some of these hypotheses in translational and clinical studies – that we couldn't address in the not-too-distant past.

We are now better positioned to squarely focus our attention on the heterogeneity of disease – how dementia manifests differently among individuals and across groups – and to set our sights on a precision medicine approach, targeting disease-relevant processes and delivering the right treatments at the right stage of the disease for each person affected. While, ultimately, we want to prevent or slow Alzheimer’s disease and related dementias, we are working towards serving the needs of all patients at all stages of the disease.

NIH funding has been applied to [a broad multidisciplinary programme](#) where research moves through a pipeline from studies of basic mechanisms to an application in clinical trials and studies. Our efforts are broad and far-reaching, directed to:

- Enabling precision medicine research through advances in genomic sciences and deep molecular phenotyping of existing cohorts and the launch of new diverse cohorts;
- Using an open science research model of the [Accelerating Medicines Partnership for Alzheimer’s Disease](#) to hasten the discovery of the next generation of therapeutic targets and biomarkers;
- Creating new translational infrastructure programmes to enable rapid sharing of data and research models and enhance research rigour and reproducibility;
- Developing emerging therapeutics in academic centres and in the small business community; and
- Making advances in disease monitoring, assessment and care, powered by the revolution in mobile technology, which are helping us bring in people living with AD/ADRD and their caregivers, as direct partners in research.

Several efforts focus on “open science,” a participatory approach to research in which progress is accelerated by making research data, methods and tools available to all qualified investigators. NIH has been taking a leadership role in promoting the broad availability of research data for quite some time. With the rise of big

data and new analytical approaches that can help us to better understand human wellness and disease in a person-specific manner, this focus is vital to our progress.

Reflecting from the halfway mark to the 2025 national goal, we recognise more clearly than ever that Alzheimer’s disease and related dementias are complex and challenging foes. Yet our scientific capabilities and momentum are growing rapidly. We are closing in on the research advances that may ultimately contribute to an end to a public health crisis that has penetrated the United States and the world in a way that few other conditions have.

“The National Institute on Aging (NIA) at the National Institutes of Health (NIH), which leads the U.S. biomedical research effort on Alzheimer’s and related dementias, is spearheading an ambitious research agenda to better understand, diagnose, prevent and treat these diseases, with a goal of finding effective treatments by 2025.”

We also need public support – none of these efforts will be successful unless we engage the public and secure the commitment of people from all walks of life to [participate in clinical research](#).

NIA is uniquely positioned to keep the momentum in discovery going and to push forward not only an agenda but concrete, specific guidance and efforts to turn the tide for the better for millions of affected people – and their families, friends and communities – who need solutions. ■

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A balanced approach to the global challenge of dementia

Dr Yves Joanette, Scientific Director at the CIHR Institute of Aging argues for a balanced approach when it comes to their collaboration-based approach to face the challenge of dementia

Thanks to advances in health care and public health programmes throughout the life trajectory, the world's population are getting older as both the number of older individuals and life expectancy itself are increasing.

Canada follows this trend, as it will reach in some decades the club of super-aged countries, led by Japan, where more than 30% of the population is age 60 or more.

One of the most impacting health challenges in older age – and the incidence increases dramatically as one gets older – is dementia. This condition is the expression of numerous neurodegenerative diseases that are typical of ageing, with the most common being Alzheimer's disease.

Dementia is characterised by a slow and progressive impairment of memory and other cognitive functions, as well as changes in personality and mood. While the disease process is extremely complex and intermingled, it is known that some of the underlying mechanisms causing dementia began over 25 years before the first clinical signs appear.

More than 400,000 Canadians age 65 or older are among the 50 million people estimated to be living with dementia worldwide. The number affected by dementia are at least double when the impact on caregivers is considered.

The challenge is particularly acute for women. Two-thirds of people living with dementia are women. Women are often the primary caregiver for family members with

dementia. In addition, some women must cope with caring for a parent or partner and caring for children at the same time.

Because of the complexity of the challenge and because answers are needed both for those living with dementia and for those who would not want to live with dementia in their future, CIHR has adopted a balanced approach under its Dementia Research Strategy (DRS). The Strategy takes advantage of Canada's existing strengths in the neurosciences, clinical research and the social sciences, while establishing a platform for coordinating research activities and facilitating international collaboration.

The Canadian Consortium on Neurodegeneration in Aging (CCNA) is the flagship initiative of the DRS in Canada. The CCNA supports the collaboration of leading researchers from universities and research centres across the country. It is funded through a partnership between CIHR and a group of charities, industry partners, provincial research funding agencies and philanthropic organisations.

The CCNA addresses the challenge of dementia in a balanced way by focusing on preventing, treatment and quality of life issues.

Since it was launched in 2014, the CCNA has made significant progress. They have assembled teams to focus work on the themes and specific topics. They established the infrastructure to standardise and share data and results. Their work has so far resulted in 100 health oriented peer-reviewed publications. Most importantly, they have established new inter-disciplinary and inter-sectorial research collaboration which takes advantage of the Canadian strengths across universities and provinces.

To tackle the complexity of the diseases causing dementia, CCNA has created a unique clinical research platform involving more than 1,600 Canadians with dementia, mild cognitive impairment and self-report memory problems. The data collected from participants will help identify the mechanisms underlying the development and progression of dementia.

Notably, the CCNA is the only national dementia research platform in the world that includes a cross-cutting sex and gender component, allowing for comparisons of

women and men and male and female animal models. This focus will help researchers better understand the sex and gender differences in dementia.

The CCNA is also the main Canadian hub for international collaborative efforts as the global challenge of dementia requires a global answer.

Most recently, the Canadian Academy of Health Sciences asked the CCNA to draft a consensus statement on dementia. The draft statement was the basis for a global statement released by the InterAcademy Partnership (IAP), which includes a World-Academy supported call to action that aims to develop an evidence-based and public health-oriented approach to tackling the challenge of dementia. The IAP joins other global bodies, including the World Health Organization and the World Dementia Council, which are urging coordinated global action on dementia.

Under the DRS, CIHR is contributing to the global efforts and supporting the participation of Canadian researchers in international research programmes. For example, Canada was the first non-European Union member of the Joint Programme for Neurodegenerative Disease Research, the largest international collaborative initiative in the area of dementia.

CIHR is also supporting the participation of Canadian researchers in established collaborative research programmes, such as the U.S. National Institutes of Health's Alzheimer's Disease Neuroimaging Initiative.

Dementia is one of the world's most pressing health challenges. Canada has heard the call. Together with its partners, CIHR is working hard to respond to this challenge and improve the health and wellness of people living with dementia and their families, for today and for tomorrow. ■

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Infections may be the new paradigm explaining the pathogenesis of Alzheimer's disease

Tamas Fulop from Université de Sherbrooke's Research Center on Aging, explains precisely why infections may be the new paradigm explaining the pathogenesis of Alzheimer's disease (AD)

Alzheimer's disease (AD) is one of the most deleterious neurodegenerative diseases. Starting with memory problems, it progresses unstoppably towards the total loss of the patient's identity.

In our ageing society, it has become one of the most disastrous plagues of humanity. AD and dementia are expected to almost triple during the next 30 years. Today, we do not know the exact cause and therefore, no real cure exists. Due to the failure of the present approaches, new and bold avenues of research need to be pursued to unravel new pathomechanisms leading to successful prevention and/or treatment of AD.

Alzheimer's disease (AD) as described by Alois Alzheimer has been known for more than 100 years. The prevailing hypothesis for AD, termed the amyloid cascade hypothesis, states that local production and deposition of amyloid beta peptide (A β) is the cause of the disease. This protein forms fibrillar structures in the brain resulting in extracellular amyloid plaques which lead to inflammation and neuronal synapse destruction. Neurodegeneration in AD is also related to intracellular hyperphosphorylation of Tau (ptau) and the formation of neurofibrillary tangles. The failure of more than 400 clinical trials targeting A β and especially the dele-

terious results observed when A β levels decrease in the brain indicate that we have not completely grasped this hypothesis. Furthermore, we need a radically new approach to discover new treatments.

There is growing evidence that AD is a syndrome and may have multiple causes. Notably, the vascular hypothesis and the infection hypothesis are very strong candidate explanations for the pathogenesis of AD.

Even if the vascular hypothesis could not be a stand-alone cause, it has been integrated as a risk factor for the development of AD and led to clinical trials for AD prevention. Under the leadership of Professor Cunnane, we have performed interventional trials including the use of exercise¹ but above all ketogenic interventions².

We pioneered the use of a brain ketone PET imaging. We have also tested a dietary ketogenic supplement for the prevention/treatment of AD at various stages. Ketones are an important fuel for neurons. They also inhibit the inflammasome and consequently decrease inflammation. We have shown that brain uptake of ketones is not altered in patients suffering from mild cognitive impairment (MCI) or AD and that supplementation with ketones improves several domains of cognitive function in MCI and AD.

The recognition of the role of neuroinflammation is important to understand AD pathology. The destruction of the synapses is the first direct consequence of neuroinflammation and leads to neuron death. Since neuroinflammation starts many decades before the appearance of clinical symptoms, we ask ourselves how exactly the immune system is involved and what is causing neuroinflammation.

Prof Fulop is leading the work on the elucidation of the involvement of the peripheral immune system in AD. We have made considerable progress in mapping the role of each element of the peripheral immune system in the early stages of AD pathogenesis. Recognition that the blood-brain barrier becomes more permeable during the development of AD supports a role for the peripheral immune response in this disease. The previous paradigm that the brain is an immune-privileged organ has now been superseded by general acceptance that peripheral immune cells may be found in the brain. We have shown that peripheral monocytes, NK cells, neutrophils and lymphocytes are differentially activated at various stages of AD, likely by a stimulus other than A β ³.

These observations provide a new trigger for the study of neuro- and



systemic inflammation in AD. Many years ago, several groups evoked the infection hypothesis of AD. They discovered remnants of various microorganisms (viruses, bacteria and fungi) in the AD and pre-AD brain. These findings led to intense investigations; however, progress has been very modest because it is difficult to prove a causative versus innocent bystander role.

Recently, the infection hypothesis was reinforced by the discovery that A β is an antimicrobial peptide (AMP). This peptide inhibits the growth of bacteria and fungi as well as viruses. We contributed importantly to the understanding of this mechanism, especially the role of A β as an antiviral peptide^{4,5}. There is still a missing link, however, relating infection to development and progression of AD: how do microorganisms provide a long-term stimulus to A β synthesis? We made progress in this area by showing that microorganisms may survive over a substantial time in microglia and in circulating monocytes where they may become reactivable under certain circumstances.

Together, these findings lend support to the infection hypothesis, suggesting

that latent and chronic infections stimulate a pro-inflammatory response. The stimulation of the central nervous immune system by infective agents may pass either directly through the olfactory bulb or by mouth, or indirectly by innate immune cells. Once exposed to infective agents, neurons secrete A β as a means to protect neighbouring neurons. A β and pathogens are then taken up by functioning microglia and the infection and inflammation are halted. However, when the infection becomes chronic, the microglia are no longer able to neutralise all the A β produced and amyloid plaques convert into biofilms enclosing the microorganisms, neuroinflammation further proceeds and neurons are destroyed⁶.

Recognition of this infection-induced vicious circle between the periphery and the central nervous system is the strategy we propose for research for the future treatment of AD. The following approaches should be explored in the near future: 1. the use of effective antibiotics to destroy microorganisms which can be detected in a personalised manner using peripheral biomarkers (since different individuals will have different chronic infections) at very early stages

in cognitive decline and; 2. the use of polyvalent vaccines.

Alzheimer's disease treatment research: ketones and antimicrobial interventions

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Why more investment is needed to put people at the heart of dementia research

Colin Capper, Head of Research Development and Evaluation at Alzheimer's Society, discusses why greater investment is needed in today's dementia care research

Dementia is now the UK's biggest killer, with someone developing it every three minutes. Yet decades of underfunding has left dementia research lagging far behind other health conditions. The treatments available for people with dementia don't help to manage the symptoms for long and currently don't work for all types of dementia.

At the same time, there will soon be over one million people living with dementia in the UK and even more affected by dementia when you take into account informal carers and support. There's currently no cure for dementia, so good quality care is vital for people living with the condition to maintain their wellbeing and be able to continue to do the things they enjoy.

It is only through research that we can fully understand what causes dementia, develop effective treatments, improve care and one day find a cure. But for research to truly progress, we need to hear from more people affected. At Alzheimer's Society, we pioneer public involvement in dementia research through our [Research Network](#). Our philosophy is that people with dementia and carers are able to contribute a unique insight into every stage of the research process, which is why they play a vital role in reviewing and monitoring all the research projects we fund. But their involvement shouldn't stop there.

When setting broader research priorities, for us and for organisations across the world, the voice of people affected by dementia is just as important. The [Dementia Statements](#) reflect the specific things people with dementia have said are essential to their quality of life. They are grounded in International Human Rights Law and outline the rights people affected dementia have in order to live well. Crucially, one of these statements outlines that people with dementia have the right to

an early and accurate diagnosis and that they should receive the appropriate care and support that they need.

It's been five years since the leaders of the G7 nations agreed on a goal of finding a cure or disease-modifying therapy for dementia by 2025. This goal has generated a substantial wave of investment in dementia research, including the £290 million UK Dementia Research Institute, which Alzheimer's Society is a founding funder, the \$100 million global Dementia Discovery Fund and other significant increases in dementia research funding across the U.S. and Europe. In biomedical dementia research at least, there is a sense of renewed optimism and momentum towards a breakthrough in new treatments for dementia.

Sadly, there is not the same level of momentum in dementia care research. The global cost of dementia is estimated to reach \$1 trillion this year, doubling to \$2 trillion by 2030 – our existing social care systems are not cut out to cope with this demand, and yet less than 5% of all dementia research, globally, addresses the care and support that people with dementia vitally need. Around the world, it is imperative that focus is placed on creating a more person-centred approach to how we invest in and programme research. This would help to ensure that the quality of life for people living with dementia is improved in both the long and short-term.

To guide dementia research towards this approach and address this imbalance, Alzheimer's Society launched a [research roadmap](#) which outlines how research ambitions for care and cure can sit side by side. Developed by a task force of researchers, policymakers and, most importantly, people with dementia, the roadmap contains five research goals that detail how care research can deliver for people living with dementia. These goals are supported by detailed recommenda-



tions and an implementation plan to improve future dementia care, intervention and prevention research:

Goal 1 – Prevent future cases of dementia by increasing the knowledge of risk and protective factors.

Goal 2 – Maximise the benefits to people living with dementia and their families when seeking and receiving a diagnosis.

Goal 3 – Improve the quality of life for people affected by dementia, by promoting functional capabilities and independence, while preventing and treating the negative consequences of dementia.

Goal 4 – Enable the dementia workforce to improve practice and skills by increasing evidence to inform changes in practice and culture.

Goal 5 – Optimise the quality and inclusivity of the health and social care systems that support people affected by dementia.

These goals are not just for Alzheimer's Society or even the research community to aim towards. They concern everyone who has a stake in dementia research,

including people with dementia, health and social care professionals and those involved with public health programmes and we must work collaboratively to share expertise and resources. These goals have the potential to change millions of lives worldwide – but, as with the search for a cure, achieving them will require major political and financial commitments and global coordination.

Research will beat dementia but until the day when we find a cure, we need to be researching cause, care and prevention. As we owe it to the 850,000 people currently living in the UK with dementia to understand the condition better so that they can live better. ■

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Mental Health Europe gauges if the continent can meet the emerging challenges around mental health

Claudia Marinetti, Director from Mental Health Europe gauges if Europe can meet the emerging challenges around mental health

In September 2018, I took over as the Director of Mental Health Europe (MHE) – a non-governmental network organisation with more than 70 members working in 30 different countries. The well-being of all people has always been a topic close to my heart and being able to continue my work in a field as important as mental health is a great opportunity and honour. Moreover, this is definitely an exciting time to take over the reins at MHE.

Europe is at a critical juncture, not least for mental health. The European Parliament and the Council of the EU are debating funding for the 2021-2027 period and we are just six months away from the next European Parliament election. Important decisions made over the next few months by national governments, MEPs and ordinary citizens will decide the direction of travel for Europe for the next decade or more!

MHE has a human rights-based and recovery-centred approach to mental health. We are committed to the promotion of positive mental health, the prevention of mental distress, the improvement of care, advocacy for social inclusion and the protection of the rights of ex-users of mental health services, persons with psychosocial disabilities, their families and carers.

Across all these areas, European states have made real progress in recent years. But our mental health systems are still far from perfect. Agreements like the United Nations Convention on the Rights of Persons with Disabilities (CRPD) or the European Convention on Human Rights (ECHR) have improved services in principle, but things still need to improve in practice.

Earlier this year, MHE released a report – Mapping and Understanding Exclusion in Europe. It is a unique analysis of mental health systems in more than 35

European countries. It found that many mental health services are not compliant with human rights and whilst reform is happening, progress is slow.

The benefits of a human rights-based approach are obvious for the individual – they afford dignity and respect and safeguard against discrimination, violence, exclusion, unlawful or arbitrary institutionalisation, overmedicalisation and more. But there are significant positives for society too – indeed, such an approach leads to more cohesive, resilient and productive communities.

In some countries – such as France, Belgium, Ireland, the Netherlands, Portugal and Germany – mental health systems are falling short when it comes to human rights and well-being. Mental health services still feature coercion, forced medication, loss of rights and reliance on involuntary hospitalisation. Across the EU, MHE estimates that at least half a million people with mental health challenges live under full guardianship, a form of substitute decision making which leaves people isolated from society and deprived of the right to make everyday choices about their lives.

With Brexit, trade wars, migration and international security high on the political agenda, it would be easy for EU policymakers to overlook not just mental health, but health policy in its entirety. But if we are going to address existing and emerging mental health challenges in Europe, all key stakeholders need to act now.

With the debate still ongoing around funding for the 2021-2027 period, how money is allocated is one route to achieving the systemic change which is needed. Looking ahead to the European Commission's next Multiannual Financial Framework 2021-2027 (MFF), funding should be used to promote human rights compliant and person-centred mental health services



Claudia Marinetti, Director

based in the community. As a minimum, countries which do not comply with the CRPD, or who aren't making progress towards compliance, should be penalised when it comes to accessing development funding. We should also make sure we avoid the pitfalls of previous funding cycles when money was used to promote systemic changes, like the deinstitutionalisation of mental health services, but progress was not rigorously or independently monitored.

Another window of opportunity to achieve change is during the upcoming European Parliament elections. MEPs have one of the strongest European-level policy-making voices. They are well placed to raise an awareness of mental health and to tackle stigma and discrimination. They can ensure the meaningful involvement of stakeholders in EU policy making, back investment in mental health research, promote increased transparency in mental health care and support the continued transition from institutional to community-based care.

As we approach May 2019, we hope that every voter who recognises the vital importance of mental health will make sure every prospective MEP knows it too. We want more MEPs than ever to back a human rights-

based and recovery-centred approach to mental health. More than this, we want incoming MEPs to recognise that mental health is not just a policy area in its own right, but an integral part of many other important issues that together can lead to real well-being for all people. Mental health should be mainstreamed across all relevant policy areas, including employment, education, social affairs, migration and fundamental rights. This all-encompassing approach is the key to providing better support for EU citizens.

The path to change might not be simple, but if we are going to address the existing and emerging mental health challenges in Europe, now is the time to act. ■

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Autonomous in Old Age

Lisa Ehrhardt, Deputy Director "Regional Offers Living in Old Age" at Pfalzkllinikum presents the work of their day centers for the elderly in the Palatinate



Image: SchelbyDC

Pfalzkllinikum is a service provider for mental health in Southwest Germany. Its three certified day centres for the elderly focus on the promotion of cognitive and motoric skills, such as the one detailed below in italics.

The tips of your thumbs touch the other fingertips of your hands one after the other. First the index finger, then the middle finger, after that the ring finger and finally the little finger. Both hands perform this exercise parallelly, however, in opposite directions. If the left hand begins with the thumb – index finger, the right hand starts with the thumb – little finger.

This exercise elucidates one of the fundamental principles of the SimA® training. SimA® stands for "autonomy in old age" (Selbstständigkeit im Alter). By linking movement and memory performance, both cerebral hemispheres are addressed simultaneously. It has been proven that, thus, maximum training results are achieved. This concept was worked in 1991 and is based on a prevention study of the University of Nürnberg-Erlangen in Germany headed by Prof Dr Wolf Dieter Oswald and the positive effects in the case of regular training were substantiated in two longitudinal studies which were conducted over several decades.

Training promotes cognitive and motoric skills

Since 2015, Pfalzkllinikum has offered the SimA® training courses. Pfalzkllinikum is a service provider for mental health in Southwest Germany. Its certified day centres follow a resource-orientated approach to help maintain their day guests' autonomy as long as possible.

"It's great that my father is fostered in the day centre despite his forgetfulness. At home, he shows more interest now and leaves through the newspaper again", says the relative of a day guest.



With SimA® movement and memory performance are linked – both cerebral hemispheres are addressed simultaneously. This promotes cognitive and motoric skills

Image: SchelbyDC

Being the first scientifically proven non-drug training concept for cognition and psycho-motorics, the particularity of the programme is its continuous adjustment to the level of difficulty. Therefore, this training can also be used for persons suffering from dementia or other cognitive impairment. For these people, too, the second study proved to have a positive effect regarding their autonomy. So, the frequency of falls was reduced, and the skills learned could be transferred from practice to everyday life. The more often the training is carried out, the better the results are. However, one training session a week is enough to maintain one's autonomy and promote resources.

The certified programme offered in all three day centres

The SimA® training can only be offered by trained and certified persons having passed a written exami-

nation. The qualification comprises several modules with a total of 56 teaching units. In these, the basics of memory, psycho-motorics, changes due to dementia, skills training and bibliographical work are imparted. In the subsequent practical period, the knowledge shall be put into practice. The qualification ends with a written examination.

The three day centres for the elderly have seven SimA® trainers and are, thus, certified as an institution. The SimA® activity offered in the day centres is embedded in a varied and personalised range of services and activation programmes. The day centres care for people over the age of 60 who seek company and interaction and specifically wish to maintain their autonomy. Naturally, this offer also supports the caring relatives at home since the burden on them is eased and practical skills for everyday life are trained.

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Why governments must do more to help people with diabetes and their families

Professor Nam H. Cho, President of the International Diabetes Federation (IDF) explains why governments across the world could and should do more to help people with diabetes and their families

Diabetes is a serious threat to global health. In 2017, diabetes was responsible, either directly or indirectly, for an estimated four million deaths, according to figures from the International Diabetes Federation (IDF). Many of these deaths could have been prevented or delayed. Our current projections suggest the number of people with diabetes will increase to 522 million over the next decade, equivalent to one in ten people.

Diabetes does not just affect individuals; diabetes affects entire families. Today, diabetes is a concern for every family – from the parents of children with diabetes to the family members caring for an adult family member living with the complications of diabetes. It is fair to suggest that most of us know somebody living with diabetes.

With the rising healthcare and societal costs associated with diabetes – \$727 billion in direct medical costs alone in 2017 – we must think about how the increasing prevalence of diabetes, Type 2 in particular and its related complications can be, prevented reversed and, hopefully, cured. It is an ambition that will require a whole-of-society approach. We all have a role to play but governments, in particular, need to do more to help us protect family members from developing Type 2 diabetes and its life-threatening complications and ensure people with diabetes have access to the medicines and care they require to stay healthy.

Prevention through education

Of the estimated 425 million people living with diabetes, around 10% have Type 1 diabetes. This type of diabetes has to be treated with insulin. At present, there is no way to prevent Type 1 diabetes. If untreated, the diagnosis of Type 1 diabetes is a death sentence. This leaves around 90% with Type 2 diabetes. In many cases, up to 80% according to some figures, Type 2 diabetes can be

prevented through regular physical activity and healthy eating habits.

Unfortunately, Type 2 diabetes often flies under the radar. Onset can be slow and the warning signs and symptoms not obvious. In fact, one-in-two of all people currently living with diabetes remain undiagnosed.

Governments can help stop the rise in Type 2 diabetes by focussing on education initiatives and establishing policies that support an improved lifestyle and dietary choices. They need to help identify people who are not yet diagnosed and those at high risk, so the medical community can intervene early before people are left needing treatment for diabetes complications. Diabetes is a leading global cause of blindness, lower limb loss, heart attack and kidney failure.

More than two thirds (70%) of premature deaths amongst adults are often the result of behaviour that starts during adolescence. It is critical then that we get into the learning environment to educate children and young adults about the behaviours that can lead to Type 2 diabetes. It is critical we influence the adoption of habits that will facilitate prevention and create environments that encourage health. It is critical we work with parents to help them provide their children with a blueprint for a healthy future.

Government action to support families

The diagnosis of diabetes can be difficult for the individual. The impact diabetes can have on a family is often overlooked. Families have a significant role to play in supporting any family member with diabetes to help that individual to manage their condition.

While the diabetes epidemic has become a concern for the public, there is also a strong perception that those



Professor Nam H. Cho, President of the International Diabetes Federation

in a position to bring about change are not taking the right steps to prevent this non-communicable disease from drastically affecting lives.

IDF recently asked people across the globe to evaluate the governmental response to diabetes. We asked “Does your government have a responsibility? Is your government doing enough?” Globally, 44% of people believe their government has a responsibility to provide diabetes care. But only 17% think their government is doing enough to tackle the disease.¹

With the majority of cases of diabetes preventable, there are significant cost savings to be made by investing in education and prevention. If governments were to do more, such as providing guidance to the one-in-five health professionals who have not received post-graduate training on diabetes, they would support the prevention, early diagnosis and treatment of diabetes and its complications, which would help to build a

more sustainable future. As a consequence, governments would spend less money on treating people with diabetes when it’s already too late. This could be money saved and misery avoided.

We firmly believe people with diabetes and their families should have regular and affordable access to the care, education and support that is required for them to live a full and healthy life with the condition.

Stop the epidemic in its tracks

At IDF, we campaign continually for diabetes to be put at the top of the global health agenda, so diabetes receives the attention that its serious and far-reaching impact deserves.

“Diabetes does not just affect individuals; diabetes affects entire families. Today, diabetes is a concern for every family – from the parents of children with diabetes to the family members caring for an adult family member living with the complications of diabetes. It is fair to suggest that most of us know somebody living with diabetes.”

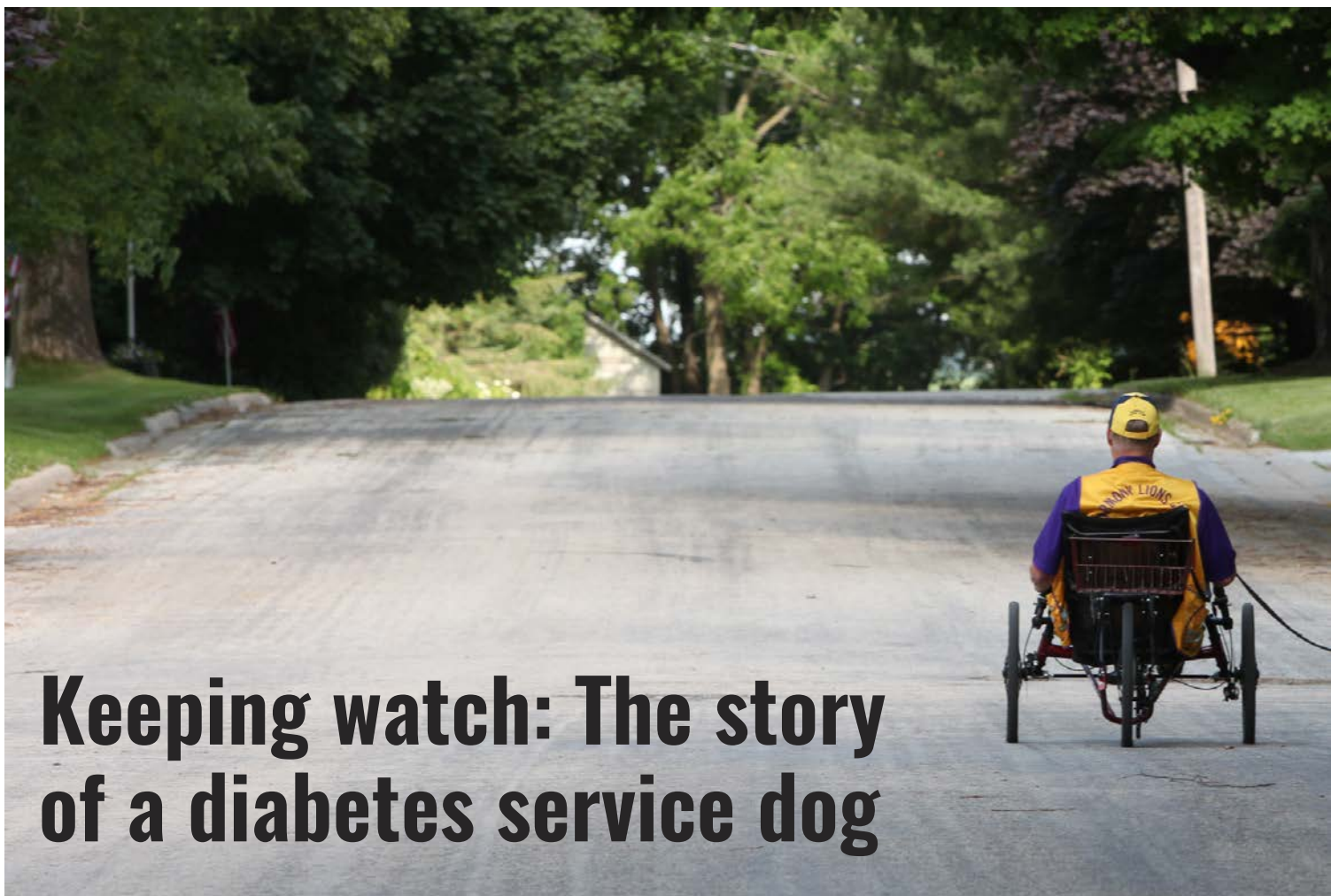
The research we have undertaken in developing and high-income countries shows the global population is demanding more action to treat and prevent diabetes, with the introduction of new lifestyle-led initiatives having the added long-term benefit of reducing medical expenditures.

Diabetes is a serious global problem and it is at the point of becoming uncontrollable. Governments can make a significant impact in preventing the unnecessary deaths and disabilities of millions of people across the world. We need to work together to make the changes today that will protect the health of families tomorrow. ■

1 IDF World Diabetes Month and Day Report, Arlington Research, August 2018

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Keeping watch: The story of a diabetes service dog

Joan Cary from Lions Clubs International explains the organisation's excellent work in providing service dog to assist those with diabetes

Every few months, Minnesota Lion Lu Ommen found himself in the company of an ambulance crew. He had gone into life-threatening diabetic shock, with his blood sugar low enough to cause a dangerous seizure.

But as much as he came to like the 911 responders, Ommen has not seen them for a while. He thanks Gilbert and the Lions Clubs International for that. Gilbert, a 62-pound Black Labrador Retriever became Ommen's 24-7 companion four years ago. Where Ommen goes – the golf course, his Harmony Lions Club meeting where he is now president, the pickleball court, to church, or to bed – his diabetes service dog goes too.

When Ommen's blood sugar is too low or too high – under 100 or over 140 – Gilbert alerts him by tapping him with his paw. "The more out of whack it is, the more aggressively he taps," says Ommen. "If I really get out of whack, he might bark."

On occasions, Gilbert has also alerted Ommen's companions of blood sugar concerns when he's been around them, catching the signs on their breath and then tapping them with his paw. "What he does, he can do to anybody," says Ommen. "He's a great dog."

Gilbert, six, came to Lu and Sue Ommen from Can Do Canines, a

Lions-supported non-profit outside Minneapolis that, since 1989, has provided more than 600 service dogs free of charge to people in Minnesota and nearby Wisconsin. He is trained to monitor his human partner's breath, both night and day.

Lion Alan Peters, the organisation's founder and executive director explains that the change in blood sugar starts in a person's stomach and creates a particular smell on their breath. Although it is impossible for humans to detect, it is clear to the sensitive nose of a trained dog.

Peters is also a diabetic, having discovered it by checking his own blood while volunteering at a Lions' glucose screening event.

Dogs like Gilbert were unheard of



when he began the organisation, but they are now in high demand. Can Do Canines have a waiting list of 184 people and have partnered 42 dogs with diabetics. The other dogs among the 600-plus serve as hearing assistants, mobility dogs, seizure and autism service dogs.

“When Ommen’s blood sugar is too low or too high – under 100 or over 140 – Gilbert alerts him by tapping him with his paw. “The more out of whack it is, the more aggressively he taps,” says Ommen. “If I really get out of whack, he might bark.”

Often, the people most in need of a service dog are the ones who can’t afford them, says Peters. Each service dog costs the organisation about \$25,000 from birth to age two, when they are typically introduced to their owner, and that’s where the support

of Lions in Multiple District 5M has helped.

Minnesota Lions donated more than \$182,000 to the organisation during Lion year 2016 to 2017, says Peters.

“They are our biggest single supporter. We see a lot of value in them, and it’s not just because of the money. Lions are more likely to know the needs in their community.”

With \$75,000 in donations from individual clubs and a \$75,000 Lions Club International Foundation grant, Can Do Canines was also able to add 10 kennels to their facility.

Gilbert might recall those kennels on a visit, but now he sleeps next to the Ommens’ bed, responsibly waking at night to check his partner’s breath.

“I keep a pretty close eye on him,” says Ommen. If Gilbert could talk, he would say the same.

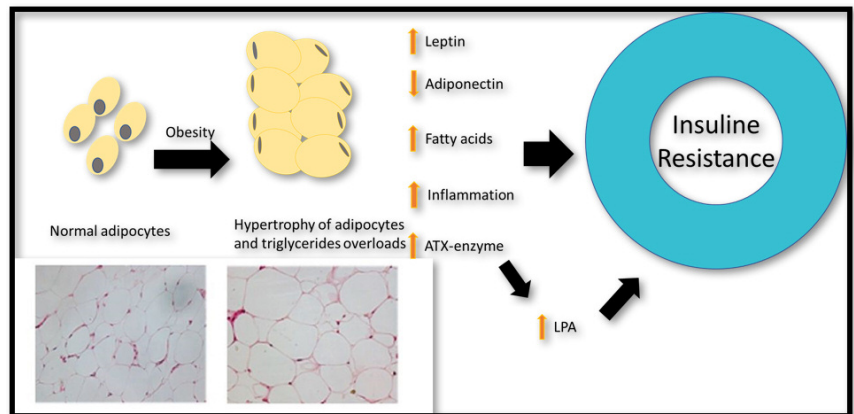


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Type 2 diabetes mellitus and obesity, what is the link?

Chester Medical School explores the pathogenesis of Diabetes Mellitus Type 2 (T2DM) with novel approaches

Diabetes Mellitus Type 2 (T2DM) remains a major public health problem with financial implications for healthcare systems worldwide. According to Diabetes UK, 3.7 million adults were diagnosed with diabetes mellitus and 12.3 million were at risk of developing the disease in 2017. The cost to the NHS is an estimated £1.5 million an hour – equating to about 14 billion a year.



A report by the Health and Social Care Information Centre has also shown in the eight years between 2005/06 to 2013/14, the cost of drugs and treatment of T2DM had risen by 56.3%¹. It is recognised that a major driver for T2DM is obesity-induced insulin resistance. Insulin resistance is a condition where the insulin produced by the pancreas is unable to work properly resulting in high blood glucose and T2DM. The mechanism by which obesity induces insulin resistance signals the induction of T2DM has not been fully elucidated. Research programmes at Chester Medical School aim to shed light on potential mechanisms by which obesity triggers the pathogenesis of insulin resistance T2DM.

How obesity causes insulin resistance

Obesity is essentially the abnormal accumulation of body fat in a process involving the increase of fat cells size and number – known as hypertrophy and hyperplasia. During hypertrophy and hyperplasia fats cells release bioactive adipokines and enzymes that regulate the uptake of triglycerides in

the blood. Leptin and adiponectin are major adipokines, which are released from fat tissue in the abdominal area and have an essential role in regulating blood sugar level. Leptin increases fatty acid oxidation and reduces blood sugar and body fat.

Adiponectin, however, plays an essential role in stimulating insulin sensitivity and its level is decreased by obesity. Conversely, the level of leptin has been shown to increase in obesity due to leptin resistance. Leptin normally signals the brain to quench hunger sensation when enough energy is stored in the fat cell. However, overeating causes a reduction in the number of leptin receptors leading to leptin resistance and a further increase in food intake. Another molecule released by fat cells which have implications for insulin resistance is lysophosphatidic Acid (LPA).

LPA is a bioactive lipid that regulates various physiological conditions, such as vasoregulation, chemotaxis, cell growth and survival. The enzyme autotaxin (ATX), produced by fat cells,

is the major determinant of serum LPA. Aberrant production of LPA, however, has been associated with impaired glucose homeostasis and obesity-induced insulin resistance.

How does Diet affect LPA?

Serum concentration of LPA is regulated by fasting and dietary intake. In mice, the circulating levels of ATX-LPA levels were significantly decreased by about 50% following 16 hours fasting, whereas higher levels were detected in fed state. Following feeding, LPA induces the differentiation of adipocyte and pre-adipocyte, as well as decreased glycogen storage in the body. Macronutrients (fats, proteins and carbohydrates) have also been shown to regulate ATX-LPA expression, in particular mice fed high-fat diet or obesogenic diet; a high-fat- high-sucrose diet (45% kcal, 17% kcal sucrose) induced a 62% increase in serum levels of plasma LPA².

It there a link between LPA and obesity?

Adipocyte hypertrophy and hyperplasia are both regulated by the ATX-LPA

axis through autocrine and paracrine signalling. The ATX-LPA signalling pathway also plays an essential role in recruiting premature fat cells (pre-adipocytes), altering adipose tissue biology and expanding adipocyte fat mass. *In vivo*, extensive reports in murine models have shown ATX-LPA axis plays an important role in nutritional fatness and obesity.

However, it is not clear whether obesity induces increased LPA expression or vice-versa. A study has shown that feeding a high-fat diet to mice with and without the ATX gene causes an increase in adipocyte fat size suggesting adipose hypertrophy at least can be signalled without ATX-LPA axis^{3,4}. In humans, however, a recent report shows that LPA concentration in serum directly correlates with BMI⁶. Serum ATX concentration has also been shown to correlate with waist circumference and BMI of obese and overweight patients⁷.

How does an increased level of LPA affect insulin resistance and glucose homeostasis?

ATX-LPA levels in human serum correlate with several insulin sensitivity and glucose homeostasis markers, such as glucose infusion rate, fasting blood sugar and insulin resistance. The protein concentration in serum predicts glucose homeostasis is in relation to age and obesity⁵.

Also, ATX mRNA levels in the abdominal adipose tissue of obese women who exhibited impaired glucose intolerance were significantly higher when compared to control. In animal studies, ATX-LPA axis is implicated in the regulation of obesity glucose homeostasis. Exogenous injecting of a supraphysiological dose of LPA induced acute glucose tolerance in both chow and high fat fed mice⁴. This suggests a

direct role for ATX-LPA in regulating glucose homeostasis and insulin resistance. Clinical evidence of LPA signalling T2DM remain speculative and understanding of the signalling pathway of LPA could help elucidate the signalling mechanism between obesity and T2DM.

Currently, several PhD and Biomedical MSc students in the Chester Medical School are conducting studies aiming to understand the mechanism by which insulin resistance is induced. For example, we are investigating the effect of the anti-obesity supplement: Conjugated linoleic acid on insulin resistance and diabetes markers in obese and overweight women.

Another study is looking at the effect of probiotic-derived from the fermented milk on insulin resistance markers and other metabolic markers. Additionally, a PhD project is looking at the concentration of serum LPA in T2DM patients compared to healthy volunteers and how it correlates with insulin resistance and other diabetic markers.

Chester Medical School is not only keen to contribute in establishing several T2DM types of research but also, we are running the MSc Diabetes and MSc Cardiovascular Disease programmes. These two programmes aim to familiarise our medical students from various professional backgrounds with the current and novel pharmacological and non-pharmacological treatment options for T2DM and its associated CVDs complications. One important approach of these two programmes - in common with other Chester Medical School MSc programmes is to engage our medical school students in evidence-based practice to embed research in the mind of the clinical practice and to encourage proposing the novel man-

agement and treatment strategies for T2DM and its associated complications.

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WDF Programme Manager Susanne Olejas (right) during a field visit to the Karail slum in Dhaka, Bangladesh

Why isn't diabetes at the top of every health agenda?

Gwen Carleton, Communication Manager for the World Diabetes Foundation, explores how diabetes still isn't prioritised by governments and in global development – despite the clear business case for doing so – and hopes that 2018 will mark a turning point

Imagine your community is facing an epidemic. Left unaddressed, this epidemic would prematurely cripple and kill millions of your citizens, many of them bread-winners in their most productive years, and leave future generations at high risk of developing the disease. Imagine that information, medical equipment and medication to treat the disease were widely available, much of it available at a low cost and that addressing this threat would not only save lives but offer economic benefits to boot. You would tackle and defeat the epidemic, right?

Unfortunately, when the hypothetical becomes real, the outcome is different. Diabetes is an epidemic that currently affects 425 million people worldwide. About 5 million people died from diabetes in 2017 – that is significantly more deaths than from HIV/AIDS, tuberculosis and malaria combined. About 79% of people with diabetes live in low- and middle-income countries, which can least afford the devastating direct and indirect costs of the disease¹. Annual GDP losses due to diabetes and other non-communicable diseases range from 3.5% – 5.9% and the amount it will have

cost developing countries between 2011 and 2025 will be more than \$7 trillion. That's equivalent to the combined GDP of France, Spain and Germany in 2017².

Yet governments continue to under-prioritise non-communicable diseases in general and diabetes in particular. The global development community under-prioritises them as well: only about \$475 million (1.3%) of development aid for health was dedicated to NCDs in 2015³. HIV/AIDs received eight times that amount, reflecting a long-term prioritisation of communicable diseases over NCDs.

“Annual GDP losses due to diabetes and other non-communicable diseases range from 3.5% – 5.9% and the amount it will have cost developing countries between 2011 and 2025 will be more than \$7 trillion. That's equivalent to the combined GDP of France, Spain and Germany in 2017.”

A turning point?

Since 2002, the World Diabetes Foundation has worked to alleviate human suffering related to diabetes and its complications among those least able to withstand the burden of the disease. We do this through partnerships. Civil society, academia and other non-state actors identify needs in their communities and apply to us for funding and technical support to meet them. This has resulted in more than 500 projects that have provided care to more than seven million people and reached millions more through screening, educational and prevention efforts.

WDF is still one of the few funding mechanisms dedicated specifically to preventing and treating diabetes in the developing world. Our combined efforts are making a difference. We bring our partners together whenever possible to share their learnings and amplify their voices. But our impact is not nearly enough to meet the global need.

Why aren't NCDs in general and diabetes in particular, at the top of every health agenda? The business case is clear: the return on investment in NCDs significantly

outweighs the costs. A 2018 WHO report⁴ shows that for every dollar invested in NCDs, there will be a return to society of at least \$7 in increased employment, productivity and longer life.

The answer, according to the WHO, is a lack of political will, commitment, capacity, action and accountability⁵. But 2018 may well be remembered as a turning point. Over the past year, a wide variety of voices have united in urging governments to make more concrete, tangible commitments to defeating NCDs, as part of the build-up to the Third UN High-Level Meeting on NCDs which took place on 27 September. This gathering gave high-level decision-makers the chance to go beyond generic language and make concrete, tangible commitments on NCDs. We hope that they take full advantage of this opportunity. Nothing less than millions of lives are at stake. ■

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Danish Diabetes Academy aims to train and educate the world's best (young) diabetes researchers

In this analysis, the Danish Diabetes Academy explains how they intend to train and educate the world's best (young) diabetes researchers

Education, networking and scholarships are keywords at the Danish Diabetes Academy (DDA). The DDA collaborates with universities, hospitals and the life science industry to keep Danish diabetes research education at the highest international level.

Around 422 million people in the world have diabetes. According to the World Health Organization (WHO), 1.6 million deaths were directly caused by diabetes in 2015 and every day millions of people around the world struggle with complications of diabetes such as blindness, kidney failure, heart attacks, strokes and lower limb amputations.

There are clearly many reasons to develop new knowledge to promote better prevention and treatment of this devastating disease, which is exactly what the DDA facilitates and has been doing since 2012.

The DDA is a networking and education platform funded by the Novo Nordisk Foundation. Its mission is to educate and train the next generation of researchers in the field of diabetes. Not only does the DDA want to train and educate the next generation, but the DDA also aims to train and educate young researchers to be among the best diabetes researchers in the world.

Taking diabetes research training to new heights

As the main mission of the DDA is to educate the world's best diabetes researchers, the DDA is very ambitious when it comes to strengthening the research training available to PhD students and postdocs in the field of diabetes.

It is the DDA's ambition to educate young researchers to provide them with a holistic and innovative cross-sectoral and interdisciplinary mindset and approach to their work so that they can set the future scene for developing new prevention programmes and treatment methods to combat the disease. This cannot be done alone, which is why the DDA organises up to 20 educational activities annually in close collaboration with academia, hospitals and the life science industry, but also with research institutions abroad.

Educating young people to become future top researchers in the field of diabetes means offering them the opportunity to continuously develop their professional skills. Therefore, the DDA constantly goes the extra mile in arranging events and activities to challenge young researchers and really make them feel that the DDA takes its responsibility very seriously.

"For example, with the support of the strong Danish university-based diabetes community, we have established strong collaborative relationships with research institutions from Germany, UK and the U.S. and this has quite definitely raised our profile in the provision of educational activities", explains managing director Tore Christiansen.

A national and international diabetes networking hub

Growing new networks to connect diabetes researchers from different research disciplines and sectors and cultivating those already in existence is a cornerstone of the DDA. A particular focus for the DDA in the coming years will be facilitating improved collaboration between academia and the life science industry.

By acting as a bridge between academia and industry, the DDA can encourage translational research while at the same time, providing young researchers with invaluable training and perhaps also the opportunity to make a career in life science.

"We have already established a fruitful collaboration with the biotech firm MedImmune, with young postdocs from two Danish universities set to work closely with researchers from MedImmune. These young postdocs



will thus be drawn into the DDA's educational activities so that they can teach young PhD students about the opportunities available in the life science industry. We hope to establish several such collaborations with national and international life science companies, perhaps within the EU's Innovative Training Network programme under the Marie Skłodowska-Curie actions", reveals managing director Tore Christiansen.

"Around 422 million people in the world have diabetes. According to the World Health Organization (WHO), 1.6 million deaths were directly caused by diabetes in 2015 and every day millions of people around the world struggle with complications of diabetes such as blindness, kidney failure, heart attacks, strokes and lower limb amputations."

Each year, the DDA arranges the DDA Annual Day, a networking day for junior diabetes researchers in Denmark. This offers junior diabetes researchers a tremendous opportunity to present their latest research findings and to meet other young diabetes researchers in other research disciplines.

"We find that opening doors to all kinds of diabetes research stimulates young researchers to come up with new research ideas, which is very inspiring", says managing director Tore Christiansen.

The recruitment of talented national and international diabetes researchers

Among the 100 young diabetes researchers to be recruited by the DDA over the next couple of years, the DDA aims for 30% of these to come from abroad. One way in which DDA will attempt to achieve this is through the EU's Marie Skłodowska-Curie actions in Horizon 2020, where the precise aim is to stimulate regional, national or international programmes to foster excellence in researchers' training, mobility and career development.

"In addition, the DDA always advertises through international channels when announcing grants and the DDA does its utmost to help applicants from abroad make contact with Danish senior researchers. We've had good past experience of this", says managing director Tore Christiansen, who

also points out that the quality of grants awarded by the DDA can best be ensured by our strong international panel of experts in basic and clinical research, who assess all applications.

The DDA's research grants are always awarded in open, free and transparent competition, with priority given to applications supporting the three major strategic areas of the DDA: internationalisation, interdisciplinarity and collaboration across sectors.

"Over the past five years, we have wholly or partly funded in the region of 150, mainly young, researchers, many of whom now hold good posts in the life science industry, at universities or in hospitals. I am certain that, with its provision of educational and networking activities, the DDA has played a part in shaping their careers", says managing director Tore Christiansen.



Danish Diabetes Academy,
 established in 2012
 Funded by the Novo Nordisk Foundation
 (grant number NNF17SA0031406)
 Located at Odense University Hospital,
 Denmark
www.danishdiabetesacademy.dk

The power of digitalising diabetes with SocialDiabetes for the future of healthcare

SocialDiabetes is participating in two NHS testbed projects to pilot the future of digital health and patient-centric diabetes care, as Ikuska Sanz, the firm's Director of Operations describes

The World Health Organisation considers diabetes to be one of the biggest health crises of the 21st century. There are currently 425 million diabetes patients worldwide and this figure is expected to increase to 629 million by 2045.¹ The typical sedentary lifestyle in Western societies, combined with a worsening diet over the last few decades, has caused a significant increase in obesity rates. The condition is closely linked to Type 2 diabetes, which is rapidly on the rise.

In the United Kingdom, someone is diagnosed with diabetes once every three minutes. There are currently 4.5 million people living with the disease in the country², more than the total combined figure for cancer and dementia sufferers and this number has more than doubled over the last 20 years. As a chronic condition, diabetes causes a significant strain on the public healthcare system, which takes responsibility for most of the costs related to the disease.

The latest generation of digital technology has opened unprecedented opportunities to deal with what is rapidly becoming a major public health problem. The intensive use of smartphones is permeating all major aspects of our lives, including our health. The majority of internet users have searched for a health topic online and 60% of smartphone owners have downloaded a health-care app at some point. The truth is

that most people live permanently connected to their mobile phones and an increasing number of young people and adults are using the internet for health-related purposes.

As one of the most data-driven diseases, diabetes is not a stranger to digital transformation. From movements such as the Open Artificial Pancreas System ([#OpenAPS](#)) to big biotech initiatives around automated insulin delivery systems and the multiple apps that help patients improve their daily control, technology is impacting all touchpoints for diabetes self-management, treatment, education and support. Digital tools are rapidly becoming an instrument to help transform the way organisations deliver medical care and diabetes is at the forefront of this transformation.

In this context, SocialDiabetes is set to become one of the best solutions to foster the digital management of diabetes. The company, a renowned start-up headquartered in Barcelona with offices in the UK, was first created to meet the needs of Victor Bautista, a Type 1 diabetes patient and current CTO & co-founder. The team now includes several people with diabetes and healthcare professionals.

"Our main goal is to help patients make better decisions at every step, and to make it easier for them to communicate with the healthcare professionals that are treating them",



Maria Salido and Víctor Bautista, co-founders

explains María Jesús Salido, CEO of SocialDiabetes. "We want to change the way diabetes is managed in the 21st century. We focus on healthcare systems that believe in innovation, such as the NHS, which is embracing technology and adopting innovative ways of doing things differently, including diabetes care.

SocialDiabetes has started working in the UK with support from the NHS. The company is already building strategic alliances with pharmaceutical, healthcare and medical device partners. "We offer a competitive product and we have received a very warm welcome. It is extremely fulfilling to work in such an open environment that allows us to innovate and provide added value", notes Salido.

An internationally recognised solution

After a couple of years of dedicated innovation and development, the result

of a continuous interaction with the community of users, the platform offers a safe and user-friendly solution that empowers Type 1 and Type 2 diabetes patients. It connects users with their peers, family members and healthcare professionals while giving doctors and nurses the chance to follow up with their patients online and collaborate across the wider system.

How SocialDiabetes works

The platform works as a virtual clinic where healthcare professionals are able to manage patients remotely and provide them with individual treatment and support. Clinicians monitor patients using a single dashboard that is filled with information from the in-app patient activity. All data is stored in the cloud. Healthcare professionals can prescribe SocialDiabetes as part of the treatment and can then monitor patient data (food intake, exercise, insulin dosage, emotions, etc) without having to wait for the next office visit. The traditional patient-doctor dynamic turns into a proactive one, both for the patient at home and the care provider at the clinic or hospital.

The outcomes are promising. A retrospective analysis of the SocialDiabetes database found that the use of the solution for six months results in 1% to 2% drop in estimated A1c³ for poorly controlled patients (initial eA1c greater than 8%). According to the International Diabetes Federation, every 1% drop in A1c reduces the risk of diabetes-related deaths by 21%, microvascular complications by 37% and heart attacks by 14%. The study also showed that the risks of hypoglycemia and severe hyperglycaemia are reduced by 25 to 40% for Type 1 patients after six months of use of SocialDiabetes.

These results were presented this year at the Advanced Technologies & Treatments for Diabetes (ATTD) con-

ference in Vienna and the Diabetes Technology Meeting in Maryland, 2017. The platform has the backing of the main regulatory agencies and complies with the quality regulations.⁴

Last year, the company was awarded a €1.6 million grant by the European Commission as part of the SME Instrument – Horizon 2020 program. The start-up came first in its category and received top marks across all factors evaluated: impact, excellence, quality and effective implementation. With over 350,000 downloads, the app has been translated into 11 languages and has more than 20,000 active users per month, a figure that the start-up hopes to multiply ten-fold by the end of 2019.

The NHS’ commitment to SocialDiabetes

NHS Scotland chose SocialDiabetes to help educate patients with Type 1 diabetes with the use of mobile technologies. In this project, the company has partnered with Oxford University, Nottingham Trent University, Bertie Online and Lelan Solutions. The company has developed a version of their platform that is adapted to the project requirements and it includes a new feature that allows users to socialise with each other. The version, named SocialDiabetes Connect, allows patients to interact, share information and experiences and provide mutual support. The app also uses gamification to tell patients how well they are dealing with their disease.

SocialDiabetes is also a member of Diabetes Digital Coach, that focuses on diabetes self-management as a key point to improve health outcomes and lower costs.

SocialDiabetes is poised to transform diabetes, supporting front-line healthcare professionals, specialists and patients. The start-up’s short- and

medium-term plans include integration with Alexa and Google Home, introducing predictive analysis, improving outcomes reports with aggregate patient data and adapting to UK-specific needs, as well as launching new social features for the community of users.

“We know what patients need and we focus all our efforts on improving their quality of life. Our mission is to digitalise diabetes management so that data is put to work in helping patients and medical professionals”, states María Jesús Salido. “In the absence of a cure technology is the solution and SocialDiabetes will play an important role in the design of new health models based on the collaboration of everybody.”

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Mobile health monitoring systems that address diabetes

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group shares her thoughts on mobile health monitoring systems that address the global concern of diabetes

According to the World Health Organization (WHO), cases of diabetes have displayed a dramatic increment during the past decade, exhibiting a global prevalence of 9% among adults aged 18 years and older. The WHO says that an estimated 1.6 million deaths were directly caused by diabetes during 2015. Indeed, diabetes is expected to become the seventh leading cause of death by 2030, with more than 350 million individuals projected to be directly affected.

Diabetes has particularly increased among low- and middle-income countries, which suggests an increasing global socioeconomic burden. In addition, diabetes constitutes one of the primary causes of kidney failure and heart disease deaths. Diabetes also affects many other systems indirectly (Sahin and Naylor, 2017). In fact, diabetic retinopathy is caused by damage to the small blood vessels in the retina, resulting in a progressive loss of vision. This effect is dramatically increasing in people under the age of 40. Apart from that, almost 60% of non-traumatic lower-limb amputations in adults occur in people diagnosed with diabetes.

Under this framework, glucose monitoring becomes vital to avoid life-threatening or disability situations (David and Rafiullah, 2017). Approximately 50% of patients need to control their blood sugar levels with more than a single drug after completing the first three years of treatment. The remaining 50% require multiple therapies after 10 years of starting planned therapy. It is important to highlight that adherence to treatment also represents a major concern in diabetes. Over 50% of patients diagnosed register problems with adhering to monitoring and treatment, as well as measuring their blood sugar levels and calculating target levels, all of which are factors that lead to serious healthcare complications.

Opportunities and solutions

Despite the advent of disruptive innovations attempting to address the increasing concern among the scientific and clinical communities about diabetes, statistics continue to reveal a remarkable augmentation in the number of cases and deaths associated with advanced diabetes (Van Cauwenberghe, 2016).

Mobile health (mHealth) constitutes a breakthrough technology that significantly empowers patients by allowing them to set the pace of their treatment in a more individualised manner (Bradway et al., 2018). Indeed, mHealth interventions, including mobile apps, smartphones, handheld tablets and many other wireless devices, presently constitute one of the most promising approaches for the self-management of diabetes (Kitsiou et al., 2017).

The advent of the Internet of Things (IoT) and artificial intelligence (AI) are also encompassing mHealth solutions, providing them with a broad spectrum of functions (Fatehi et al., 2017). The growing incidence of chronic diseases, such as cardiovascular disease and diabetes means that mHealth and point-of-care devices become vital to help patients manage and track their health conditions. Thus, for instance, a glucometer can be connected to a smartphone to monitor a patient's condition in a way that promotes comfort and ease of use.

Data is automatically recorded and can be shared instantly with the caregiver and/or stored in the cloud. Data can also be transferred via audio connectivity technology, which requires no internet connection. Overall, no extra batteries are needed, therefore, presenting remarkably superior competitive attributes in comparison with conventional blood glucose monitoring technologies (Rajan, 2018). Even better,

wearable devices, either in the form of a band or a patch, can be also adapted to use at home for monitoring patients' conditions.

Impact on the economy

The WHO estimates that there will be a shortage of 12.9 million healthcare workers worldwide by 2035. Consequently, mHealth monitoring systems are expected to play a crucial role in managing the growing burden of diseases, along with the depleting number of healthcare workers. mHealth monitoring may facilitate accurate, precise tests without the need for skilled personnel and patients. Moreover, mHealth monitoring reduces the need for onerous healthcare facilities, especially benefiting lower income economies.

Significant cost savings can be achieved by reducing doctor visits and laboratory overhead costs. Furthermore, mHealth monitoring focuses on prevention, early diagnostics and an improved management of chronic disease conditions, therefore, notably enhancing clinical outcomes and the cost of care. mHealth monitoring systems also provide patients with a more comfortable experience and relationship with the disease, which also contribute to a better quality of life.

Final remarks

Achieving appropriate glycemic control and effectively reducing the risk of hypoglycemia is presently focused on closed-loop, smartly monitored, insulin delivery system for patients with Type 1 diabetes mellitus. The real-time feedback between glucose levels and insulin delivery similar to insulin-producing cells, or beta cells of the islets of Langerhans, constitutes the distinguishing feature of the closed-loop system (Van Cauwenberghe, 2016).

New business models are emerging between large pharmaceutical/biopharmaceutical companies and medical devices firms with the objective of accelerating the delivery of novel therapeutic systems to the industry. Medical device companies and drug manufacturing companies sign long-term partnership agreements to combine their drug delivery devices with the most active diabetes therapeutics, thereby bringing down

the operational costs and saving a significant amount of time during the process. ■

Acknowledgements

I would like to thank all contributors from industry involved with the development and delivery of this article from the TechVision Group at Frost & Sullivan.

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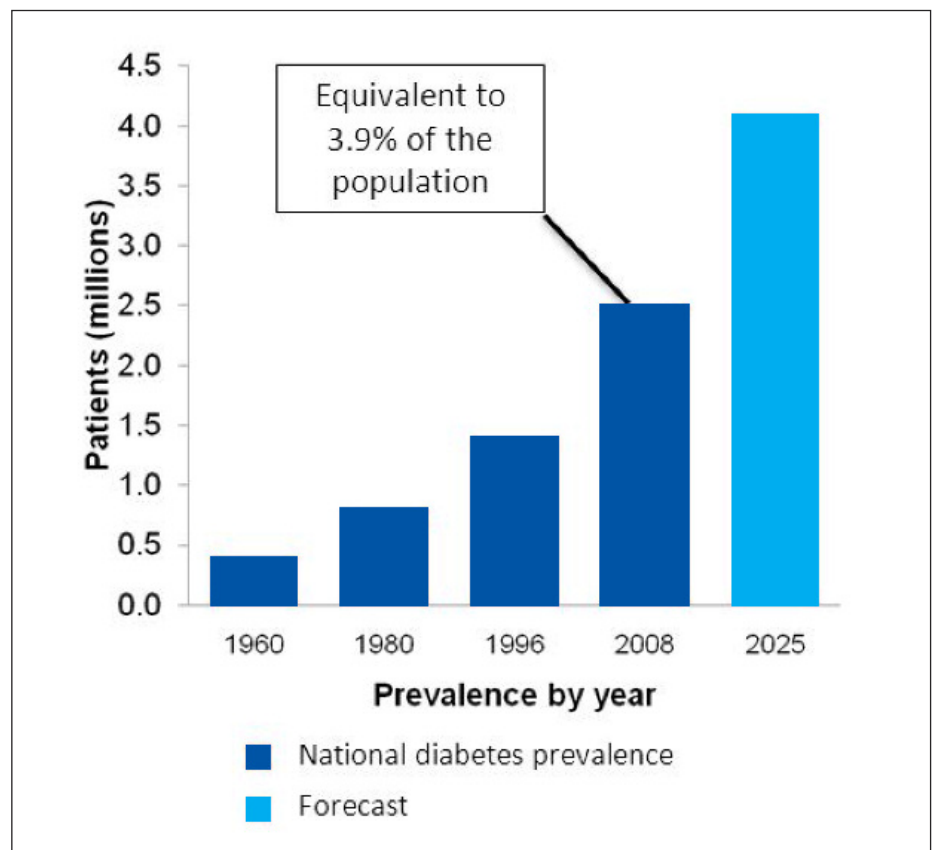
Flexible e-learning systems help busy healthcare practitioners to stay abreast of diabetes management changes

An intriguing e-learning programme that helps busy healthcare practitioners stay abreast with changes in diabetes management

Medical science has reattached limbs and replaced human hearts, yet the challenge of diabetes remains to be conquered. Globally, nearly 600 million people are expected to have diabetes by 2035, according to the International Diabetes Federation. The [World Health Organisation \(WHO\)](#) estimates 60 million people in the European Region have diabetes (3 to 4 million in the UK), representing about 10% of the population over age 25. In the UK and across Europe, these numbers are expected to rise steadily in the coming decade without a comparable increase in medical specialists who focus on managing this disease.

This necessitates training of more general practitioners (GPs), nurse specialists and other healthcare professionals to fill the gap. "For a treatment regimen to be effective, diabetes care must be closely individualised for the patient and carefully monitored over time," notes Dr Tim Heise, Lead Scientist at Profil, an international diabetes research institute based in Germany.

Too often, people with diabetes face long delays in diagnosis and poor control of their symptoms. The disease is dangerous and often deadly if not managed properly. The [National Diabetes Audit](#) reports upwards of 24,000 needless deaths in the UK due to diabetes each year. WHO projects a



doubling of death rates from diabetes between the years 2005 and 2030. Of those who lose their lives to diabetes, over half are under the age of 60. Advocacy organisation Diabetes UK estimates that these deaths – and over 7,000 amputations annually – could be avoided if patients had better management of their disease. As pioneer diabetes specialist E.P. Joslin once observed, "The diabetic [patient] who knows the most, lives the longest."

Why is it so hard to gain control over diabetes? Keeping up with changes in

diabetes treatment is like trying to follow a moving target, says Dr Heise. "A number of anti-diabetic agents have become available recently which expand treatment options, but also require detailed knowledge on their efficacy, limitations and side-effects to optimise diabetes treatment according to the needs of each individual patient," he explains. "Unfortunately, the increasing complexity in diabetes treatment has aggravated clinical inertia – doctors do not react adequately to findings of unsatisfactory glucose control in their patients."

London-based medical education company Liberum IME set out to meet this challenge by allowing healthcare providers to tailor their diabetes education in a way that best fits their own learning styles. “Most GPs cannot spare time away from their practices to travel to conventions,” explains Liberum Managing Director Celeste Kolanko. E-learning has soared in popularity, but some people still like a traditional format – read and respond to questions – and others prefer an interactive, collaborative approach. Liberum’s Diabetes Knowledge in Practice [website](#) allows learners to pick and choose among diabetes topics and learning formats that best meet their needs. The choices include a Journal Club, latest conference coverage, expert panel discussions and a unique do-it-yourself programme called “CME-in-a-box” that is exclusive to Liberum.

“What if you want to use cutting-edge E-learning resources, but you also prefer to share ideas and strategies with your colleagues?” Ms Kolanko asks. CME-in-a-box allows learners to download a toolkit with slides, handouts and discussion questions and then customise these materials to fit their needs. “It makes it easy for the user to design and run his or her own accredited meeting for colleagues,” she notes. This might work well for a doctor who needs to update his or her practice team, a nurse running a training session, or a medical student organising a study group with friends. The site provides accredited education both through EACCME and ACCME, primarily in the English language, but more multilingual options and regionally tailored programmes are in the works.

“Diabetes is now a world pandemic,” acknowledges Prof David Matthews, Professor of Diabetic Medicine at

University of Oxford and Chair of the Journal Club on Diabetes Knowledge in Practice. “Because so many healthcare professionals need to grow their expertise in managing this disease, there is a vital need for easily available educational tools, materials and resources.”

To remain relevant, diabetes education needs to keep up with the latest changes. Diabetes practice guidelines are revised almost yearly, as new medications are introduced and new strategies evaluated. Not long ago, the diabetes treatment paradigm shifted dramatically with the introduction of agents that modulate incretin, a hormone that stimulates insulin secretion in response to food. Incretin mimetics include multiple classes of drugs, some oral and some injected, often used in combination.

Determining how and when to use insulin is another complex challenge – multiple formulations are available and vary based on the onset and duration of action, the timing of meals, the need for overnight blood sugar control and other factors. “I am particularly impressed with the interactive aspect of CME-in-a-box,” says Dr Ronald Goldenberg, a Canadian diabetes expert who chairs that section. “It asks you to make decisions you might face in your own practice and then helps you to evaluate whether that is the best decision.”

Centuries ago, physicians used to smell or even taste their patients’ urine to detect excess sugar that might signal diabetes. Today, diabetes management is highly sophisticated – but it must be applied optimally to keep patients’ blood sugar under control and prevent serious complications such as vision loss, limb amputation and cardiac complications like heart attack or stroke.

“Online education platforms like Diabetes Knowledge in Practice provide state-of-the-art learning that helps clinicians stay abreast of current information that can be accessed at any time and any place,” Dr Goldenberg adds. “By consolidating a wealth of data into a single ‘one-stopping shopping’ format, web-based materials are ideal for the busy provider.”

Diabetes Knowledge in Practice is open to grant support from multiple organisations. The current content is supported by a grant from Novo Nordisk, which has no influence on the content. Educational materials are developed by an independent steering committee comprised of international diabetes experts in conjunction with Liberum IME.

“Because so many healthcare professionals need to grow their expertise in managing this disease, there is a vital need for easily available educational tools, materials and resources.”



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Time for a rethink in healthcare: The treatment of diabetes

Paulus Carpelan, Vice President at Quattro Folia Oy argues that now is the time to rethink healthcare when it comes to the treatment of people with diabetes

Diabetes, as a chronic condition, is managed through the daily decisions on how to eat, sleep, take medication, exercise, etc. These small decisions directly affect the overall care balance of a diabetic and in that respect, to the risks of diabetes-related complications.¹ Traditional diabetes care is handicapped to prevent the diabetes-related complications, as it cannot help diabetics with their own everyday challenges. It is only when complications emerge, that active healthcare interventions are used. It is time to focus on managing diabetes to prevent as many complications as possible.

The problem in diabetes care today is that the current care model is not designed for people with a chronic condition. Pre-scheduled routine appointments do not meet the needs of a diabetic. The clinician's ability to help the diabetic is very limited, based on such encounters. As a result, time and time again, you can find comments from diabetics repeating how the current care model leaves them alone and helpless with their diabetes.

"I told my consultant that I felt horrendous, he replied 'I'm not here to talk about your emotions.'"²

In-between the routine appointments, the diabetic is totally on their own to

treat their diabetes and the outcome is depending on the individual's own know-how and motivation to treat themselves every day with no visibility of the progress on the way.

"The worst thing is the sheer isolation, I'm left to work it all out on my own with no help or support."²

From fixing the consequences to managing the problem

In the UK, each year, 75,000 people with diabetes die, 32% of them die early.³ Diabetes is the leading cause of blindness in people of working age.^{4 5} Every week diabetes-related complications cause over 100 amputations. Up to 80% of these are preventable.⁶

In the UK, the cost of diabetes is predicted to grow from the current 10% to 17% of the entire NHS budget over the next 20 years. Of that, up to 80% of the costs are due to complications. Add to that the social security costs related to diabetes complications.⁷

At the same time, the studies show that up to 50%...80% of complications could be avoided by focusing on helping diabetics to better manage their diabetes condition.^{6 8} Based on the available evidence, it is time to look at new ways of how to take care of people with diabetes.

Balansio - New way to provide timely and need-based care

Balansio is a diabetes management system for hospitals and clinics to provide diabetes care directly to the daily life of their diabetic patients. With clinical intelligence, Balansio follows automatically every diabetic using the system on a 24/7 basis, by analysing their care data. This helps the diabetic to better follow the agreed care plan on a daily basis. The goal here is to enable the individual with diabetes to learn and improve their own diabetes management routines. Balansio system is a cloud-based software-as-a-service (SaaS) solution, which is used through a mobile app and web application. Balansio is CE marked medical device.

Balansio puts the focus on managing diabetes

Visibility to the care status enables timely intervention and progress recognition

Visibility to a diabetic's self-care data changes diabetes management into data-driven, fact-based care. When the data is enriched with clinical intelligence highlighting the progress and issues to focus on next, it enables the diabetics themselves and the care team to recognise the achievements and build on that success the next improvements needed, one by one. When that is combined with Balansio's daily HbA1c estimation, the whole care team have holistic and continuous visibility to the diabetic's overall care balance.



Interview with Paulus Carpelan, Vice President of Quattro Folia, company behind Balansio, the newest technology for diabetes management

More time for the clinicians to concentrate on diabetics who benefit their help right now

In the data-driven care model, the need for routine appointments disappear. Automation and clinical intelligence provide the routine help and guidance directly to the diabetic's mobile application. For the clinicians, Balansio highlights the patients who need professional help the most.

Care motivation is built on increased understanding and achievements

When the clinicians have better visibility and more time to provide individualised care, they can motivate and support the diabetic including the emotional and psychological health aspect. Overall, care motivation is built on success and a feeling of empowerment. The best boost for motivation is that your clinician recognises your success and praises you on your achievements.

Goal-oriented and measurable results

The digitalised care plan in Balansio is tailored for each individual with diabetes. The care automation helps and motivates the diabetic on reaching his goals.

When new technology and intelligence is combined with the professionals to focus on helping and supporting people with diabetes to better manage their condition, it is possible to change the future of healthcare. This is mandatory, not only due to the overflowing public healthcare costs, but because it is the right thing to do for each individual with diabetes.

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New report on hospital safety for people with diabetes in the UK

Chris Askew, Chief Executive at Diabetes UK argues that more needs to be done to support the one in six people in hospital that have diabetes, who currently experience unnecessary harms that can lead to long lasting harm or death

Over a million people with diabetes were admitted to hospital in 2017. Currently, one in six hospital beds are occupied by someone with diabetes and by 2030 it is predicted this will rise to one in four.

A hospital stay for a person with diabetes can be a frightening experience and it is easy to understand why; in hospital, people with diabetes have higher infection rates and greater lengths of stay – on average one to three days more than patients without the condition.

“The NHS is under immense strain and diabetes is just one of the complex issues competing to be a priority. The evidence clearly shows that properly resourced, proactive and educated diabetes inpatient teams lead to happier patients and shorter lengths of stay.”

In 2017, an estimated 9,600 fell into a coma and required emergency treatment during their hospital stay as a result of a severe hypo; a condition where someone’s blood sugar drops too low and requires the assistance of a third party. One in 25 people also experienced diabetic ketoacidosis (DKA) a condition caused by consistently dangerously high blood sugar levels. It’s more likely you’ll experience this condition inside than out of a hospital. We can and must do better for people living with diabetes in a hospital.

The National Diabetes Inpatient Audit, launched in 2010, shows that some hospitals have made year-on-year improvements in diabetes care, but the audit also highlighted that there are huge variations in the quality of care that patients are receiving.

In response, Diabetes UK has developed a report,

Making hospitals safe for people with diabetes, by visiting over 20 hospitals, talking to people with diabetes, inpatient teams, healthcare professionals working in hospitals and hospital managers.

To make every hospital a safer environment for people with diabetes, our report – published in early October 2018 – recommends the following should be in place:

- Multidisciplinary diabetes inpatient teams in all hospitals;
- Strong clinical leadership from diabetes inpatient teams;
- Knowledgeable healthcare professionals who understand diabetes;
- Better support in hospitals for people to take ownership of their diabetes;
- Better access to systems and technology and;
- More support to help hospitals learn from mistakes.

Multidisciplinary diabetes inpatient teams in all hospitals

Evidence shows that diabetes inpatient teams reduce the amount of time people stay in a hospital and improve patients’ experience, yet a quarter of hospital sites still don’t have a diabetes inpatient specialist nurse (DISN). Last year, 235,000 inpatients should have been seen by a diabetes inpatient team and were not.

Strong clinical leadership

Diabetes inpatient teams that have made clear progress and improvements in care demonstrate exceptional

leadership, based on a foundation of resilience, courage and influence.

It's essential that diabetes is championed at a local level and that leaders are in place to ensure diabetes remains high on the agenda and that ownership is felt by staff across all hospitals.

Knowledgeable healthcare professionals who understand diabetes

Healthcare professionals are under immense pressure and pre-registration training, for nurses and doctors, doesn't always provide a sound knowledge for dealing with diabetes. Ward pressures also mean that many staff cannot access the training on offer. High staff turnover and use of agency staff also make the sustainability of training difficult.

To overcome this considerable challenge, Diabetes UK Clinical Champion, Ruth Miller, has created a 10-point training programme to recognise the reality that many of the most complex patients have their care delivered by non-experts. You can find this training on the [Diabetes UK website](#).

Better support in hospitals for people to take ownership of their diabetes

While healthcare professionals have a key role to play in helping a patient manage their diabetes, it is a condition that requires a considerable amount of self-management. Too often people are unable to determine the amount of carbohydrate in their food and the choice of meals is poor. Snacks need to be readily available, reducing someone's chance of experiencing low blood sugar, particularly at night. Where appropriate, patients should also be able to self-administer insulin and to manage their blood sugar levels. All patients living with diabetes should benefit from a care plan, developed in collaboration between the healthcare team and the patient.

Better access to systems and technology

New hospital systems have revolutionised the way specialist teams work. Effective systems enable teams to identify people with diabetes on admission and to monitor those at risk throughout their stay.

Electronic prescribing and the use of electronic patient records have the potential to reduce medication errors dramatically but in 2017 only 17% of hospital sites used both. With almost one in three people with diabetes suffering a medication error, introducing new systems is fundamental to improving care.

More support to help hospitals learn from mistakes

Four per cent of people with Type 1 diabetes experienced hospital induced diabetes ketoacidosis as a result of under treatment with insulin in 2017. This simply should not happen in a hospital. Since it is not always reported as serious harm it is routinely under-reported so there's no opportunity to learn from the event. People with diabetes experience fewer harms in hospitals where errors are reported, owned and managed, with action taken so they don't happen again.

Conclusion

The NHS is under immense strain and diabetes is just one of the complex issues competing to be a priority. The evidence clearly shows that properly resourced, proactive and educated diabetes inpatient teams lead to happier patients and shorter lengths of stay. Change can be difficult, but with the right support, by sharing learnings and successes, it is possible. We will continue to work for better care for people with diabetes until every patient feels safe in a hospital, from the time of admission to the point of discharge. ■

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The Roche digital solution to the diabetes challenge

Diabetes is described as the epidemic of the 21st Century, in the view of Roche Diabetes Care, who are using digital technology and data management to help patients, healthcare professionals and payers address this costly challenge

There are more than 400 million people globally who live with diabetes¹. In the UK alone, this figure is 4.5 million people². The incidence of the disease, which is a characterised condition by high blood sugar levels, is growing – indeed, estimates suggest that some 629 million people worldwide will have diabetes by 2045¹.

Much of this increase is driven by type 2 diabetes, but type 1 diabetes is still a concern with the number of cases increasing by 4% a year³. Regardless of the type, however, diabetes is a chronic condition, which is posing a costly concern for healthcare systems around the world. Meanwhile, people with diabetes are forced to juggle complex and fragmented data and make difficult medical and lifestyle decisions for themselves 24/7.

In many ways, diabetes has reached a tipping point. Just 6.5% of people with type 2 diabetes in Europe achieve their combined therapy targets⁴; the rest are struggling. In addition, physicians lack time and infrastructure support to sufficiently manage their patients and the disease. Together, this is putting pressure on healthcare systems and the costs are mounting¹; in the UK, for instance, treating diabetes and associated complications represents 10% of the NHS budget, amounting to £10 billion each year⁵. The healthcare challenge presented by diabetes is immense – but it's not insurmount-

able. The challenge is making the system sustainable in the long-term.

The solution to this complex problem cannot solely be delivered by the introduction of another pharmaceutical drug. As Dr Partha Kar, diabetes and endocrinology consultant and associate national clinical director of diabetes with NHS England, said recently during techUK Rise of the Machines event: "It's not a new insulin alone that's going to change diabetes treatment – it's technology".

Roche Diabetes Care believes that digital health solutions and integrated diabetes management solutions have the power that will move the needle, bringing true relief to people with diabetes and developing a transparent system for healthcare professionals and payers that drives optimal care for this chronic condition.

Roche Diabetes Care envisions a holistic approach to addressing the diabetes challenge. Driven by technology and integrated solutions, this one open ecosystem, involving input from partners and other stakeholders, will ensure people with diabetes benefit from improved outcomes, physicians have the means to manage the disease and treatment, while payers can track the costs.

By better managing diabetes and designing more efficient healthcare

infrastructure and support systems, great strides can be made in avoiding the costly and life-altering complications associated with this disease. Roche Diabetes Care's approach aims to directly address the multifaceted and clinical complexity of diabetes currently seen across the healthcare system⁶.

The key to achieving improved outcomes is focusing on the data, with the patient at the centre. Diabetes is a complex condition where people with diabetes must monitor various and often times confusing, data sources including insulin and blood sugar levels, activity and nutrition. This complexity can be mastered by moving beyond drugs alone and taking a holistic approach where tools can integrate and analyse the data to help make treatment decisions, delay disease progression and empower people with diabetes to better manage their disease. This data can also be shared between the person with diabetes, their healthcare professional and their payer.

The Eversense[®] XL continuous glucose monitoring (CGM) system by Senseonics Inc is one example where Roche Diabetes Care, as the distributor in the UK and some European countries, is combining digital technology with data management in an open ecosystem to improve outcomes for people with diabetes. The Eversense XL CGM system by Senseonics is an implantable CGM

sensor, which can measure glucose values for up to 180 days, compared to seven or up to 14 days for non-implantable systems that are currently available in the market⁷.

The sensor is implanted underneath the skin on the upper arm and communicates with a rechargeable wearable smart transmitter, which alerts the person with diabetes when glucose levels become too high or too low. Meanwhile, real-time insights on glucose data and trends are relayed to The Eversense smartphone app. This CGM system provides people with diabetes more support in managing their blood glucose levels and therefore helps to better manage their condition. Furthermore, this data can easily be shared with the individual's physician for a more personalised approach to care.

In clinical trials, people with diabetes who used The Eversense CGM system for 180 days saw a reduction of 0.35% in their HbA1c, which identifies the average plasma glucose concentration⁷. The higher HbA1c, the greater the risk of developing diabetes-related complications, CGM has also been shown to support people in managing the extreme fluctuations of glucose which can cause both immediate harm and long term damage such as cardiovascular disease.

Systems such as The Eversense XL CGM system are digitising the data in such a way to make it more meaningful and transparent for people with diabetes and healthcare professionals. By managing the flow of this data, systems such as The Eversense CGM system are directly addressing the vast majority of the problems and challenges associated with diabetes. In addition, digitising data allows healthcare to move in the direction of personalised treatment, providing the right treatment for the right patient at the right time, which will also help to



Interview with Françoise Le Poulichet, Roche Diabetes Care, International Business Leader, Insulin Delivery Systems

overcome clinical inertia, improve outcomes and cut costs.

It's particularly notable that solutions such as continuous glucose monitors and digitally connected and integrated diabetes management solutions are what people with diabetes want. Healthcare systems around the world have already witnessed patients who, frustrated by the slow uptake of technology, have turned to reverse engineering and algorithms to create their own diabetes management solutions themselves.

In response to this do-it-yourself movement, the US-based JDRF has called for greater action on the part of industry and regulators to accelerate getting this technology to market and find ways to put in place the regulatory and legal frameworks for safe and approved technology to support the evolving research and development of artificial pancreas technology. Roche Diabetes Care is currently exploring different ways this collaboration with JDRF and other stakeholders could work. This is also an example that tackling the diabetes challenge requires a collaborative and innovative approach

that taps into the new technologies available.

Now is the time to elevate the debate, to involve all stakeholders, including people with diabetes, to work alongside the medical devices industry to address the challenges of this complex condition and to improve the outcomes for people with diabetes and healthcare systems alike.

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Digital innovation in diabetes: From health promotion to integrated care provision

Prof Dr Freimut Schliess, Director of Science & Innovation at the Profil Institut für Stoffwechselforschung GmbH shares his views on data-based solutions for diabetes

By way of background, diabetes today is a huge and multidimensional challenge for global societies. Many patients don't reach their treatment goals. According to the UK National Diabetes Audit data 2016-2017, only 30% of people with Type 1 diabetes (T1D) and 67% of people with Type 2 diabetes (T2D) achieved a HbA1c target of not more than 58 mmol/l (7.5%).

When considering also blood pressure and cholesterol targets, these figures dropped to 19% and 41% respectively. The good news is that diabetes leaves a huge space for innovation – due to the modifiability of risk factors, the potential reversibility of the disease and the outstanding role of the patient's self-management.

Diabetes – a data management disease

Diabetes was referred to as a data management disease. Informing the patient's treatment decisions by a (digital) processing of real-time and real-life metabolic and behavioural data is the procedural core component of contemporary diabetes therapy and leads to the generation of a vast amount of data – leaving exciting opportunities for digital solutions in personalised and integrated diabetes care.

The digital processing of real-life data also has an enormous potential to fully exploit the preventability and



reversibility of T2D. Moreover, in a collaboration between the JDRF and IBM big databases are established following the ambition to phenotype T1D classes, to predict the onset of T1D and to model T1D progression.

Digital biomarkers in clinical trials

The sensor-based collection of real-life data for the assessment of digital biomarkers in diabetes trials is going to greatly improve the external validity of clinical trial outcomes. Digital biomarkers will help to model the impact of treatment-effect-modifiers on drug efficiency and will include endpoints relevant for coping with everyday life. Thereby, digital biomarkers will help to narrow the well-known discrepancy between drug efficacy found in well-controlled clinical trials and drug

effectiveness, observed in everyday clinical practice (E2E gap).

Innovation barriers – cross-sectional topics

Digital health technologies combined with the increasing availability of user-generated databases create huge opportunities for people-centred solutions improving health, health-related quality of life and health economic sustainability – and a strong momentum for societal and entrepreneurial investment in digital diabetes care. Focusing on a highly modifiable medical indication across the continuum, from early disease interception to disease management, could be attractive to set up a paradigm example for generating an impact that is really tangible for societies. At the same time, it seems appropriate to drive



forward a cross-sectional approach to remove innovation barriers to digital health technologies.

“Promoting digital innovation for gradually optimising diabetes management in a personalised way will realise the twin objective of improving everyday metabolic control and re-adapting behavioural habits to prolong the patient’s independence and prevent the development of frailty & disability, as well as comorbid conditions.”

Cross-sectional topics best addressed in an open and collaborative innovation culture integrating actors from R&D, education and business creation include the following:

- Co-creation: The involvement of users and other stakeholders early in the design and evaluation of digital solutions. Joint decision-making power along the lines of marketing authorisation, added value definition and eligibility for reimbursement.

- Data: The debate is on ownership, availability, integrity and the remuneration of data sharing. Data management policies and systems securing interoperability, privacy and cyber-resilience are considered to be of the utmost importance.

- Regulation: Quality assurance and regulatory requirements for lifestyle and medical apps need to be clarified. Also, the exploitation of real-world data repositories for marketing authorisation and informing personalised treatment decisions is a key concern.

In perspective: closing the loop towards an integrated personalised diabetes management

Digital diabetes technologies available today, such as devices for a real-time continuous and flash glucose monitoring (rtCGM, FGM) and automated insulin delivery (AID, artificial pancreas systems) can be considered as transition technologies. Digital tools are predicted to gradually become integrated

as part of a more interconnected holistic ecosystem of digital health and social care.

Here, a comprehensive monitoring of metabolic signatures and parameters reflecting patterns of everyday behaviour will produce a huge amount of real-world data which could be processed by self-learning control algorithms. The outcome will trigger an adjustment of therapies, social interventions and behavioural patterns which again will provide feedback in terms of the captured parameters.

Promoting digital innovation for gradually optimising diabetes management in a personalised way will realise the twin objective of improving everyday metabolic control and re-adapting behavioural habits to prolong the patient’s independence and prevent the development of frailty & disability, as well as comorbid conditions.



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The link between diabetes and mental health

Open Access Government investigates the link between diabetes and mental health

People with diabetes suffer disproportionately high rates of mental health problems, such as depression, anxiety and eating disorders. But new approaches are being developed to integrate physical and psychological care.

Living with a long-term condition has an obvious physical cost but, in the past, the mental toll of living with the pain and stress has often been overlooked.

Some 3.7 million people in the UK have been diagnosed with diabetes, according to the most recent figures from charity Diabetes UK. It estimates that another one million are living with the condition but have not yet been diagnosed – and a further 12.3 million are at heightened risk of Type 2 diabetes.

“As the NHS turns 70, integrated talking therapy services are a big step forward for our patients and a crucial part of putting mental health at the centre of our plans for the future of the health service in England.”

Research by the same body, published in November 2017, shows that three in five people with diabetes experience emotional or mental health problems because of their condition.

One in five of the 8,500 people surveyed had sought professional counselling or support to help them manage their diabetes. Only around one in three (30%) said they felt fully in control of their diabetes.

“Diabetes affects more than 4.5 million people in the UK and is the fastest-growing health crisis of our time. It can lead to heart disease, stroke, kidney failure and lower limb amputations”, says Chris Askew, Chief Executive of Diabetes UK.

“This research brings to light the isolation that can come from managing an invisible condition and how detrimental living with diabetes can be to a person’s emotional wellbeing without the right support.

“Effective diabetes care requires that a person’s emotional needs are taken into account alongside their physical care needs.”¹

The first model of care in the UK to integrate diabetes, psychological and social care for people with poor glycaemic control was launched in 2010. The Three Dimensions for Diabetes (3DFD) service, based at King’s College Hospital NHS Foundation Trust, was aimed at people living with complex psychological needs that could not be met by existing, generic psychological therapies.

It focused on the London boroughs of Lambeth and Southwark, which had some of the highest levels of deprivation in the capital and an estimated 28,000 people living with diabetes. Around one-third had psychological or social problems, such as homelessness, debt or unemployment, that affected their ability to self-manage their condition. As a result, they often failed to engage with regular health and social care services and made frequent visits to A&E.

The 3DFD scheme found that patients valued being supported by a single team, with different skills allowing a faster, more integrated response to their needs.

It also found that for patients with regular hospital admissions and poor engagement with scheduled care, the time in the hospital provided a good opportunity to intervene in order to shorten admissions and enable engagement.

Furthermore, it demonstrated that “hard to reach” groups were not necessarily so. Patients’ perceptions of the service were an important factor in their engagement and the team found that telephone contact, SMS reminders, home visits and feedback to referrers improved attendance rates, particularly among Black, Asian and Minority Ethnic (BAME) communities.

An evaluation of the programme in 2013 found significant improvements in psychological scores relating to depression, anxiety and diabetes-specific distress.

There were also improvements in measurements of social functioning across multiple categories, including personal responsibility, living skills, social networks, substance misuse, meaningful use of time and accommodation.

Less than 10% of patients from phase one of 3DFD were referred back to the service in phase two, indicating the integration of patients back into routine care and low relapse rates.

In addition, the programme showed a saving of £56,700 for 119 patients during the first phase through a reduction in A&E and acute diabetes-related hospital admissions and re-admissions over a 12-month period. Analysis by the Diabetes Modernisation Initiative projected further savings of £102,000 per 120 patients, year-on-year, across Lambeth and Southwark in delaying or preventing diabetes complications.²

More recently, in 2016 NHS England began testing new services that integrated mental and physical treatments for long-term conditions under the Improving Access to Talking Therapies (IATT) programme.

These services provide a “whole-person assessment” that focuses on the mental health care patients may need to manage their condition.

One scheme in Cambridgeshire and Peterborough showed that timely and effective mental health care for people with diabetes, cardiovascular or respiratory illness reduced inpatient hospital attendance by three-quarters and A&E admissions by 61%, saving £200,000.

Overall, the IATT service, which has been described as “the world’s most ambitious effort to treat depression”, delivered a record high recovery rate for patients of 51.9% earlier this year.

NHS England National Director of Mental Health, Claire Murdoch, says: “Effective NHS mental health care for people with long-term illness is a game-changer for our patients and good news for taxpayers. By integrating talking therapies with treatment for diabetes and heart conditions, NHS patients get care for mind and body at the same time.

“As the NHS turns 70, integrated talking therapy services are a big step forward for our patients and a crucial part of putting mental health at the centre of our plans for the future of the health service in England.”

The NHS has also announced that it will scale up the Diabetes Prevention Programme in 2017-18 and 2018-19.

Additionally, around £44 million a year has been allocated to a Diabetes Transformation Programme to improve treatment and care by promoting access to evidence-based interventions. Clinical commissioning groups (CCGs) can bid for the national funding to support the uptake of structured education; improve access to specialist inpatient support and to a multi-disciplinary foot team for people with diabetic foot disease; and improve the achievement of treatment targets while reducing variations between CCGs.³ ■

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The impact of mental health and physical treatments on wellbeing

Sarah Bateup, Chief Clinical Officer at Ieso Digital Health, introduces the first in a two-part series of articles demonstrating how combining mental health treatments with physical treatments can have a positive effect on the overall wellbeing and outcomes for patients

Approximately 3.2 million people have a diagnosis of Type 2 diabetes in the UK. It is estimated that this number is likely to rise in the next 10 years. People who have Type 2 diabetes are twice as likely to have a common mental health disorder such as anxiety or depression. Anxiety disorders and depression can make it harder for people with diabetes to manage their condition effectively and this can lead to further complications and poor quality of life.

It is recognised that people who have diabetes and a co-morbid mental health disorder, respond well to evidence-based psychological therapies such as cognitive behavioural therapy (CBT). However, most of the research studies, to date, have focused on the provision of face-to-face CBT. While highly effective, there is an insufficient provision of CBT to meet the needs of the numbers of people who require it. Other methods of delivering effective interventions are required.

Online methods

Online guided self-help methods are one response to the lack of availability of CBT. The shortage of therapists who are trained to deliver psychological interventions for patients with a long-term condition, such as diabetes, is a significant issue.

Guided self-help methods do not require specialist clinicians to deliver



a psychological therapy as they rely on web-based materials that patients can read in their own time. Patients may also receive occasional support by phone or email to help guide them through the online reading materials.

Guided self-help methods have been demonstrated to be effective, although high drop-out rates have been reported.

The Ieso Method

One online method, which is significantly different, has been developed and implemented by Ieso Digital Health. This method uses the British Association of Cognitive & Behavioural Psychotherapy (BABCP) accredited CBT therapists to deliver CBT, online, using synchronous written communication.

Patient and therapist communicate through typed conversation in real time. The transcript of each therapy

session, conducted in this way, is encrypted and held on a secure site for both the therapist and patient to access at any time. An example of a CBT session conducted using this method can be seen in Figure 1.

One aspect of this method that is novel and unique is the availability of therapy transcripts for every therapy appointment attended. This is the first time that it has become possible to examine live therapy material, at volume, in a clinical setting.

In addition to a weekly CBT appointment, the therapist and patient can also communicate with each other in between therapy appointments. This asynchronous communication can be used to amplify the effect of CBT by encouraging the patient to focus on between-session tasks, goals and consolidating learning that has taken

place during a therapy session. Contact with a therapist between appointments tends to be less common in traditional, face-to-face, CBT.

The Ieso Method has demonstrated equivalence to face-to-face CBT in the treatment of over 20,000 with common mental health disorders. Patients are equally as likely to recover using the Ieso Method. In addition, this method enables patients to access effective interventions at a time of their choosing and therefore widens access to psychological therapies. This ability to access therapy from home at any time of day has clear advantages for patients with a long-term condition, such as diabetes.

While it is established that the Ieso Method is an effective and convenient way to deliver CBT, this method has far more to offer. When you put a computer between a CBT therapist and a patient, you develop a data set that has the potential to reveal the answers to many important questions and these answers will help drive up the standards of care. For the first time ever, it has become possible to understand what the best therapists are doing with their patients and, conversely, what the least effective therapists are doing.

The possibilities for future care

The possibilities for future care are ground-breaking. The Ieso Method is basically a standard trial platform, whereby Ieso's clinicians, researchers and scientists are able to systematically answer a series of research questions including:

- Why are some CBT therapists better than others?
- Why have recovery rates for anxiety and depression stagnated?
- How do you increase recovery rates?

Live Session

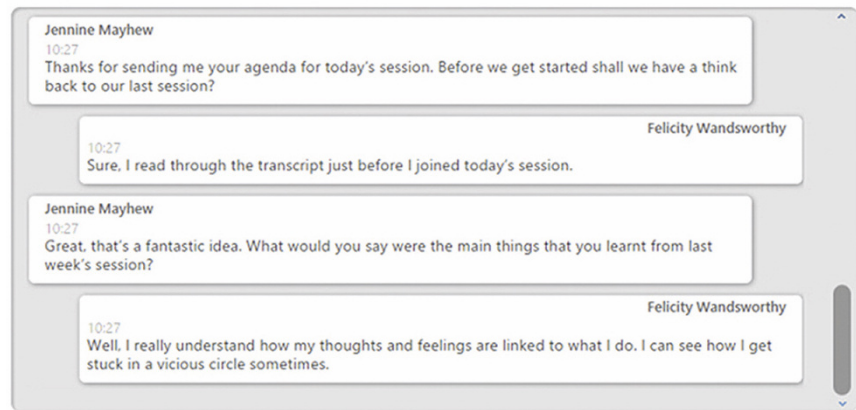


Figure 1: An example of CBT being delivered via the Ieso Method

- How do you help therapists to be the best they can be?
- What are the most effective treatment protocols for depression?
- How can you enable patients with a long-term condition to cope with and manage their condition?
- How do the therapist's beliefs impact on the delivery of treatment?
- How do you personalise psychological medicine?

The team at Ieso are beginning to answer these questions both in the lab and in clinical settings. The learning that is drawn from research questions like this can quickly be implemented in clinical service delivery enabling more patients to benefit.

Ieso is currently working on a research trial of 1,000 patients who have Type 2 diabetes and a co-morbid common mental health disorder. Ieso will train a cohort of its 500 CBT therapists in diabetes-specific CBT. The therapists will treat patients who have a diagnosis of Type 2 diabetes and a co-morbid mood disorder. The research questions for this study are:

1. Does the Ieso Method demonstrate equivalence to face-to-face CBT in relation to recovery rates for anxiety and depression and reduction in diabetes distress?

2. Does the Ieso Method enable patients to increase self-efficacy in managing their diabetes as measured by the Patient Activation Measure (PAM)?

This is the first study that investigates the efficacy of online, therapist-delivered CBT specifically for patients with diabetes and a co-morbid mental health condition. The research is timely and necessary now, particularly if we are to begin to tackle the dual problem of a lack of availability of CBT and an increase in the prevalence of diabetes and mental health disorders.

Imagine a world where technology enables everyone to access evidence-based psychological therapy...



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Could escalating diabetes rates reverse success in reducing heart disease deaths?

Simon Gillespie, Chief Executive of the British Heart Foundation ponders if escalating diabetes rates could reverse success in reducing heart disease deaths

Since the 1970s, the UK has achieved tremendous success in halving the number of deaths from heart and circulatory diseases. This has been bought about by better medical treatment, more effective medicines reaching those people at risk and, importantly, a huge drop in the number of smokers.

Nevertheless, heart and circulatory diseases still contribute to more than a quarter of all deaths in the UK, killing on average one person every three minutes.⁽¹⁾ While this number remains high, there are worrying signs that the improving trend will reverse in the future.

Reductions in death rates could be threatened

One of the key risk factors for these conditions is diabetes. Diabetes happens when there are constantly high levels of glucose in your blood. This is because your pancreas can't produce enough of a hormone called insulin which controls your blood glucose levels. High levels of glucose in your blood can damage the walls of your arteries, making it easier for fatty deposits to stick to them. If this happens you are at higher risk of heart and circulatory diseases such as a heart attack or stroke.

In England today, approximately 4 million people suffer from diabetes and this figure is expected to rise to over 5 million in the next 20 years.⁽²⁾ The vast majority of people who suffer from diabetes have Type 2; only 10% are diagnosed with Type 1 in the UK.

It's all connected

We know that people living with diabetes are three times more likely to have a heart attack or stroke. As such, any rise in the numbers of diabetes cases will lead to similar sharp increases in deadly heart and circulatory events.⁽³⁾



Simon Gillespie, Chief Executive

New figures we released last month forecast that the number of people suffering heart attacks and strokes as a result of Type 2 diabetes will rise by 29% by 2035. Or put another way, in 2035, 39,000 people living with diabetes will suffer heart attacks and 50,000 people will suffer strokes. However, the good news is that Type 2 diabetes can be prevented and treated.

Causes of diabetes are complex

It's clear that the causes of diabetes are complex and linked to many variables, which are often beyond our control, including where someone lives, their family and socio-economic group. People from poorer backgrounds and certain ethnicities are more likely to develop diabetes. Although we're still working to fully understand the reasons why someone develops diabetes, we do know that we need to improve prevention of diabetes, especially amongst the most vulnerable



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groups to reduce the gaps in society, which are so closely linked to health.

Tackling diabetes head on

We need bold action to tackle the factors, such as obesity and a poor diet, that are leading to spiralling rates of Type 2 diabetes, greater awareness within the general public and a sharper focus within the health sector on earlier diagnosis.

The regulatory action also has a part to play. Chapter two of the UK government's Childhood Obesity Plan is a welcome step, but we need to ensure that those commitments within the plan are taken forward, helping to empower individuals to make the healthiest choices for themselves and their families.

This includes restrictions on television and online advertising of junk food to children and banning the promotion of unhealthy food and drink by price and location. We know that the odds are stacked against some people, but changes to legislation can lead to significant health gains, as previous governments' actions on smoking have shown.

We also need more research to better understand why particular groups are at higher risk of diabetes and to combat heart and circulatory diseases in people living with diabetes, so that they are able to live healthier lives for longer.

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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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Living with acute myeloid leukaemia (AML)

Bethany Torr, Campaigns and Advocacy Officer at Leukaemia Care explores the challenges of living with acute myeloid leukaemia (AML)

September 2018 was Blood Cancer Awareness Month and Leukaemia Care launched findings from their second leukaemia patient experience survey. Living with Leukaemia reveals and quantifies the issues experienced by leukaemia patients from diagnosis through to living with or beyond blood cancer.

The survey conducted between September and December 2017, received 2329 responses from leukaemia patients, 443 of which were from acute myeloid leukaemia (AML) patients.

AML is a quickly progressing (acute) type of blood cancer. There are around 3000 people diagnosed in the UK each year. Two-thirds of patients (66%) are over the age of 65 years old at diagnosis, but it is a cancer that affects people of all ages, including children.

Survival of AML is significantly age-dependent with children responding very well to treatment, but overall five-year survival rates are incredibly poor. In England, five-year survival for men is 14% and 16% in women. Unfortunately, while understanding of AML subtypes has improved over time there has been little progress in treatment over the past few decades, with intensive chemotherapy remaining the first line of treatment. This is something which many patients are not fit enough to tolerate.

The Leukaemia Care survey revealed that two in three patients were not offered a choice of treatment options at diagnosis. This may be due to both the lack of treatment options and the necessity to begin treatment quickly. Over half of patients (55%) start treatment within a week of receiving their diagnosis, with 20% starting on the same day.

Many AML patients are, however, offered the choice to join a clinical trial (62%). This is more likely to happen



80% of AML patients are offered some form of additional support, such as CNS access, counselling or psychotherapy, and support groups

if patients have relapsed following initial treatment because there are limited options for these patients beyond a stem cell transplant and survival is very poor.

Patients report significant side effects of treatment, with 41% stating the side effects had a large impact and just 14% stating that they were barely noticeable. The most commonly experienced side effects are: fatigue (70%); constipation or diarrhoea (43%);



Two thirds of AML patients are over the age of 65 years old when they are diagnosed



53% of all AML patients are diagnosed by an emergency route

infections (41%); muscle, bone or joint pain (37%); neutropenia (34%); nausea or vomiting (34%); and itchy skin/rashes (34%).

The impact of an AML diagnosis, however, goes much further beyond survival statistics and treatment side-effects. The quality of life for a patient and their family is significantly affected by the diagnosis in terms of emotional, practical and financial implications.

Leukaemia affects people of all age groups, not just the elderly and children and 63% of patients were in work or education at the time of diagnosis. Of these people, the majority (79%) are forced to stop work/education following diagnosis. While this is temporary for many people during treatment, over one in three patients (38%) are forced to permanently stop, demonstrating the long-term implications of a diagnosis.



79% of AML patients were forced to stop work/education following diagnosis

This ultimately has implications for financial circumstances with 56% of AML patients stating that their diagnosis had a negative impact on their finances, due to increased costs or reduced income. The cost of AML, for those who state a negative impact, is on average over £600 each month.

From the shock of receiving a diagnosis to going through treatment and facing the practical and financial implications, it is no surprise that patients face a significant emotional burden during this time. Two in five patients (42%) report feeling more depressed or anxious following diagnosis and 5% stated feeling constantly depressed or anxious. Fortunately, 80% of patients are offered some form of additional support, such as clinical nurse specialist access, counselling or psychotherapy and support groups.

Leukaemia Care is using the Living with Leukaemia survey findings to guide both the work they are doing to support patients and their campaigns to improve outcomes and the quality of life. This includes the Blood Cancer Awareness Month campaign, Spot Leukaemia.

Currently, 53% of all AML patients are diagnosed by an emergency route, which significantly impacts both one and 12-month survival. Spot Leukaemia aims to improve early diagnosis of leukaemia by improving public understanding, raising awareness of the signs and symptoms and supporting GPs to better recognise and diagnose blood cancers. Early diagnosis saves lives. ■

Find out more about Leukaemia Care's Living with Leukaemia report and Spot Leukaemia campaign by visiting: www.leukaemiacare.org.uk/get-involved/our-campaigns/

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CD33-directed therapy: Current and future perspectives on targeted therapy in acute myeloid leukaemia (AML)

Mohammed Gbadamosi and Jatinder K Lamba from Department of Pharmacotherapy and Translational Research at the University of Florida explain CD33-directed therapy for acute myeloid leukaemia (AML), focussing on current and future perspectives

Acute myeloid leukaemia (AML) is a complex heterogeneous disease characterised by a variety of cytogenetic abnormalities and recurrent molecular mutations and aberrant expression patterns. As the most common and second most common leukaemia in adults and children respectively, many strides and efforts using new technologies and personalised treatment approaches are being undertaken to address and improve therapy surrounding the disease.

However, despite these efforts, outcomes surrounding the disease remain abysmal. In particular, for younger patients, complete remission (CR) rates of greater than 80% are achievable, however, the 5-year overall survival (OS) still remains relatively low at ~40% in comparison to other cancers due to high relapse rates. The outcome is even worse for older patients with five-year overall survival at less than 25%.² To address these poor outcomes, several targeted therapeutics have become popular additions to the mainstay 7+3 induction therapy.

Among these promising options are CD33-directed immunotherapeutics including antibody drug conjugates, as

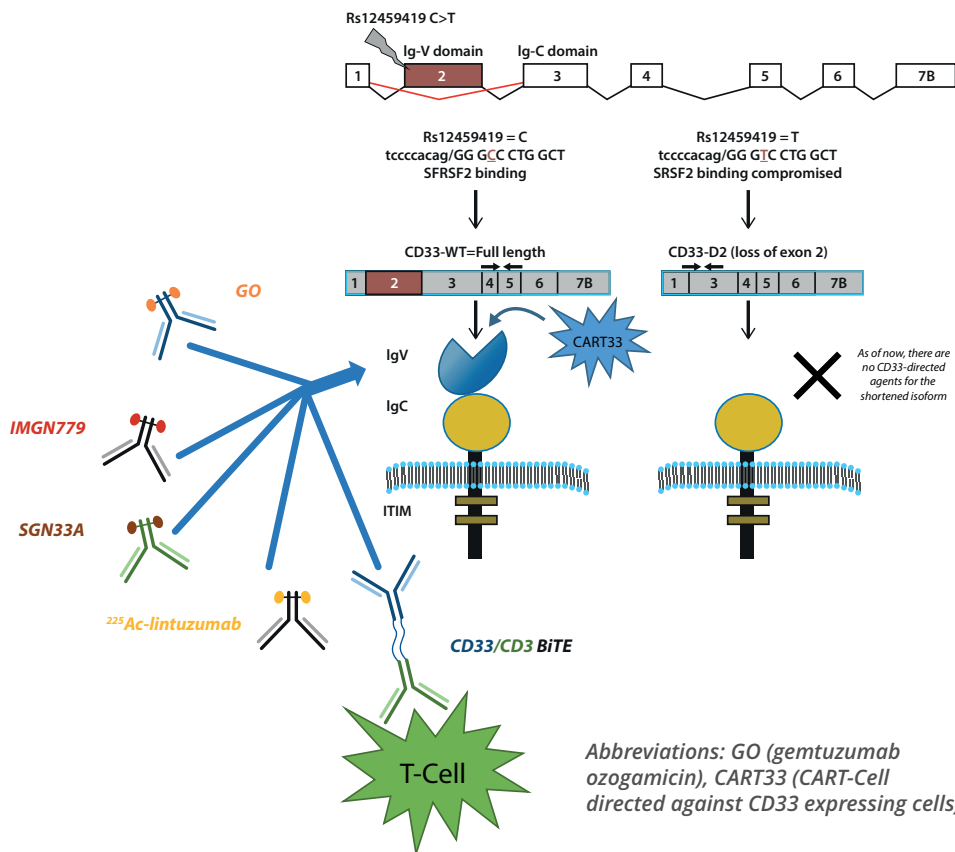
well as other CD33-directed therapies using newer technology like bispecific T cell engaging antibodies (BiTE) and chimeric antigen receptor T-cell (CART) therapy. The efficacy of these CD33-directed therapies is rooted in the ubiquitous nature of CD33 as an antigen marker present on AML blasts in 90% patients making it a potent distinguisher of AML blasts.³ While its specific biological function is yet to be elucidated, CD33 is a known regulator of various cell processes related to calcium mobilisation, cytokine release and transcriptional activation.⁴ Additionally, CD33 is internalised when engaged with antibodies thus making it an ideal vehicle for antibody-based therapies.

Emergent CD33-directed therapies

The recognition of this internalisation mechanism is the inspiration behind many of the ADCs targeting CD33 such as gemtuzumab ozogamicin (GO; Mylotarg™) which recently received reapproval by the FDA in September 2017. GO is structurally composed of hP67.6, a CD33-directed monoclonal antibody, covalently linked to the cytotoxic agent N-acetyl gamma calicheamicin.⁵ The story of GO in AML has been remarkable,

starting with accelerated approval in 2000 based on promising results from phase II studies, voluntarily withdrawn in 2010 due to increased induction death and no observed survival benefit in the post approval phase III study. Despite these setbacks, much has been and still remains to be learned from the story of GO and results from multiple subsequent phase III clinical trials have allowed recent breakthrough re-approval of GO as a low fractionated dose for treatment of AML.⁶⁻⁸

Following GO, several other ADCs directed to CD33 were designed and are currently undergoing development. Vadastuximab talirine (SGN33A) is generated through conjugation the CD33-directed antibody lintuzumab and a pyrolobenzodiazepine dimer.⁹ Early clinical trials in relapsed AML have shown encouraging results, but unfortunately, due to a higher rate of deaths in phase III clinical trials, all SGN33A studies have been placed on hold. At this time, the cause of these early deaths is not clear, further work will be required before the potential of SGN33A can be re-evaluated for treatment of AML. IMGN779 is another ADC directed to CD33 using a humanised anti-CD33 antibody



How can we improve CD33-directed therapy?

With a growing catalogue of CD33-directed therapeutics, interest surrounding treatment paradigms utilising CD33 have been piqued (Figure 1). Specifically, factors influencing crucial steps related to internalisation processes, release and activation of a therapeutic warhead, the intracellular levels and DNA binding capabilities of cytotoxic agents, as well as the efficiency of downstream DNA damage repair pathways and apoptotic pathways can play a critical role in defining the therapeutic efficacy of CD33-directed agents.

Expression levels of CD33 have been evaluated from multiple phase II and phase III clinical trials of GO. Previously, *in vitro* data have shown CD33 expression to be associated with greater GO efficacy; however, results from initial clinical trials in adult AML patients have shown conflicting results with CD33 expression with clinical response. Overall, the relationship between CD33 blast expression levels is inconclusive with follow-up studies needed, however, this information can be used to determine patients should receive CD33-directed agents based on the potential benefit to be gained.

In our group, we have described genetic polymorphisms in CD33 that may be related to the response of GO.¹⁵ Through our studies, we have identified rs12459419 (C>T; Ala14Val) as a critical regulator of response. Located in exon 2, rs12459419 is a coding SNP present within four base pairs of the intron/exon junction and impacts the exonic splicing enhancer binding site for SRSF2 resulting in skipping of exon 2. The shorter CD33-isoform (D2-CD33) lacks the IgV-domain due to alternate splicing. Loss

Z4681A and contains DGN462, a novel DNA-interacting IG N molecule.¹⁰ With encouraging results from *in vitro* studies, phase I trials are for IMGN779 currently underway. Newer approaches using alpha particle therapy and other radioimmunology-based strategies have also shown encouraging results.²²⁵Ac-lintuzumab, the premiere the therapeutic of this drug class for AML uses ²²⁵Ac to generate α-emitting isotopes, which induces a cytotoxic dose of alpha radiation killing AML blasts.¹¹ Promising preliminary results from a first-in-man safety and pharmacology study, as well as preliminary data on the feasibility of combinatorial treatment regimen are currently available.¹²

CD33 has also been explored for use in the realm of T-cell therapy. AMG330, a CD33/CD3 Bi-specific T-cell engager (BiTE), contains two fused single-chain monoclonal antibodies, which allows AMG330 to simultaneously take advantage of the pervasive nature of CD33 as an antigen in AML

and the activation pathway of T-cells through CD3 binding.¹³ In essence, AMG330 works by recognising CD33⁺ AML blasts and forming a link to neighbouring T-cells. The connected T-cell then releases proteins, which induce apoptosis of the AML blast. *Ex vivo* and *in vivo* studies using patient samples and immunodeficient xenograft mice models respectively have demonstrated effective recruitment of T-cells by AMG330 and significant inhibition of tumour growth. Chimeric antigen receptor T-cell (CART) therapy, using CD33 as a target, is being investigated as well. CART cells targeted to CD33 (CART33) are developed by using a disarmed virus to engineer the T-cells to produce receptors for CD33 on their surface.¹⁴ Preclinical experiments have demonstrated potent anti-leukemic activity of CART33, with much excitement surrounding the development of next-generation CART cells targeted to CD33 as well as other strategies surrounding the use of CD33 in CART therapy.



Mohammed Gbadamosi

of the V-set antibody binding domain has two significant implications: it appears that most (perhaps all) available diagnostic antibodies are directed at the V-set domain, thus carriers of the T allele for rs12459419, would appear to be CD33 negative due to the lack of inclusion of the V-set domain. More importantly, loss of the V-set domain would directly affect the binding, internalisation and clinical efficacy of CD33-directed therapeutics. Altogether, these results suggest that loss of IgV domain due to presence of the splicing SNP compromises GO efficacy and, similar to expression levels, CD33 genotype can be used as a means of stratification to decide patients who will benefit from regimens including CD33-directed therapeutics.

While targeted immunotherapy is still relatively young in the realm of AML treatment, their potential in changing the field forever is palpable. Ultimately, much more additional research is needed to understand the capacity of these therapeutics, the factors affecting efficacy and the potential limita-



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tions that may arise, however, the future for the role of immunotherapy in AML treatment remains bright and propitious.

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Funding from National Cancer Institute (R01-CA132946 and R21-CA155524) supported AML pharmacogenomics in Lamba Lab.



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Improving the care of children in Europe with rare cancer

The European Society for Paediatric Oncology together with Coordinators for the PARTNER Project and ERN PaedCan highlight the importance of collaboration in order to improve the care of children in Europe with rare cancer

The challenge of **Very Rare Tumours (VRTs)** in paediatrics form a heterogeneous group of cancers that are infrequently encountered in daily practice, even in large paediatric oncology centres. For children affected by exceptionally rare tumours, the very low incidence of their disease has often limited the interest in research capable of collecting significant clinical and biological data. It is particularly difficult to produce evidence-based treatment guidelines for these patients with VRTs and consequently, physicians are forced to treat such patients only on an individual basis.

Until recently, the paediatric oncology community has shown little interest in this group of tumours, which partially explains our lack of understanding of the biology of these disorders and the difficulties encountered in conducting clinical trials.

Some VRTs arise at the paediatric age, such as pleuro-pulmonary blastoma or pancreatoblastoma. Other tumours develop more commonly during adulthood or may even be frequent in adult patients (i.e. colon cancer or malignant melanoma), but they only rarely develop in children and adolescents. There is growing evidence that at least some of them are biologically and clinically distinct from their adult counterpart. In addition, a substantial group of “borderline” tumours with uncertain clinical behaviour and no standard treatments are usually also included in the group of VRTs.

Diagnosis and treatment guidelines adopted for children often are extrapolated from those used to treat adults. However, the clinical and biological characteristics of the diseases may differ in children. Moreover, the more severe long-term consequences of radiotherapy and chemotherapy in children have to be considered.

Within such a context, these factors emphasise the need for a tailored therapeutic approach.

The recognition and treatment of such patients pose a challenge for paediatric oncologists and it may take many years to establish diagnostic guidelines and treatment concepts.

Even at the European level, some diseases are too rare to enable the recruitment of a sufficient number of cases to conduct clinical trials leading to evidence-based treatment guidelines. Therefore, the need to develop international collaborations dedicated to paediatric VRTs is imminent.

An international network dedicated to VRTs should also be able to take in charge these 'rare tumours' as promptly as possible, reducing the time gap between the first description of a tumour and the formulation of guidelines or treatment protocols.

The European paediatric oncology community, including all SIOP Europe members, have increasingly recognised the necessity to develop projects dedicated specifically to rare paediatric tumours to overcome all these obstacles. Investing more funds in investigating the relatively uncharted territory of rare cancers may be one way to maximise impact.

Introducing the PARTNER project

PARTNER (Paediatric Rare Tumours Network – European Registry) is a three-year EU project that is part of the European Reference Network for Paediatric Cancer (ERN PaedCan). Over the three-year duration, it aims to create a Paediatric Rare Tumour European Registry dedicated to children and adolescents with very rare tumours (VRTs) linking existing national registries and to provide a registry for those countries that do not already have a registry for VRTs in place.

Concretely, the following points detail the reasons why the PARTNER project is needed to tackle the challenge of VRTs:

- Very rare tumours (VRTs) are clearly part of the orphan diseases in Europe;
- A European registry will provide oversight and is a step

further on the way to improve the care of VRTs patients;

- Data collection may contribute to optimised consultation of patients with VRTs;
- Experts are ready to increase clinical research and knowledge and;
- A European registry is a fundamental tool to sustain a European network dedicated to VRTs.

The objective of this project is a platform for VRTs that could represent a model for a comprehensive approach (case registration, international case consultation and treatment recommendations and website to provide information to parents/patients) in the field of rare diseases. Specifically, the PARTNER project will create such a platform including a European registry through:

- The identification of the VRTs entities;
- The selection of a core of variables for specific entities;
- The use of common definitions and;
- Implementation of harmonised procedures for data collection, data quality control and central review.

The expected outcomes of the PARTNER project are quite concrete and specific and can be summarised as follows:

- Creating a harmonised platform that will constitute a necessary instrument to improve care for children and adolescents with VRTs;
- Harmonising data in the existing national registries in collaboration with the JRC registry platform;
- Linking the EU registry with a virtual consultation system;
- Providing a registry for those countries that do not already have a registry for VRTs in place;
- Enabling detailed diagnostic/treatment recommendations that can be easily accessed by EU healthcare providers;

- Increasing the capacity to provide international consultation and fostering access to expert diagnosis, and treatment improving the chances of cure for children with VRTs across Europe and;
- Improving care for patients through the instruments outlined and hence reducing inequalities in cancer outcome across the EU Member States through improved information channels and accessible expertise.

Links to the European Reference Networks in Paediatric Cancer (ERN PaedCan)

As of the year 2000, national initiatives were launched in different European countries having recognised the necessity to develop dedicated projects for rare paediatric tumours. Although they have shown various activity levels, these national groups share the idea that multinational cooperation is of great importance in order to improve knowledge and the outcome for children with VRTs.

The European Reference Network on Paediatric Cancer (ERN PaedCan) aims to help national health systems cooperate in the interest of patients and is, therefore, the ideal framework within this multinational collaboration on VRTs.

The PARTNER project is very much within the scope of the ERN PaedCan network facilitating the lives of both healthcare providers and patients, whose conditions require specialist expertise and tools not widely available, due to low case volumes or a lack of resources. By cooperating and exchanging life-saving knowledge at European level, patients across the EU should be able to gain access to the best expertise available. This network offers a platform for virtual consultations allowing information to travel, rather than the patients and supports training and knowledge sharing.

PARTNER project benefits for public health

The strategic value of PARTNER in the field of public health is based on the European wide gathering of information on treatment of VRTs and the provision of this information to experts generating new guidance recommendations for daily practice for use by ERN and non-ERN Institutions. The collection of data will contribute to optimised consultation of patients with

VRTs. Consequently, experts will increase clinical research and knowledge. The proposed tasks and milestones will increase the collaboration amongst the member states in paediatric oncology and will be able to also include LHEAR (Low Health Expenditure Average Rate) countries in the process.

Innovation will be embedded in the new platform: original IT tools will link the existing databases with the help of the EUPID system assuring interoperability and anonymisation of patients' data. This may serve as a model for data set integration at the EU level, thus, paving the way for the integration of registries in the near future across the globe. This project builds upon work and actions from the EU-funded ENCCA and ExPO-r-Net projects. The information collected and tools developed will be disseminated to key stakeholders (other ERN, European Clinical Trials Groups, parents and patients) to enhance further collaborations.

In conclusion, it is expected that the PARTNER project will strengthen the collaboration between the countries involved and stimulate the formation of similar groups in other European countries. In addition, collaboration with already existing disease-oriented registries and collaborative groups will be actively sought, as world-wide initiatives are necessary. This will improve research quality hopefully and the outcomes of treatment for children who have, until recently, been rather neglected. ■

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Prostate cancer: A wake-up call for men

Roger Wotton, Chairman of Tackle Prostate Cancer explores the key issues around prostate cancer, the most common cancer in men

Prostate cancer is the most common cancer in men. In the UK there are over 47,000 new cases and over 11,800 men dying a lingering, painful death from prostate cancer every year¹. These figures are increasing, with the UK having one of the highest death rates in the world despite having one of its richest economies. Deaths from prostate cancer have recently overtaken those from breast cancer in women.

The poor relation of cancers

One of the problems with prostate cancer is that it is invisible, doesn't always present with symptoms and because it affects men "down below" it is often ignored as men stick their head in the sand, don't talk about it and leave it too late to seek advice. Many men end up suffering more from the emotional and psychological effects of being diagnosed with prostate cancer than they do from the physical manifestations of the disease. This is another difficult nut to crack!

A visit to the doctor

Examples still crop up where GPs are reluctant to offer a simple blood test. Despite continuing controversy, for the foreseeable future, this blood test for Prostate Specific Antigen (PSA) remains the only initial, simple, cheap option available to screen for prostate cancer in asymptomatic men and detect it at an early, curable stage. Although UK men over the age of 50 are actually entitled to a PSA test in line with the recommendations of the Prostate Cancer Risk Management Programme (Public Health England, March 2016)², many GPs are unaware of this and are unable to provide up to date counselling³. This is of particular concern to men of black African and Caribbean heritage who carry a one in four risk of getting prostate cancer and similarly for men with a positive family history.

To screen or not to screen

Since PSA came into general use in the 1990s, its use, over-use and misuse have led to widely varying rates of utilisation across nations and controversy over its benefits versus harms, with harms characterised as "over-diagnosis" and "over-treatment" of non-aggressive, indolent, harmless cancers. PSA based screening studies from Europe have been running well over 10 years and are reporting falls of over 40% in the death rate from prostate cancer^{4,5}. UK mortality lags well behind and probably less than 10% of UK men seek screening⁶.

Whilst the UK has no national screening programme, most national and international urological guidelines for PSA screening recommend screening from age 45 for men with a family history of prostate cancer and black African or African Caribbean men, obtaining a baseline PSA in a man's forties to predict future risk, linking PSA to a "risk calculator" to assess need and frequency of future PSA testing and not to screen men below 40 or with less than 10 years' life expectancy.^{7,8,9}

Whilst screening for prostate cancer in the UK has remained static, its clinical treatment has taken big steps forward. Furthermore, the advances have been backed by solid and highly influential UK trial and audit evidence, as detailed below.

The PROMIS¹⁰ and PRECISION¹¹ trials

These UK trials demonstrated that if a multiparametric MRI (mpMRI) was performed prior to biopsy for men with a raised PSA, no biopsy was necessary for 25% of men in whom no MRI abnormality was detected. If prostate cancer was present in such men, it was non-aggressive and not clinically significant. Thus, the risk

of “over-diagnosis” and risk of unnecessary biopsy have been greatly reduced. Visible abnormalities, however, are likely to be significant and can be targeted with certainty.

“One of the problems with prostate cancer is that it is invisible, doesn’t always present with symptoms and because it affects men “down below” it is often ignored as men stick their head in the sand, don’t talk about it and leave it too late to seek advice.”

The ProtecT Trial¹²

This UK trial reported the 10-year outcome of 1643 UK men with apparent, non-aggressive, PSA screen-detected prostate cancer randomised to receive radical treatment or active surveillance. After 10 years, the death rate was only 1% whether treated radically or merely followed by active monitoring. It thus confirmed the safety of active surveillance alone for non-aggressive prostate cancer.

The 4th National Prostate Cancer Audit¹³

This demonstrated that between April 2015 and March 2016 nearly 42,000 men were diagnosed with prostate cancer in England and Wales. 54% were over age 70 and 51% had advanced prostate cancer at presentation – 15% have metastatic disease. Whilst these statistics confirm the paucity of early diagnosis in the UK, the latest statistics on biopsy and treatment are much more encouraging. mpMRI is increasingly being used prior to prostate biopsy and only 8% of men with low-risk, localised prostate cancer underwent radical treatment. Thus, potential “over-diagnosis” is being minimised and “over-treatment” continues to reduce, having fallen from 12% in 2014/15.

These advances in clinical care starkly illustrate the widening gap between our poor screening statistics and the excellent care now available to all UK men lucky enough to have screen-detected prostate cancer at an early, curable stage. Finally, concerns about the utility of PSA as a screening tool have been fully addressed by Prostate Cancer UK’s “13 Consensus Statements”¹⁴.

In conclusion, in the absence of better options, application of PSA screening according to these optimum criteria for appropriately informed men over the age of 40 would appear to be the best way we can bring about a significant reduction in the UK’s unacceptable death rate from prostate cancer. Let’s have a wake-up call for men to demand better and earlier diagnosis and give them the chance they deserve to avoid this terrible disease. ■

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TGF- β signalling – Tumor biology in prostate cancer

Identifying the molecular signalling pathways leading to advanced prostate cancer to improve therapy and diagnosis

Prostate cancer is the most common tumor in men in the Western society and the incidence is expected to increase. However, we still lack good molecular tools to identify aggressive prostate cancer.

Our aim is to identify the molecular signalling pathways leading to advanced prostate cancer. This knowledge will be used to design novel therapeutic strategies and improved molecular diagnostic tools.

TGF β signal transduction

Our research is focused on TGF β signal transduction, tumour biology and molecular pathology, particularly in prostate cancer. TGF β plays an important role for regulation of migration and invasion in several kinds of cancer cells, including prostate cancer cells.

In aggressive prostate cancer there is a correlation between the amount of secreted TGF β and poor prognosis with development of metastases. We have found that the ubiquitin-ligase TRAF6 is a crucial co-regulator of TGF β -induced non-canonical and oncogenic responses, as it associates with the TGF β type I receptor. TRAF6 promotes also expression and activation of proteolytic enzymes, such as TACE and presenilin1, which cleaves the TGF β type I receptor to liberate its intracellular domain (ICD). The generated ICD translocate to the nucleus in

an unknown manner, where it contributes to gene transcription of pro-invasive and metastatic genes. We focus our research on exploring how TGF β regulates invasive and metastatic behaviour of prostate cancer cells. We have access to unique collections of biobanked material at Biobanken Norr in collaboration with researchers here in Umeå.

Collaboration

We collaborate with national and local cancer researchers in the field of prostate cancer and renal carcinoma.

We collaborate with [SciLifeLab Drug Discovery Platform](#) in order to design novel and more specific cancer drugs.



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“Our aim is to identify the molecular signalling pathways leading to advanced prostate cancer. This knowledge will be used to design novel therapeutic strategies and improved molecular diagnostic tools.”

The priorities for tackling infectious diseases in Africa

In this interview, public health specialist Dr Wilfred Alexander Chalamira Nkhoma from the World Health Organization (WHO) Office for the Africa Region speaks to us about the priorities for tackling infectious diseases in Africa, with a particular focus on Tuberculosis (TB) and viral hepatitis

On the priorities for tackling infectious diseases in Africa, with a particular focus on Tuberculosis (TB), Dr Wilfred Nkhoma from the World Health Organization (WHO) Office for the Africa Region explains that the traditional way to treat and control communicable diseases revolves around the three standard domains of public health.

The first domain is primary prevention which is about what actions are taken by the health system or the individual to protect themselves from or to prevent diseases. Actions here include improving living conditions or immunisation, for example. The second domain is secondary prevention, that revolves around the identification of infection or active disease and taking actions to modify what one finds. Here, ordinarily, you identify what diseases you are dealing with and when you do find something, you should link people to the appropriate treatment that works, Dr Nkhoma underlines.

The third domain is tertiary prevention, which means you are dealing with somebody who already has a disease and they have developed complications but you want to maintain and improve their quality of life. The same principles apply to diseases such as Tuberculosis (TB), Dr Nkhoma tell us, which people can pick up when they are exposed to TB causing germs in community settings where they live or in households where they are in close proximity to somebody who already has this infection. Therefore, people need to take steps to improve their own health and governments need to deliberately invest in improving the social economic status and living conditions of their people, Dr Nkhoma argues. He goes on to detail additional priorities to tackle infectious diseases, in his own words.

“The prevalence and incidence of TB and other infectious diseases are very high, so there must be universal access to quality diagnosis and uninterrupted supply of effective quality-assured medicines for timely treatment close to where the people live. We should also have programmes and systems that support those patients in the event that they develop complications and disabilities from that infectious disease, so their quality of life does not become unbearable.”

While people infected with TB bacteria have a 10% lifetime risk of falling ill with it, Dr Nkhoma proceeds to explain how this affects those with compromised immune systems, such as people who are living with The AIDS virus or use tobacco, for example. He tells us that the natural progression of TB means that bacteria can get inside a person and infect them. That the individual can either get rid of the infection or contain it within the body system for a long time or go on to develop the acute disease. He goes on to explain more about the negative role immune system lowering conditions, including HIV and AIDS, cancer and diabetes, that stay with a person for life, play in increasing the likelihood of the infection progressing to active or recurrent disease.

“If you are of normal immunity, the proportion of those who will keep a disease, contain it or get rid of it will be much larger. When you have low immunity, however, for example through HIV infection, diabetes, cancer, smoking or other immune-reducing events then your probability of progressing to active disease after getting infected by bacteria increases substantially.

“When you are HIV-infected, you remain in that state for life. The difference between these other immune lowering conditions compared to HIV is that it depends



on how much damage you have incurred in your lungs where smoking is concerned. If you stop smoking before your lung systems are destroyed, you limit the chances and extent to which the TB bacteria can take advantage and proliferate.

“The prevalence and incidence of TB and other infectious diseases are very high, so there must be universal access to quality diagnosis and uninterrupted supply of effective quality-assured medicines for timely treatment close to where the people live. We should also have programmes and systems that support those patients in the event that they develop complications and disabilities from that infectious disease, so their quality of life does not become unbearable.”

Dr Nkhoma then details the extent to which TB is one of the leading causes of death worldwide and the most single infectious agent, ranking even above HIV/AIDS. We know that there has been an analysis of the impact of these described conditions and also hepatitis. The world has now woken up to the fact that there are more people today living with hepatitis than those with HIV, TB or malaria, Dr Nkhoma emphasises.

“The analysis from 2000-2015 looked at the extent to which these conditions resulted in deaths and it shows that since 2000, the mortality rate of those with HIV was going up significantly but by 2005, when antiretroviral

therapies (ART) became widely available, that trend has declined significantly to such an extent that by 2015, hepatitis has taken over HIV, malaria and TB. And viral hepatitis is the one infection among these conditions whose mortality rate has continued to increase.

“So, the one other communicable condition that the world should now be taking notice of is viral hepatitis. After this comes TB and by 2015 it was killing close to 1.3 million people. In the same year, hepatitis resulted in the death of 1.5 million people. HIV had slightly declined to around 1.2 million people. The high mortality burden from HIV/AIDS and TB were still there, but the significant observation to make is that the decline in mortality from HIV/AIDS is much deeper and faster, while that from TB is steady but slower compared to that from HIV/AIDS. By the time we get to 2030, if we leave things the way they are then HIV deaths will be much lower and TB deaths will be higher than HIV deaths alone.”

Dr Nkhoma adds that in the African region, the early increase in deaths of people with TB was because of the immune debilitating effect of HIV/AIDS, but this has hugely been and continues to be positively impacted on by the successful rollout of ART’s in communities. However, the mortality rate of those with TB that does not come from HIV co-infection requires continued aggressive actions to find and treat active TB cases in a timely manner. He then details his thoughts on malaria, where analysis shows that around 500,000

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Antimicrobial resistance (AMR) at the Southern Africa Centre for Infectious Disease Surveillance

Mecky Isaac Matee, Leader of the SACIDS AMR CoP profiles the excellent antimicrobial resistance (AMR) research taking place at the Southern Africa Centre for Infectious Disease Surveillance (SACIDS)

Antimicrobial research activities in the Southern Africa Centre for Infectious Disease Surveillance (SACIDS) is led by the antimicrobial resistance (AMR) Community of Practice (AMR CoP). This CoP was formed five years ago to address the burden of AMR in the southern African region and therefore, contributes to the global effort.

We set out to address the AMR problem from the One Health perspective in humans, animals and the environment and, therefore, our research team combines expertise and experience from the three sectors. We realised that although AMR is a global issue, in low-income countries, it is compounded by (i) a lack of access to appropriate antimicrobial therapy, (ii) weak of regulation in the use of antibiotics for humans and animals, (iii) weak AMR surveillance and resistance levels, (iv) a lack of updated antibiotic use and treatment guidelines, (v) a lack of continuing medical and veterinary education on antibiotic use for prescribers, (vi) a weak regulatory framework for the use of antibiotics in animal production and aquaculture, (vii) a high degree of drugs abuse by livestock keepers through; (viii) a lack of basic knowledge on the concept of antibiotic resistance among livestock keepers (ix) unregulated disposal of

industrial waste and finally, (x) self-medication using antimicrobials.

What is its composition?

The SACIDS AMR CoP, led by Professor Mecky Matee of the Muhimbili University of Health and Allied Sciences (MUHAS) also includes participating scientists from MUHAS, the Catholic University of Health and Allied Sciences, the Sokoine University of Agriculture, the National Institute for Medical Research, the Tanzania Veterinary Laboratory Agency, the Tanzania Wildlife Research Institute and the Kilimanjaro Clinical Research Institute.

Regionally, SACIDS member institutions are the University of Zambia, the University of Kinshasa, the Democratic Republic of Congo and the University of Eduardo Mondlane in Mozambique. SACIDS works in partnership with the London School of Hygiene and Tropical Medicine, the London International Development Council, the Royal Veterinary College, the Giessen University in Germany, the University of Bergen in Norway, the University of Virginia, U.S and the American Society of Microbiology.

How do we operate?

In AMR, SACIDS utilises a multi-disciplinary and multi-sectoral OH approach that provides evidence-

based information and data to improve practices and inform decision-making processes. The core activities of the AMR CoP include training, research and the provision of technical expertise in different disciplines, namely clinical microbiology, molecular biology, disease surveillance, One Health analytical epidemiology and One Health molecular biology.

The CoP advocates a 2-Level OH approach to addressing AMR. Level 1 consists of phenotypic screening and surveys by national public health and veterinary laboratories. Level 2 consists of genomic surveillance by the SACIDS-Africa Centre of Excellence partnership and/or other specialised laboratories.

SACIDS has also designed and deployed digital disease surveillance tool packages under the AfyaData platform, utilising a participatory OH approach. AfyaData will be used to support surveillance on AMU and AMR at community and primary health care levels and enhance data linkage to WHONET.

What do we aim to achieve?

SACIDS AMR CoP, working with other stakeholders, is aiming to attain a holistic understanding of the factors and nature of spread and persistence

of AMR to develop appropriate intervention models; the role of livestock production and animal health systems in the evolution and spread of AMR in Africa; the socio-cultural and economic determinants of AMR in Africa and role of food chains in spread of AMR in the southern African region. The overall expected outcome is a cost-effective, evidence-based policy that is relevant in health and agricultural systems in the region that will be adopted by policymakers to minimise the AMR problem and serve as a model for resource-limited countries.

What is our working hypothesis?

Our working hypothesis is that “human and animal activities and ecosystems complexity exacerbate the transmission of bacterial zoonoses, including the emergence, spread and persistence of antimicrobial resistance.

Our research approach to addressing AMR

Our AMR research is centred on examining the genomic epidemiology of AMR in the context of health systems and the analysis of the socio-economic and policy analysis approaches to define the scale and the impact of AMR in Tanzania and neighbouring countries and to define intervention policy solution that is locally relevant and feasible.

Training and research strategies

The SACIDS training and research programme provides evidence-based action for AMR in Eastern and Southern Africa. Currently, one postdoc and seven PhDs are working on various aspects of AMR in three compartments i.e. animal, human and the environment, i) including Genomic epidemiology of ESBL-producing Escherichia coli in hospital and environmental settings in Dar es Salaam,

Tanzania and ii) Genomic epidemiology of AMR in short-cycle food animals (poultry, pigs and fish) – (driven by AMR surveillance in animals, aquaculture and environment).

“We set out to address the AMR problem from the One Health perspective in humans, animals and the environment and, therefore, our research team combines expertise and experience from the three sectors.”

Provision of technical expertise and government engagement

Over the years, SACIDS has provided support to different national technical working groups of the National One Health Coordination Desk under the Tanzania Prime Minister’s Office, the Ministry of Health, the Ministry of Livestock and Fisheries in addressing the burden of AMR in the country. SACIDS has also been involved in the formation of the Multi-Sectoral Coordination Committee, AMR technical working groups, the development of national action plan for AMR and in the development of guidelines and implementation of strategies for AMR. The established relationship provides unique opportunities for SACIDS AMR CoP to work, according to the national strategies, requirements and plans of the country.

Beneficiaries of the SACIDS AMR research

We target populations of AMR policy; healthcare professionals, professionals working in the animal sector, patients and community groups. Academics, including policy researchers and those focusing on AMR/One Health approaches, will also benefit from the research findings, as will international policy organisations that seek to shape policy responses to AMR, including the World Health Organization (WHO), the Food and Agriculture Organization of

the United Nations and World Organization of Animal Health.

The recently established Tanzania’s One Health Platform established through the Prime Minister’s Office is a specific group that will directly benefit from the research findings as they seek to identify how best to implement One Health principles with respect to controlling the spread of AMR. Private sector groups that continue to face impacts of AMR on business interests are also likely to benefit from this research.



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people died from this condition by 2015, which is a decline from the earlier figure of 800,000.

In closing, Dr Nkhoma underscores that while the region of Africa has made progress when it comes to reducing the burden of communicable diseases slowly but steadily, Africa is still one of the regions in the world with the highest TB rates. Also, the region of Africa in light of the Sustainable Development Goals needs to end the TB endemic by 2030, a point which Dr Nkhoma leaves us with as he makes a call for action to improve diagnosis and treatment.

“One aspect of this is Universal Health Coverage (UHC), concerns prevention, diagnosis, treatment, care and social protection. In terms of coverage, for TB, to date, only 50% of our population is being covered. Therefore, we need to take urgent and major steps to find the cases we are not finding or covering. We need to put in place a programme for social protection to ensure that everybody will have access to these services without being impoverished in any way.

“To find new cases, we must adopt the most sensitive technology to identify TB. We have been using microscopy but this only identifies approximately 50% of existing cases, even in the best of hands. However, we are now moving toward molecular tests in the African region which picks up around 88-90% of TB cases. As a region, we must move away from the old methods of

diagnosis and wholeheartedly adopt the molecular tests for the sake of the whole population.

“One last message is that funding for TB is still far below what we need. We are still relying heavily on donor funding and recent documentation shows that in the African region, only 26% of what we need is being funded as part of the government’s domestic budget for TB. 34% of what we need is provided by international bodies. So that leaves us with 41% of the required budget still not funded and that is a huge gap to be filled if we are to achieve the SDG targets.

“All the core services and treatments for TB we need should be borne by our country’s domestic budget and in terms of Universal Health Coverage (UHC), nobody should have to pay for these services.” ■

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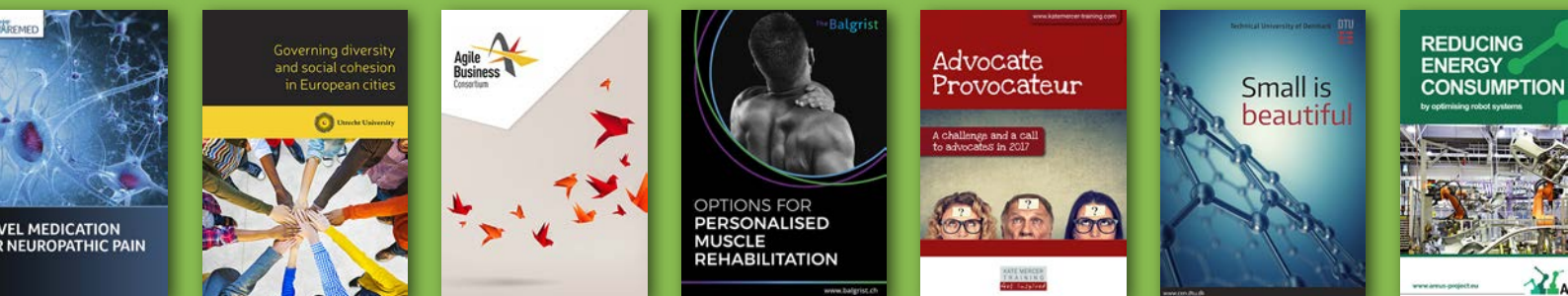
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Lack of exercise, an unhealthy diet – costing the EU billions of euros and millions of lives annually

Professor Joep Perk, Former President of the European Association of Preventive Cardiology (part of the European Society of Cardiology, ESC) and member of the ESC Advocacy Committee shares his views on the growing problem of cardiovascular disease and why public health measures are needed to tackle it effectively

A mostly preventable and deadly disease is costing the European Union (EU) €115 billion annually, according to the OECD, with four million residents below age 65 suffering premature death each year.

Eighty per cent of premature cardiovascular disease – coronary heart disease, angina, heart attack, congenital heart disease and stroke – is preventable, yet the number of cases has been increasing in Europe over the last 25 years.

Having worked in areas of the country where heart attacks are rare, I can say that living a healthy lifestyle

without smoking and filled with physical activity and fruit and vegetables is the road to change.

In the mid-1970s I had the pleasure to work for a Dutch development agency in South Africa. I was in charge of an area with 10,000 to 20,000 people and two doctors. There was a lot of work and plenty of unpleasant diseases but uniquely, in three years, I never saw a heart attack in the local population.

I was quite surprised coming from the Netherlands to go to a country where heart attacks were simply not known. Even in the rural area of Zambia, I still have yet to diagnose my first case of myocardial infarction

because, in order to survive on your small plot of land, you simply have to be physically active.

So obviously, there are two parts of the world where arteriosclerosis is not a very common disease. And last year in The Lancet there was a lovely paper from Bolivia that looked at Bolivian Indians and the amount of calcium in their coronary arteries and they discovered that these Indians had no arteriosclerosis whatsoever. These populations have few smokers, are physically active (subsistence farmers) and they do not eat junk food.

If people managed their body in the proper way, most heart attacks could be simply eliminated. It is still the main killer in Europe, and throughout the world, so we have a long – but obvious – way to go, as arteriosclerosis is a disease that very much links to lifestyle.

If we eliminate smoking, we already lose 60% of all unnecessary heart attacks. It is so clear, it is so proven that it is almost a bit worn out.

But we see young people start to smoke electronic cigarettes and they are on track to nicotine problems. A lot of these people will go on to become tobacco smokers. Clearly, this battle is not won but remains our first priority.

Even if smoking rates are coming down, there are still many public areas where smoking is allowed, including in streets, and stations, and cars. We need legislation to limit where people are allowed to smoke.

The second and third priorities – physical activity and a healthy diet – are more or less of equal importance but only one-in-six people in Europe are doing the recommended amount of physical activity every day. Life has become too easy for us. So, five-out-of-six of us are not moving around as much as our body demands.

There is a major global outbreak of obesity, with the rate in children growing fastest. We simply eat far too little fruit and especially vegetables.

There needs to be political action to make fruits and vegetables more accessible and affordable to everyone but, due to conflicting interests, prices remain high. The production chain seems to prefer burning the

overproduction of fruit and vegetables than put them on the market at lower prices.

In the less wealthy, we see four times as much cardiovascular mortality as in wealthier citizens. And that's at least partly related by people in lower income groups who are eating too little fruit and vegetables.

We need more research on effective communication strategies. We need new ways of convincing people to adopt a healthy lifestyle. People know what to do. They just don't do it.

It is never too late to start a healthy lifestyle. And you are never too old to get a good grip on the needs of your body. Things can still improve and can still change, in a 50, 60, or 70-year-old body.

If you take care of your own health, the rewards are significant. It's a simple thing. You possess a fantastic machine, but you need to know the basic principles of how to use it so that you get the most out of it.

At the European Society of Cardiology, we believe that people should not be alone in this endeavour: public health action can go a long way towards designing health-enhancing environments and reducing the adverse health impact of environmental threats. For this reason, we work closely with policymakers and health stakeholders to foster decision making which is based on the latest scientific evidence.

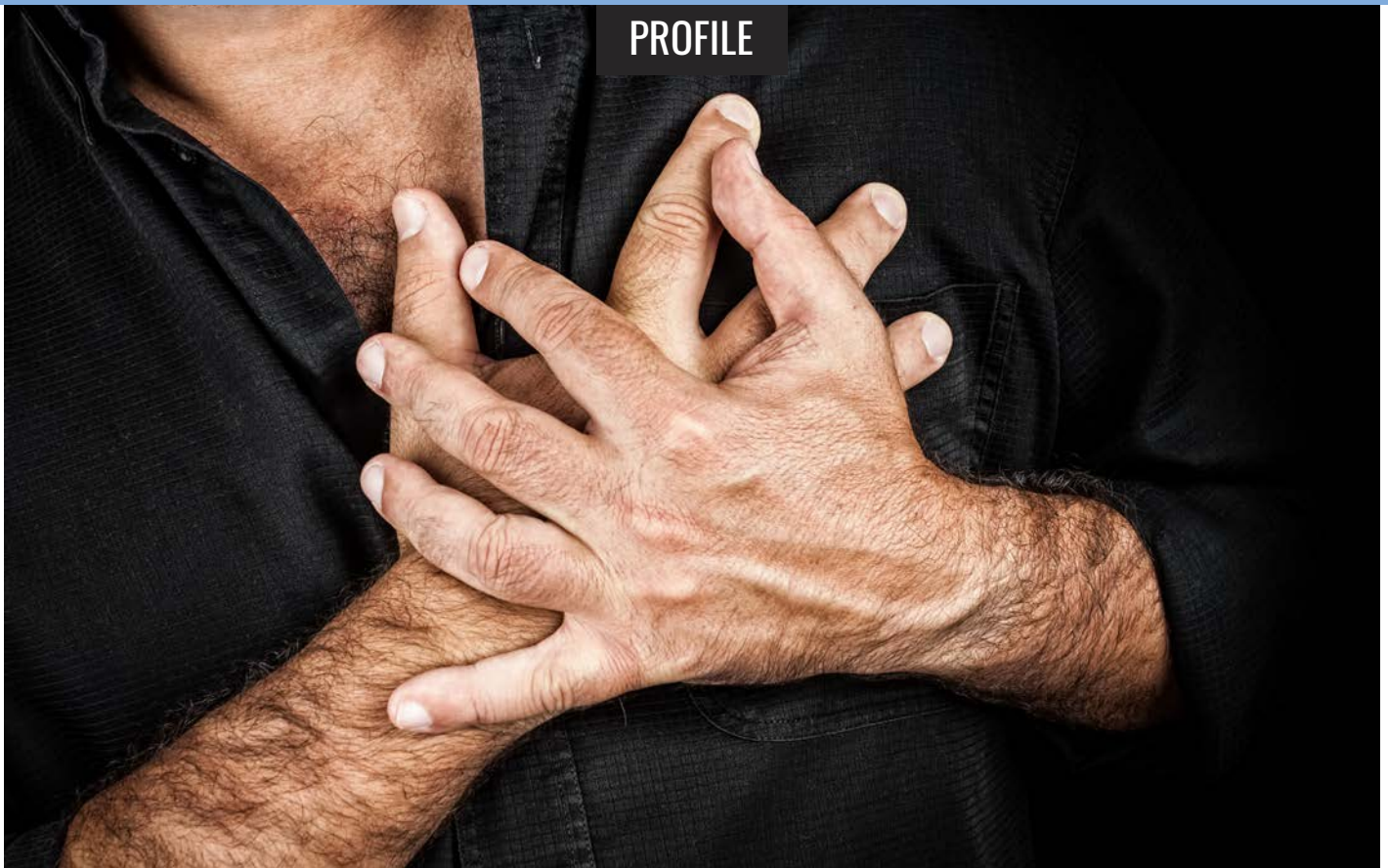
Our main call is for the EU to implement a structured framework to tackle cardiovascular disease, including targeted action addressing prevention and research, and the use of real-world data for policymaking. This will facilitate an environment where people may live long, healthy lives and where this disease is no longer the number one killer. ■

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Cardiovascular science: Novel advances in ischemic heart disease (IHD)

Novel advances in ischemic heart disease (IHD) are placed under the spotlight here by Luigi Marzio Biasucci MD from Fondazione Policlinico Universitario A Gemelli who specialises in cardiovascular science

During the last 20 years, several novel findings have considerably changed the conceptual framework of ischemic heart disease (IHD), moving the interest of clinicians and scientists from simple pathophysiological concepts as stenosis, incrustation, cholesterol, to novel and more advanced findings that may better explain the mechanisms of disease and, in turn, the more effective and focused treatments.

The first evidence in this area was produced at the end of the last century, when different groups in Europe and USA (such as Maseri in Rome, Libby and Ridker in Boston) challenged the

old and mechanistic theories that considered myocardial infarction as the results of “incrustation” of the arteries and found coronary inflammation as one of the major causes of IHD (Liuzzo NEJM 1994, Biasucci Circulation 1996, Ridker NEJM 1997). Since then, a large body of evidence has confirmed the inflammatory hypothesis and paved the way to further hypotheses.

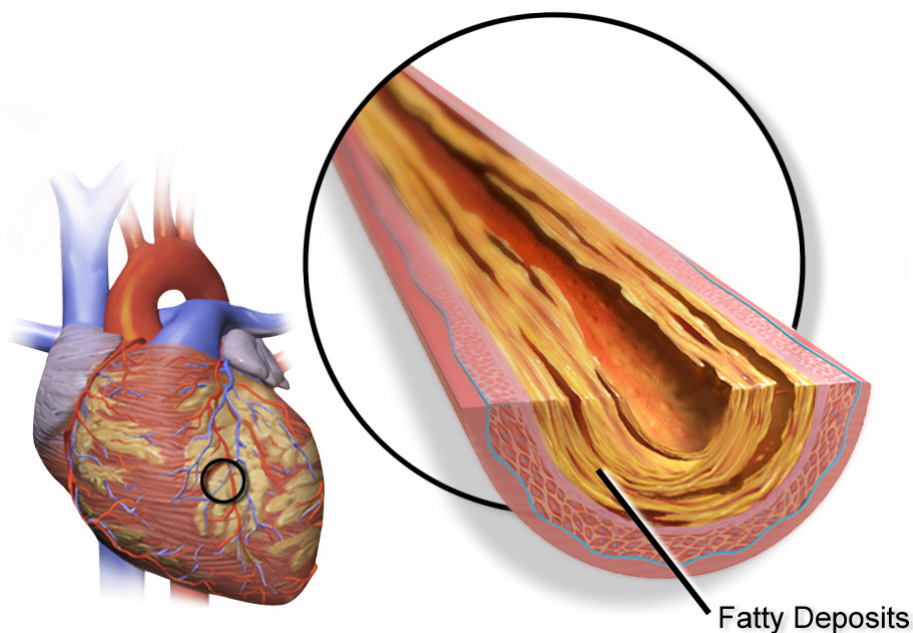
Cytokines and infarction

The pivotal role of cytokines in the pathogenesis of infarction is now well-established and the current research in the field focuses on the possible application of cytokines in this area. In

Rome, our recently published work consists of 60 papers about the role of inflammation and cytokines. Overall, 6,993 papers on the role of cytokines in IHD have been published according to website www.pubmed.gov.

Recently, a publication by Ridker and Coll increased the interest of the researcher concerning the role of cytokines in IHD, as the authors demonstrated that interleukin-1 inhibition can reduce the risk of death and reinfarction in the CANTOS trial, not at the expense of increased adverse events and without an expected or a significant reduction in cases of pulmonary cancer.

Image: Blausen.com staff (2014)



Microbiome and cardiovascular diseases

Recent findings suggest that gut microbiome is involved not only in intestinal diseases but also in IHD, heart failure, rheumatoid arthritis and psoriasis; our group (Biasucci and Coll, *Curr Cardiol Rep.* 2017) underlines peculiar aspects of the phenomenon: oxidative stress and autophagy; DAMPS and TLR-4 signalling activation; different macrophages lineage and the contribution of NLRP-3 inflammasome; adaptive immune system. A possible explanation is the evidence that increased bowel permeability may allow the translation of a gut microbiome product into circulation.

MicroRNA: Non-coding RNA and cardiovascular disease

microRNA can be defined as small ribonucleic acids (RNAs) that negatively regulate gene expression on the post-

transcriptional level by inhibiting mRNA translation or promoting mRNA degradation. Several studies demonstrated that miRNAs dysregulation have a key role in the disease process and, probably, in every step, from formation to destabilisation.

Several types of data in the available literature suggest a possible therapeutic application of miRNA modulation, in particular, dysregulated miRNAs can be modulated in the disease process, antagonising up-regulated miRNA and increasing down-regulated miRNAs. Therefore, miRNAs, although they have been largely used as biomarkers, may also represent a therapeutic option.

Long non-coding RNA are long RNAs – transcripts of more than 200nt not encoding for proteins, (lncRNA) and represent a challenging new class of epigenetic regulators. lncRNAs are

deeply involved in cardiac development and pathophysiology but their mechanisms are still unknown.

As platelets are anucleated cellular fragment, they represent an ideal scenario to unlock ncRNAs undiscovered functions. And they may represent a further novel approach for cardiovascular diagnosis and treatment.

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Advances in newborn screening for neuromuscular disease

Kristin Stephenson, Sr. VP, Chief Policy & Community Engagement Officer at the Muscular Dystrophy Association details the advances taking place in newborn screening for neuromuscular disease

Spinal muscular atrophy (SMA) is the leading genetic cause of death in infants in the United States (U.S.) and early identification and intervention are key to treating the disorder. The national newborn screening public health program now provides an opportunity to identify babies with this lethal disorder at birth – opening up treatment and care options from day one.

In July, SMA was added to the Recommended Uniform Screening Panel (RUSP) for newborns, which means that now it is officially recommended that every baby born in each state is tested for SMA immediately after birth. This is a landmark decision for the SMA community, recognising both the importance of early diagnosis and intervention in newborns and the new therapeutic options to treat the disease. Because each state ultimately determines which disorders are included

on their respective state newborn screening panels, having a disorder added to the nationally recommended list is a critical step toward making sure all babies have the opportunity to be identified. And while states drive their individual testing programmes, there are essential federal supports that help ensure implementation, testing and feasibility are considered.

What is newborn screening?

Babies born in the U.S. are currently screened for more than 30 conditions including two neuromuscular diseases – Pompe and SMA. Early detection of these diseases is vital as it allows for earlier treatment, which can improve health outcomes. Importantly, identifying babies with disorders such as SMA early in life allows for careful monitoring from day one, providing the opportunity to put in place plans and gather insights for long-term care, treatment and follow-up.

In the U.S., more than four million babies are screened annually for serious diseases through the newborn screening program – diseases that would result in significant disability or death if left untreated. Newborn screening, as a public health programme, has proven successful in saving countless lives and has been hailed by the Centers for Disease Control and Prevention (CDC) as one of the top 10 public health successes of the past decade.

Newborn screening and the states

Because newborn screening is a public health programme that falls under the authority of the individual states, the final decision on whether to test for a specific disease is up to each state. Each state must add a disease to its own screening panel. This implementation phase can be complicated and expensive and can take a significant amount of time.

Federal funding is needed to determine which disorders are ready for nationwide screening and to help implement screening in the states. Thus, federal funding for agencies that support newborn screening is essential. Funds from federal agencies such as the Health Resources and Services Administration (HRSA) and CDC provide counselling and other services to newborns and children.

For the 2018 fiscal year, the Newborn Screening Quality Assurance Program at the CDC is funded at \$8.4 million and the Heritable Disorders program at HRSA is funded at \$13.88 million ⁽¹⁾. This funding supports newborn screening initiatives by providing training in new laboratory techniques and educational materials for healthcare professionals, families and patient advocacy and support groups and additional funding will be essential to ensure that the newborn screening program has sufficient resources to fulfil its intent.

Muscular Dystrophy Association (MDA) and newborn screening

MDA is an umbrella organisation committed to transforming the lives of individuals affected by muscular dystrophy, ALS and more than 40 other neuromuscular diseases through innovations in science and innovations in care. To that end, MDA is committed to promoting early screening, diagnosis and treatment.

Once babies with these conditions are identified via state newborn screening programs, MDA Care Centers at more than 150 top institutions across the U.S. can play a key role in confirmatory diagnoses, treatment and follow-up. In many cases, the follow-up care may be lifelong and, in some situations, (for example, late-onset Pompe disease) the clinical symptoms may not manifest until later in life.

We are also committed to optimising clinical care and accelerating the development of therapy options while contributing to the understanding of the natural history of neuromuscular disease. When babies are diagnosed early in life, it allows the opportunity to learn more about how the disorder manifests and to insights into how early intervention affects the disease course. To help collect and compile this type of data in a rigorous and uniform manner, MDA has established the provider-entered neuroMuscular ObserVational Research (MOVR) Data Hub, to collect data at MDA Care Centers across the country. MOVR will collect longitudinal insights that are being applied to increase understanding of disorders, including SMA and that support regulatory science and drug development. The same Care Center network and MOVR data hub also support Duchenne muscular dystrophy (DMD) and related neuromuscular diseases, which we anticipate will also be part of the national newborn screening program soon.

As scientific progress continues to accelerate, MDA will remain committed to newborn screening and to advocating for additional neuromuscular diseases to be added to the RUSP. To learn more about MDA advocacy, visit <https://www.mda.org/get-involved/advocacy>. ■

¹ <https://www.gpo.gov/fdsys/pkg/CPRT-115HPRT25289/pdf/CPRT-115HPRT25289.pdf>

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Therapies for weak muscles

Research into personalised interventions is helping pave the way for a new generation of therapies for weak muscles at the Balgrist Campus

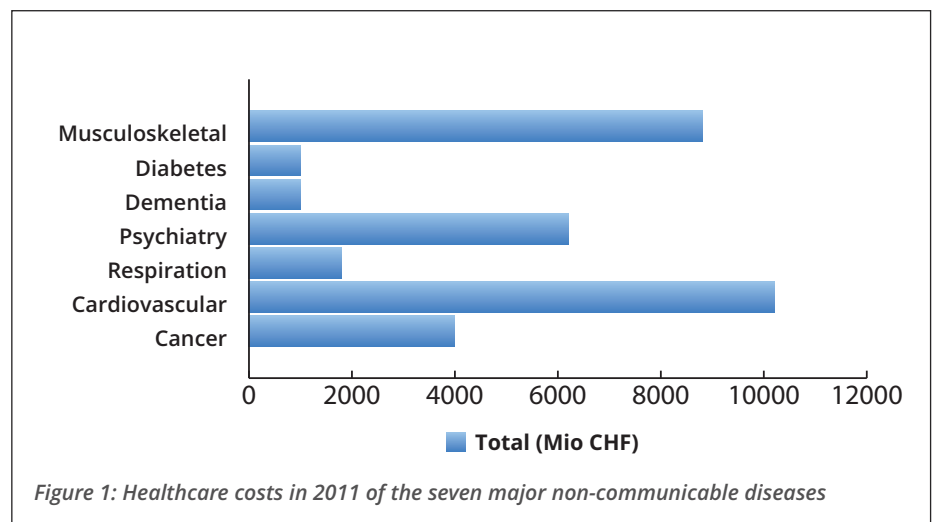
It is estimated that 10% of the cost of healthcare in Switzerland (or the equivalent of €500 billion per annum in the EU) being associated with lost work is related to injury or dysfunction of the musculoskeletal system (Fig. 1). Surgical and subsequent rehabilitative interventions are important part of the therapy that re-establishes musculoskeletal function.

The Laboratory for Muscle Plasticity at Balgrist University Hospital aims to shed light on the underlying mechanisms in skeletal muscle with the goal of translating the findings into more effective clinical applications.

Skeletal muscle plays a major part in control of movement and posture and affects whole body metabolism through its effects on energy expenditure. Affections ranging from simple overuse injury to rupture of tendons and bones, or disease, lead to deconditioning of skeletal muscle as a result of inactivity and damage signals. The consequent loss in muscle strength and fatigue resistance exerts a distinct negative impact on the quality of life and may render the affected individual dependent. In these situations a surgical intervention and rehabilitation may be indicated, yet may come too late as irreversible changes may have resulted.

Focus on muscle plasticity

The Laboratory for Muscle Plasticity investigates the mechanisms that



underlie the conditioning of skeletal muscle structure and function during recovery from surgical interventions and rehabilitation. As shown through research on sport performance, this process is driven by mechanical and metabolic stimuli. It is mediated through a gene response that instructs adjustments in muscle composition with the repeated impact of exercise during training. In consequence, force production and fatigue resistance of muscle may be improved or maintained.

By contrast, a muscle's functional capacity is reduced in the absence of a physiological stimulus by a reduction in the size of muscle fibres and their content in mitochondria (Fig. 2).

In fact, while the safety and effectiveness of physical factors for muscle conditioning are well established, the dose-effect relationship between

exercise and muscle adaptation is often not fully respected in clinical practice. An example of this biological regulation is the important role of muscle contraction and loading in preserving muscle mass of the bedridden musculoskeletal patient after surgery, who would otherwise lose muscle mass at a pronounced rate. Genetic factors (so called gene polymorphisms) significantly affect this adaptation. This indicates that gene polymorphisms contribute to the inter-individual variability of the response to surgical interventions and rehabilitation.

Research projects

The emphasis of the research team lead by Prof Martin Flück at Balgrist is on major musculoskeletal affections that arise in the context of the orthopaedic clinics at Balgrist Hospital. A special focus is put on resolving the contribution of gene polymorphisms

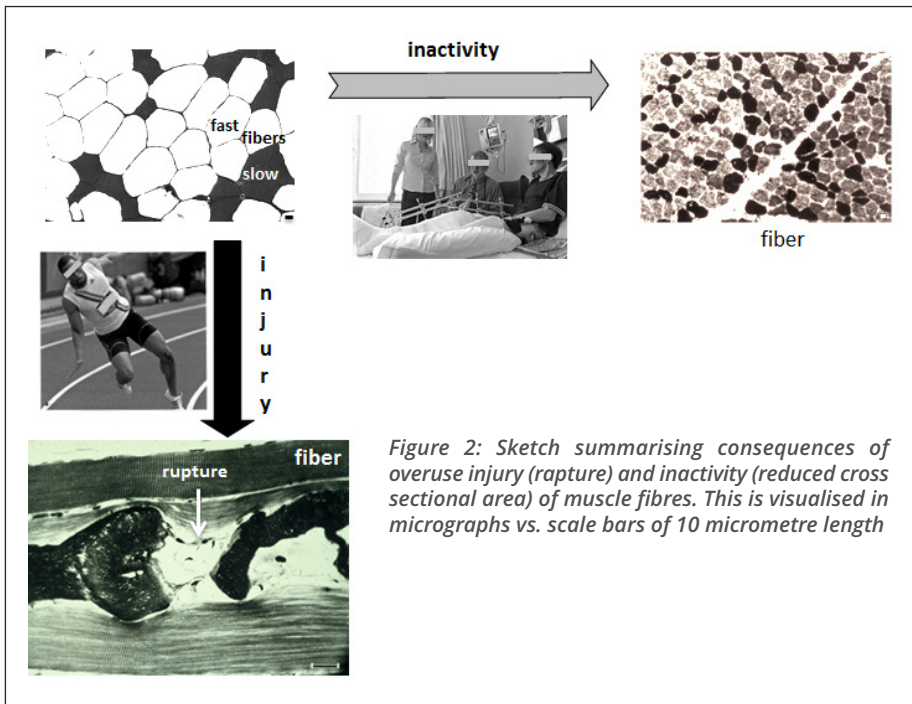


Figure 2: Sketch summarising consequences of overuse injury (rupture) and inactivity (reduced cross sectional area) of muscle fibres. This is visualised in micrographs vs. scale bars of 10 micrometre length

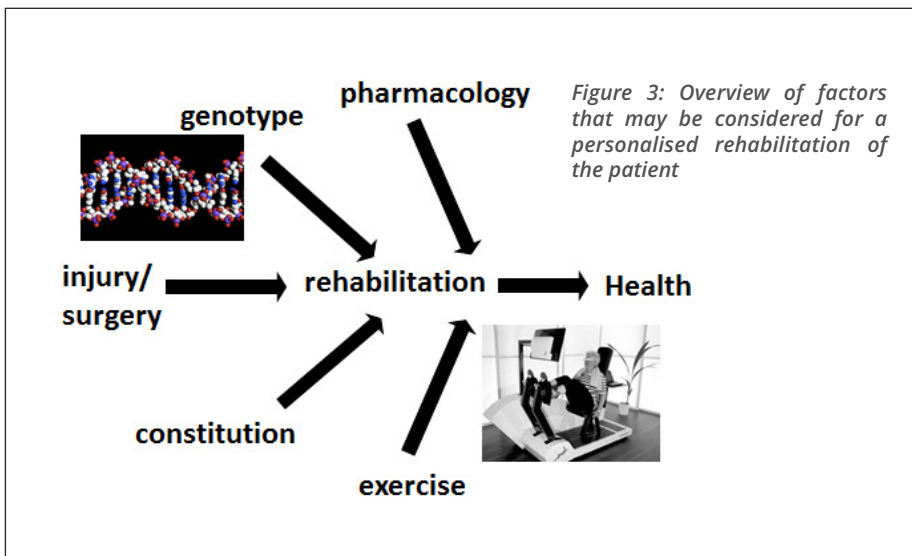


Figure 3: Overview of factors that may be considered for a personalised rehabilitation of the patient

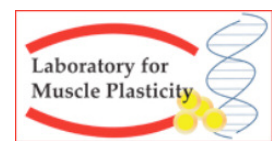
to inter-individual differences in the healing of muscle with re-attachment of the ruptured rotator cuff tendon, and the strengthening of skeletal muscle with rehabilitative exercise in patients.

The aim is to develop personalised forms of intervention that maximise muscle adaptation (Fig. 3). The latter approach is based on previous investigations pointing out the important exercise-intensity and exercise-type related influence of gene polymor-

phisms on muscle response to leisure-type sports activities. This opens a venue to tailor the therapeutically effective exercise intervention for patients which otherwise would demonstrate little plasticity to a generic exercise stimulus and for which pharmaceuticals alone do not work due to the importance of activity-induced muscle metabolism for muscle adaptations. In this regard, the clinical investigation ACE-REHAB into personalised rehabilitation of cardiac patients has been initiated.

Patient-led research

The laboratory is situated in state-of-the-art research facilities at the Balgrist Campus. A key ingredient of this research facility is an open-space landscape where research and development into musculoskeletal medicine is integrated under one roof between clinicians, biologist, engineers, and industry. The facility situates in the vicinity of the orthopaedic hospital at Balgrist; thus providing a pipeline for a reality-driven approach that re-integrates questions from bedside to bench and returns to the patient. The Laboratory for Muscle Plasticity is looking for potential partners that may want to exploit the research options presented in the future campus in the frame of collaboration.



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The key challenges around asthma in Ireland

In this interview, Sarah O'Connor, CEO of the Asthma Society of Ireland charts today's key challenges around asthma in Ireland and beyond

Asthma is everywhere in Ireland. They have the fourth highest prevalence of asthma globally and it stands out as the most common chronic condition in the country. As we begin this interview with the CEO of the Asthma Society of Ireland, Sarah O'Connor, she reveals that more than one person each week loses their life to asthma in Ireland and of these deaths, 90% are considered to be preventable. These figures highlight the impact of a disease which many dismiss as a simple childhood condition or 'nothing to worry about'.

This interview covers a number of important areas around asthma, including those who do not have their condition under control, the importance of ensuring that everyone with the condition lives a full and symptom-

free life, the research priorities and the policy priorities in the field.

What are your thoughts on those who do not have their condition under control?

In Ireland, it is estimated that up to 60% of people with asthma don't have their condition under control. For many people, this is due to the high cost of the essential controller medication which forms the core of asthma management. Controller inhalers can cost up to €70 each per month and asthma, despite being a lifelong condition, is not included in the long-term illness scheme in Ireland. As a result, these people are at risk of an asthma attack. Many people are completely unaware of how well they would feel if their condition was properly managed.

What challenges do people face in managing their asthma today?

Asthma, like many chronic conditions, is a complex disease. The diagnosis process can be quite confusing for many people and it challenges people to fully get to grips with the condition and how to manage it. Ongoing education is crucial in supporting people with asthma throughout the journey and we are actively working to expand the resources online and in person available to people during this “just diagnosed” stage.

Asthma management is an ongoing challenge which involves taking control of environmental factors and making lifestyle changes, as well as taking medication as prescribed. Identifying the factors which kick-off asthma symptoms (known as asthma ‘triggers’) are a huge part of maintaining asthma control. This can often seem overwhelming, especially for those who have just been diagnosed. People are trying to learn about and manage their homes, the weather, smoking, exercise, and air pollution. Many people are unaware that there are even ‘triggers’ to consider, they think asthma attacks and other symptoms are a normal, routine and expected part of the condition.

Asthma is a condition that can affect people at any stage in life, but it is disproportionately prevalent in children. This can bring separate and distinct challenges, as adults sometimes dismiss asthma and do not see its importance and children can struggle to express the serious impact it has upon them and can find it hard to communicate when they are feeling very unwell.

What needs to be done to ensure that everyone with asthma lives a full and symptom-free life?

In order to ensure that everyone with asthma can live a full, active life free from asthma symptoms, better and equal access to medication is desperately needed. We cannot accept a situation where people with

asthma are living with the risk of an asthma attack because of the cost of preventative medication or GP visits.

On a broader spectrum, a better public understanding of asthma is required to battle the misconception that asthma is a harmless or ‘easy’ disease. People with asthma need to understand that asthma is a condition that results in one death a week in Ireland and they need to change their behaviour about how to manage the condition. Asthma attacks are a clear indication that a person’s asthma is not under control and we want people to see their GP if they have an asthma attack.

“There is a severe lack of dedicated paediatric asthma services, particularly given that asthma affects 20% of children in Ireland. The level of current paediatric service is completely inadequate given the prevalence of the disease. Ireland currently has the lowest number of respiratory consultants in Europe, after Macedonia, at 1.3 per 100,000 people.”

It is crucial that people with asthma take their condition seriously and avail of all the helpful self-management tools which are available to them. Exercise can really help people with asthma to stay fit and well, but it does require many people with asthma to manage their condition so that they can exercise safely. We need to help people with asthma on that journey so that they get the most out of their lives.

What do you think are the research priorities for the field?

Internationally, most drug-related research focuses on new and innovative ways to reduce the symptoms of people with severe asthma. These are people who remain symptomatic and experience serious asthma escalations even at high doses of traditional medication – including asthma attacks and repeated hospital admissions.

Other new research generally relates to directly influencing the immune system. Immunotherapy is a key area of interest in asthma as it relates to controlling the symptoms of allergic rhinitis and asthma symptoms. Sub-lingual immunotherapy (SLIT) is one method which is being extensively researched in Ireland and is showing success for some patients.

“Asthma management is an ongoing challenge which involves taking control of environmental factors and making lifestyle changes, as well as taking medication as prescribed. Identifying the factors which kick-off asthma symptoms (known as asthma ‘triggers’) are a huge part of maintaining asthma control.”

On a more domestic scale, a significant research gap exists in Ireland. Studies are needed to ascertain the true number of people living with asthma in Ireland in recent years, as well as those most at risk of asthma-related death. We are seeking funding for these vital research projects so that we can better answer the big questions about people for asthma and improve their lives as a result.

Without this research, it is impossible to determine the needs of the asthma population or even ascertain the true impact of any existing or forthcoming asthma-related initiatives. We need better information to get this challenging area of health policy right.

What are the policy priorities in terms of pushing forward asthma at that level?

It is crucial that the needs of people with asthma are supported by policy decisions. The most pressing of which is government action to substantially reduce the cost of asthma medication and the provision of a free annual asthma GP review, as promised when the National Clinical Programme for Asthma was created. Together, these initiatives would significantly reduce the economic and emotional burden of asthma and certainly save many lives.

There is a severe lack of dedicated paediatric asthma services, particularly given that asthma affects 20% of children in Ireland. The level of current paediatric service is completely inadequate given the prevalence of the disease. Ireland currently has the lowest number of respiratory consultants in Europe, after Macedonia, at 1.3 per 100,000 people.

It is essential that the treatment of severe asthma and access to new drugs be made consistent across the country. At the moment, the provision of these lifesaving medications is dependent on the budget of individual hospitals and the drug is completely unavailable in certain areas – this makes it essentially a post-code lottery. This is an unacceptable and extremely dangerous situation for the people living with severe asthma in Ireland. ■

A full breakdown of the key issues we believe should be addressed by the Oireachtas is available in our pre-budget submission 2019, available on www.asthma.ie.

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Dyspnoea (breathlessness): Still an ongoing battle

Katy Beckford and Alex Christie from the Association of Respiratory Nurse Specialists detail precisely why dyspnoea (breathlessness) remains an ongoing battle today

Dyspnoea or more commonly called breathlessness or breathing discomfort continues to be a common, debilitating symptom. There is still an ongoing issue with patients' reporting chronic breathlessness often attributing it to age or self-infliction such as smoking. There also continues to be lack of understanding from non-specialist health care professionals about the extent dyspnoea can be debilitating, with delays in accessing treatments, both pharmacological and non-pharmacological.

Dyspnoea has multiple causes, such as lifestyle, which include smoking; weight and lack of exercise and can be experienced in respiratory conditions such as hypoventilation syndrome, chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis, interstitial lung disease, anaemia or cardiac disease to name a few. Then there are factors that affect levels of dyspnoea such as breathing pattern; air quality; pollution; infection/exacerbations and temperature/weather. This creates a complex problem to manage.

Assessment and diagnosis are key with dyspnoea and identifying the cause and thereby determining if it can be reversible, can go a long way in reducing the dyspnoea burden. The British Lung Foundation has developed an online 'breathlessness test'¹ for the public to use to help them decide if they should see a doctor about their breathlessness. Also, documentation of breathlessness by healthcare professionals needs to improve with tools such as the Medical Research Council (MRC) scale being an effective way to record breathlessness and monitor for worsening levels.

The role of exercise is underutilised in the management of breathlessness due to the lack of understanding by the general public regarding the link between inactivity and worsening dyspnoea. Initiatives like NHS 'Couch to



Katy Beckford and Alex Christie from the Association of Respiratory Nurse Specialists

5k', Hospital 'end pyjama paralysis' campaign or the Chartered Society of Physiotherapists 'Hate Exercise/Love activity' all aim to tackle physical inactivity and the overweight/obesity crisis. Talking to the public about exercise can be challenging, especially with the anxiety element that can occur with dyspnoea but by talking patients' through the cycle of inactivity, this can help achieve 'buy-in' to increasing activity levels.

In combination with exercise, breathing control should be addressed (both breathing patterns retraining and breathlessness management strategies) and the management of anxiety is essential to address, as this can be a significant factor for patients' experiencing breathlessness. Assisting the patient to control their breathlessness can include education on pursed-lip breathing, fan therapy, positions to ease breathlessness, relaxation or cognitive behavioural therapy (CBT)². Oxygen is still offered as a treatment for breathlessness, but evidence suggests there is no therapeutic benefit of using short burst oxygen therapy for dyspnoea where patients are not hypoxic³.

Poor air quality or pollution has received significant press coverage recently with governments around the world being pushed to create policies for reducing air pollution. The Office for National Statistics, UK⁴ reported a 25% increase in asthma-related deaths with a recent national review of asthma deaths⁵, highlighting that a larger portion were avoidable and showed links between air quality and pollution to asthma deaths. Many organisations are campaigning for the government to do more, so we can all breathe cleaner air⁶.

“Dyspnoea has multiple causes, such as lifestyle, which include smoking; weight and lack of exercise and can be experienced in respiratory conditions such as hyperventilation syndrome, chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis, interstitial lung disease, anaemia or cardiac disease to name a few.”

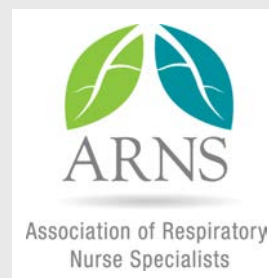
Dyspnoea, specifically worsening dyspnoea continues to be a strong prognostic indicator for hospitalisation and mortality⁷. The management of severe dyspnoea, especially at end of life, continues to be a battle with under prescribing of opioids such as morphine. The lack of understanding of the benefits of morphine both by health care professionals and the general public contribute to this. Opioids work by lowering the perception of dyspnoea, decreasing respiratory drive and can help to reduce anxiety.

The role of family and friends should not be overlooked in the management of dyspnoea. The sensation of dyspnoea can be debilitating for the sufferer but can also be frightening to their loved ones. Education of the causes and ensuring they are aware of the management and escalation plan for their loved one can help to reduce that anxiety.

Dyspnoea continues to be a complex phenomenon with significant consequences to the sufferer, their loved ones and the healthcare burden. A detailed assessment and multidisciplinary management approach are key to help sufferers manage dyspnoea and the physical and psych-social symptoms that come with it. It is not something can be solved by the health system alone, but in combination with national policy and a shift in mindsight regarding diet and activity, improvements can be achieved. ■

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Understanding the process of intravenous access

Virginia M Stewart, MD outlines when intravenous access may be needed and how the skilful process should be undertaken

Patients coming to the Emergency Department (ED) with shortness of breath may have characteristics that impede intravenous (IV) access. Such characteristics may include hypotension, dialysis dependence, morbid obesity, history of diabetes, sickle cell disease, or IV drug use. One prospective observational study identified nearly 1 in every 9 to 10 adults coming to an urban ED had difficult venous access requiring 3 or more IV attempts.¹ If peripheral IVs are not established, patients may need a central venous catheter placed for life-saving medications administered. In addition to requiring physician skill, central venous catheter insertion carries a risk of complications including infection, arterial puncture or an aneurysm, and pneumothorax. Ultrasound-guidance for peripheral IV placement (UGPIV) has prevented the need for central venous catheter placement in 85% of patients with difficult intravenous access.² UGPIV has been performed by Emergency Medical Technicians (EMTs) in prehospital settings, as well as nurses and physicians. Patients who have been identified as having difficult access have higher patient satisfaction scores when ultrasound is used in peripheral IV access attempts.³

Frequently, the large veins of the antecubital fossa are sufficient to place large bore peripheral IVs needed for resuscitation. The brachial and basilic

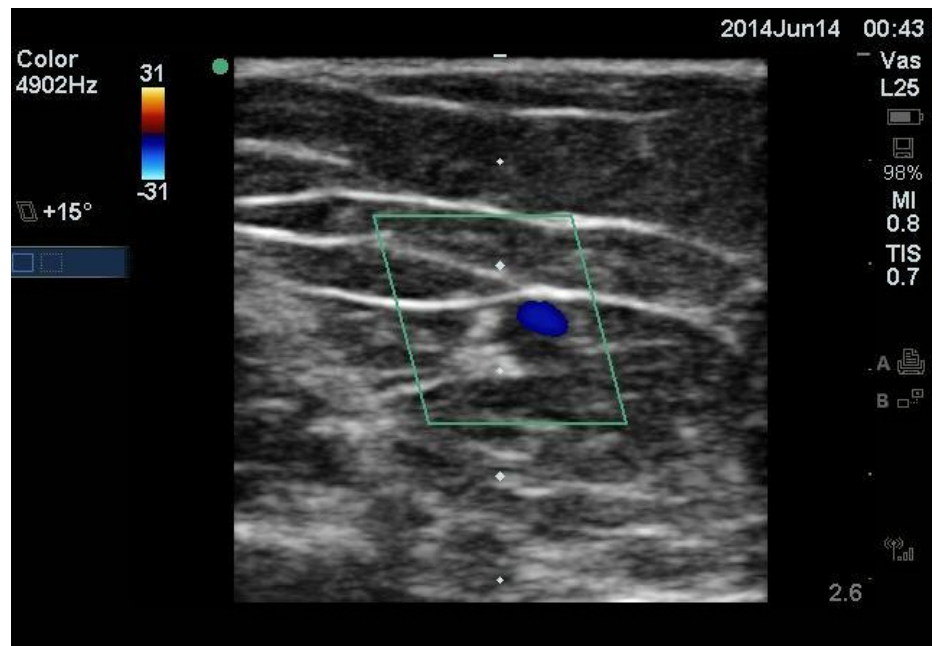


Figure 1: Short axis view of a peripheral vessel visualised with Colour Doppler (blue). The scale on the right of the screen demonstrates a total depth of 2.6 cm. A guide (white dots) in the centre of the screen marks each 0.5cm of depth. Therefore the depth of the vessel is between 1-1.5cm deep to the skin surface.

veins are easy to locate. The brachial artery is generally flanked by 2 smaller veins and the median nerve. Anatomically, these structures are medial to the insertion of the medial biceps tendon. This tendon is palpable in the antecubital fossa as the patient flexes the elbow. The basilic vein is located medial to the brachial vessels. Generally, it is more superficial, larger, and does not have an accompanying artery or nerve at the level of the antecubital fossa. As you move proximally up the arm (towards the head) the basilic vein dives deeper toward the humerus, and longer angi catheters may be required for cannulation.

When considering vascular access, there is 2 views, a short and long axis view. Cannulation from the short axis is considered 'out of plane' since the needle is perpendicular to the probe. A short axis approach 'looks' at a cross section of the vessel. Long axis uses an 'in plane' approach with the needle entering from the probe marker end, and 'looks' along the length of the vessel. Figure 1 identifies a vessel using colour Doppler in the short axis view. Figure 2 demonstrates a long axis view with a hyperechoic angiocatheter. Figure 3 is the same vessel in long axis with the angi catheter placed. While both approaches may be used for UGPIV placement, the



Figure 2: Long axis view of a peripheral vessel. The hyperechoic needle is visualized approaching from the top left of the screen into the vessel lumen.

benefit for the short axis is the ability to identify target veins as well as accompanying non-target (arteries and nerve) structures.

Identify the vein: remember the two C's

The two C's to remember for UGPIV access or for central venous cannulation are compression and colour (or Power) Doppler. Veins are thinner-walled and more easily compressed than arteries. This author advocates for finding a vessel first in the short plane, and compressing the vessel to ensure it is indeed a vein, rather than a less or non-compressible artery. Colour or Power Doppler may be utilised to determine if the pulsatile flow is consistent with an artery or vein. Colour Doppler uses red and blue to determine flow towards or away from the probe respectively. Power Doppler detects flow without concern for direction. Colour should not be relied on alone to determine arterial or venous flow due to the colour scale setting can be flipped or reversed, or aliasing can occur. Arterial flow is more pulsatile than venous. Venous flow may require distal augmentation (by squeezing the forearm distal to the probe) to appreciate the blush of colour.

Once the target vein is identified, the

depth from the skin surface should be noted. A common mistake is to use an angiocatheter that is too long or too short. A general rule of thumb is to use a catheter length that is more than twice the depth of the vessel to ensure at least half the catheter lies within the vein. Sterile ultrasound gel should be used, with a covered probe to prevent infection. To prevent the risk of multiple punctures, this author advocates for first bouncing the needle on the skin over the point of entry. The tissue should deform at the top of the screen, and confirm the needle is over the target vessel. Once the skin is punctured, the needle tip is kept in view by angling the ultrasound probe until the target vessel is punctured.

To confirm placement, either a 'bubble study' with agitated saline may be performed or Colour (or Power) Doppler utilised to visualise saline flow through the cannulated vessel. A vessel that is not properly cannulated will demonstrate extravasation of saline around the vessel into the tissue before the tissue swells to a degree which is palpable on the surface of the skin. Figure 4 demonstrates confirmation of intraosseous (IO) lines utilise Power Doppler. A 10cc saline flush is rapidly pushed through the line, and flow is demonstrated beneath

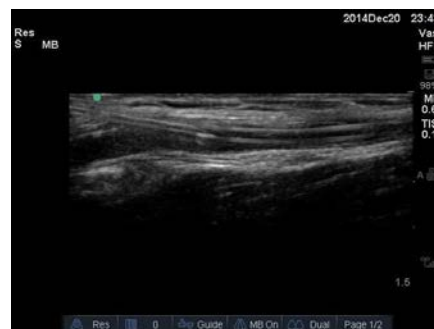


Figure 3: In this long axis view of a peripheral vessel the catheter has been threaded and is seen within the lumen of the vessel.



Figure 4: Power Doppler (orange) confirms placement of an intraosseus line within the distal tibia. The bright white line of the tibia cortex (in long axis view) is visualised at the top of the screen, with flow confirmation from a 10cc saline flush immediately distal (below) to the hyperechoic cortex.

the bony cortex in this adult tibia. If the line is improperly placed, the blush of colour using Doppler would appear in the soft tissues. For further information about UGPIV placement, visit: <http://rmgultrasound.com/piv-access/>

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Why thousands of people with asthma could be missing out on life-changing treatment

Asthma UK's recent report explores the barriers to life-changing treatment for people with uncontrolled asthma, as Joe Farrington-Douglas, Head of Policy and External Affairs at Asthma UK explains

Imagine how terrifying it would be to spend every day fighting for breath. How disruptive it would be to your life to be constantly in and out of A&E because you've had a life-threatening asthma attack. How frustrating it would be to find your medication simply wasn't working. Well, that's the reality for an estimated 200,000 people who may have severe asthma and not even know it, according to [a new report by Asthma UK](#).

Severe asthma is a misleading term as it isn't mild or moderate asthma which is particularly bad or severe. In fact, it's a particular type of asthma which is uncontrolled and doesn't respond to normal treatments of preventer and reliever inhalers. Those who are diagnosed with the condition have to take long-term oral steroids that leave them exposed to toxic side effects over time, such as osteoporosis and diabetes.

In our report [Slipping Through the net: The reality facing patients with severe and difficult asthma](#), we have revealed that while 894 people are officially registered as having severe asthma: we think this is just the tip of the iceberg and in reality, the figure could be as high as 200,000.

This means that there could be hundreds of thousands of people with debilitating asthma whose quality of life is at rock bottom and who may be unable to work, who are following their asthma medicine routine but finding it isn't making them any better.

Not only is this life-threatening for them and deeply distressing but it is costly for the NHS. Patients with severe uncontrolled asthma cost the NHS four times more than someone with normal asthma, due to the cost of treating the side effects from oral steroids, A&E treatment, hospital admissions and GP time.

Having spoken to almost 90 clinicians in primary, secondary and tertiary care, we think there is a lack of awareness amongst patients and healthcare professionals of the symptoms of severe asthma, how to diagnose it and when people need to be referred for specialist care.

When patients have an asthma attack or a hospital admission, they may or may not be referred back to their GP. They remain in primary care and aren't referred for the specialist treatment which would enable them to access life-saving drugs. We have heard extreme cases such as one patient who took 20 years to finally get the treatment they needed.

“Patient care records need to be shared across care settings. This means patients are less likely to fall through the gaps between different parts of the pathway and clinicians will be able to understand their patients’ medical history.”

There are currently no universal and consistently-followed clinical guidelines for referring and treating people with severe asthma leading to a postcode lottery of care.

So, 89% of the clinicians we surveyed refer patients for a specialist opinion only if they have taken three or more courses of steroids before they are referred. This is despite the fact that recommendations from the National Review of Asthma Deaths (NRAD) say referral should be after two courses. Other clinicians are referring patients depending on whether they have had different numbers of asthma attacks or hospital admissions within a year.

Despite the advent of safe and effective drugs for severe asthma patients, many people are not getting

the drugs they need or are missing out on ancillary care, such as therapies and psychological support.

So, what's the solution? The first step is for NHS England, NHS Improvement and the equivalent health bodies for the rest of the UK to work in collaboration with specialist hospitals and clinics to agree on clear definitions of what severe asthma is.

Specialist asthma centres need to ensure they are updating the Severe Asthma Registry. By getting an accurate picture of how many people with asthma are in need will enable the NHS to devise a plan to support people with severe asthma and allocate appropriate funding.

“Severe asthma is a misleading term as it isn't mild or moderate asthma which is particularly bad or severe. In fact, it's a particular type of asthma which is uncontrolled and doesn't respond to normal treatments of preventer and reliever inhalers.”

NHS service providers then need to ensure that those with the condition can access the care they need, irrespective of where they live. It needs to ensure new treatments are available and there are funds in place to support severe asthma treatment and care.

Patient care records need to be shared across care settings. This means patients are less likely to fall through the gaps between different parts of the pathway and clinicians will be able to understand their patients' medical history.

There is also a role for digital health technologies to benefit people with severe asthma. Examples are smart inhalers – devices fitted to an inhaler which can detect how someone is using their inhaler and send the data to a smartphone or healthcare professional in real time. This could be used to detect if a person with asthma is using their inhaler too much, a sign that

they may need support to better manage their asthma or may need help with their inhaler technique.

With appropriate consent, the cumulative data from new technologies could also be shared with researchers, to inform new treatments and service delivery. Used consistently across a locality, technology such as this could enable NHS trusts and commissioners to stratify risk and allocate their resources effectively.

The outlook for people living with severe asthma is becoming more hopeful, but the key is to make sure they are identified, referred quickly and then treated effectively. We want to support health bodies to make these changes that could transform the lives of people with severe asthma. ■

For more information about severe and difficult asthma and to read Slipping Through the net: The reality facing patients with severe and difficult asthma (<https://www.asthma.org.uk/severeasthmareport>).

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The need to improve the diagnosis of chronic inflammatory lung diseases

Michael Roth, Research Group Leader at University Hospital Basel argues for the clear need to improve the diagnosis of chronic inflammatory lung diseases

Chronic inflammatory lung diseases, including asthma, chronic obstructive pulmonary disease (COPD: smoker's lung), emphysema and pulmonary fibrosis have been rising worldwide for decades now and we do not understand the cause of this phenomenon. According to the World Health Organization (WHO), more than 420 million people are affected by chronic inflammatory lung diseases. Importantly, none of the chronic inflammatory lung diseases can be cured with the currently available therapies, so symptoms can be controlled.

The first obstacle regarding chronic inflammatory lung diseases is the lack of fast and reliable diagnostic methods available. The diagnosis of chronic inflammatory lung diseases relies largely on lung function testing (spirometry), which is based on the measurement of forced vital capacity (FVC) of the lung. FVC determines the maximum amount of air a person can forcefully exhale after taking a deep breath.

The second parameter of lung function is FEV1, which measures the forced expiratory volume in one second. This determines the maximum amount of air, which a person can forcefully exhale in one second. In all chronic inflammatory lung diseases, FEV1 is scored and low values correlate with the severity of the disease. The ratio of FVC and FEV1 can help to distinguish

between COPD and pulmonary fibrosis but needs additional tests to confirm the diagnosis. A third parameter is the forced expiratory flow (FEF) which, however, has to be adjusted to age and gender.

Lung function tests can also include bronchial challenge tests, which determine the response of the airways to inhalation of constrictive triggers such as cold air, dry air, drugs (methacholine, histamine, mannitol etc.) or after excessive exercise. Performing the challenge after inhalation of a β 2-agonist allows determine the capacity of the airways to relax, which helps the doctor to distinguish asthma from COPD.

All tests have to be performed in triplicate and never can overestimate a parameter, but often underestimate the lung function. The cause of this problem is the fact that all tests largely depend on the collaboration of the patient.

Furthermore, the equipment for performing lung function tests has to be standardised regularly and is subject to mechanical tests, which can vary on a daily basis or the condition of the equipment.

During the past two decades, many investigators and initiatives searched for disease-specific markers which can be detected in either blood, serum, or airway fluids to allow the

fast and reliable diagnosis of chronic inflammatory lung diseases. However, neither genomic, proteomic, nor transcriptomic, or other large data analysis studies produced significant new knowledge about such markers. Most studies confirmed well-known pro-inflammatory cytokines or indicated markers for small sub-types of the diseases. This knowledge resulted in the development of so-called "humanized antibodies" targeting specific cytokines including interleukin-3, -4, -5, -13 or GM-CSF (granulocyte macrophage colony stimulating factor). However, these new medications did not yield the expected curative effect and have to be further tested for its benefits in selected patient groups. Only humanized anti-IgE-antibodies seem to have a lasting beneficial effect for allergic asthma and other allergic diseases. However, in regard to diagnostics, there was no new marker or method found that can replace or reduce the above-described lung function tests.

The newest discussion is if the classification of patients according to their response to drugs based on known gene mutations (theratyping) which is a better way to improve therapies. This method requires the knowledge of gene mutations that cause a disease, which does not exist for chronic inflammatory lung diseases. This approach has helped in terms of some specific tumours to improve therapy. In regard to chronic inflammatory lung



diseases, none of the candidate genes that were linked to the susceptibility to asthma, COPD or fibrosis have been confirmed and specific drugs that may correct the function of the encoded proteins do not exist.

“According to the World Health Organization (WHO), more than 420 million people are affected by chronic inflammatory lung diseases. Importantly, none of the chronic inflammatory lung diseases can be cured with the currently available therapies, so symptoms can be controlled.”

Asthma

Asthma is characterised by variable airflow limitation including variation in expiratory airflow, which is increased when compared to healthy people and includes re-occurring wheeze, shortness of breath, frequent night cough and chest tightness. Untreated asthma presents with chronic airway inflammation, bronchoconstriction,

mucus production, airway hyper-responsiveness, or edema of the bronchial mucosa. Not all these symptoms have to be present and they can vary on a daily basis. The occurrence of these symptoms can be triggered by inhalation of cold, dry or humid air; by allergens, dust, smoke, or after eating allergens with food. In addition, asthma symptoms can occur after psychologic stress, exercise, or sports.

For many patients, asthma is a lifelong burden. Asthma starts in childhood and its severity varies over the lifetime. The European Respiratory Society reported that the prevalence of childhood asthma increased from 0.4% in 1948 to > 20% in 2004 (<https://www.erswhitebook.org/chapters/childhood-asthma/>).

Asthma reduces the social and economic activities of the patients significantly and its overall effects on life quality and performance are largely

underestimated by today's society. In addition to the patients, the disease also affects the daily life of their families. Asthma occurs in different phenotypes presenting as allergic and non-allergic disease. Clinical investigations further sub-divided asthma according to the type of immune cells that infiltrate the airway tissue. Neutrophils are increased in up to 15% of asthmatics and the activated cells release a specific range of cytokines which stimulate inflammation, assigned neutrophilic asthma. Eosinophil numbers in sputum or lung lining fluids are increased in 6-12% of asthmatics and correlate with a different set of pro-inflammatory cytokines, which increase inflammation.

The identification of asthma sub-types is based on specific staining procedures of isolated immune cells obtained from the patient during a hospital visit. The result of such diagnoses can vary between laboratories



and may also be affected by seasons, furthermore, a standardisation of such results is difficult to achieve.

“For many patients, asthma is a lifelong burden. Asthma starts in childhood and its severity varies over the lifetime. The European Respiratory Society reported that the prevalence of childhood asthma increased from 0.4% in 1948 to > 20% in 2004.”

Measurements of biological markers that circulate in the blood or are present in exhaled breath condensates (interleukins, cytokines, growth factors) have to be determined repeatedly and there are no guidelines for thresholds above which a specific cytokine is considered “highly” expressed. Thus, these methods need control samples, which are also not standardised.

Besides the above-described lung function tests and inflammation

markers, the diagnosis of asthma involves detailed information about the patient’s history, which includes family history, other diseases (specifically, allergies), working conditions and hobbies (sports, pets and plants).

COPD

Often termed “smoker’s lung”, COPD is a progressive deadly disease which manifests first in the lung before it affects the function of other organs including the heart and blood vessels. Different from asthma, COPD is diagnosed at an age over 45 and with a history of tobacco smoking. Tobacco smoking is the major cause of COPD, but new studies indicated that 30% of COPD patients never smoked. The analysis of these patient’s history revealed that frequent exposure to organic and fine dust could initiate COPD, as well as tobacco smoke.

COPD is characterised by a chronic cough or mucus production,

wheezing, chest tightness and shortness of breath after physical activities. All symptoms are shared with asthma and, therefore, the diagnosis needs a spirometric evaluation of lung function and of oxygen supply to the blood. The lung function test for COPD can include lung volume, diffusing capacity and pulse oximetry. In order to distinguish COPD from asthma, it is necessary to perform several tests including if airflow obstruction is fixed or partly reversible, the ratio of eosinophils/neutrophils in sputum and bronchoalveolar lavage, the exchange of oxygen and carbon monoxide as well as the amount of nitric oxide in exhaled breath as a measure of active inflammation.

Furthermore, the reversibility of challenged airway constriction in the presence of bronchodilators and steroids, high-resolution computed tomography and x-ray or CT-scan for detection of emphysema can help the



doctor to distinguish asthma from COPD. In addition to these lung function tests, a detailed analysis of the patient's history is needed.

Regarding the many efforts to find molecular markers for the diagnosis of COPD, none of the multiple studies has provided any useful tool. All the suggested markers such as pro-inflammatory cytokines of the Th1/Th2-type are up-regulated by other inflammatory diseases as well and do not allow to diagnose COPD or asthma specifically. Moreover, while the level of these markers in blood serum, sputum or airway fluids allow distinguishing a group of patients from healthy people, the large variability does not allow to use them as an indicator for a single patient.

Pulmonary fibrosis

Another chronic inflammatory disease is pulmonary fibrosis, which affects mainly people aged over 50 years.

Symptoms include shortness of breath, dry cough, lack of energy, weight loss and aching muscles. The cause(s) of pulmonary fibrosis is unclear. There is no cure for pulmonary fibrosis and the therapeutic options are very limited. The available drugs applied to pulmonary fibrosis extend the lifespan for some time but has severe side effects on the liver function.

“During the past two decades, many investigators and initiatives searched for disease-specific markers which can be detected in either blood, serum, or airway fluids to allow the fast and reliable diagnosis of chronic inflammatory lung diseases.”

The diagnosis of the disease includes spirometry, lung tissue biopsies, x-ray CT-scan. None of the studies indicated any disease-specific protein or factor that can be used to diagnose pulmonary fibrosis. Like for asthma and COPD, most bio-markers that are up-regulated in pulmonary fibrosis are also up-regulated in other chronic inflammatory diseases and vary between patients.

Conclusion

The diagnosis of chronic inflammatory lung diseases largely relies on lung function tests using mechanical equipment to measure airflow and breathing capacity. The diagnosis is based on the patient's collaboration and the experience of the examining doctor. X-rays, CT-scans and other laboratory parameters can help to differentiate chronic inflammatory lung diseases from each other, but none of the tests can provide a certain diagnosis. In clinical practice, the diagnosis of

many patients has to be corrected with time, according to repeated monitoring results. In consequence, the therapy has to be adjusted. Without better diagnostic methods and tools, the goal to achieve personalised therapy will not be achieved in the near future.

To solve the problem, firstly, politicians and society have to recognise the great impact of chronic inflammatory lung diseases for society. Secondly, the funding to develop new diagnostic methods has to be provided and must come from unbiased organisations. Thirdly, researchers have to take a step back and try new ideas. In order to develop better diagnostic methods and find new therapies, it may be even necessary to re-investigate the pathogenesis of chronic inflammatory lung diseases.



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Neurodegenerative disorders in the U.S.

The vital work of the National Institute on Deafness and Other Communication Disorders (NIDCD) and The National Institute of Neurological Disorders and Stroke (NINDS) are explored here by Open Access Government, with a special focus on neurodegenerative disorders

By way of an introduction, The National Institute on Deafness and Other Communication Disorders (NIDCD) is part of the National Institutes of Health (NIH) in the United States. NIDCD essentially supports and conducts research in the normal and disordered processes of hearing, taste, smell, voice, balance, speech and language.

Dr Judith Cooper, Ph.D., the current Acting Director, NIDCD sums up the work of the organisation extremely well, which has been running for over 30 years: “The National Institute on Deafness and Other Communication Disorders (NIDCD) has supported basic and clinical research and research training on communication and sensory disorders. 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 for communication disorders.”

Hearing loss research

The current Acting Director goes on to reveal that the NIDCD’s robust programme of basic and clinical research focuses, in part, on the identification of genes involved in hearing loss to lead to earlier diagnosis and treatment, as well as new therapies. These fascinating areas of the NIDCD are explained by Dr Judith Cooper in her own words.

“Nearly 30 million adults in the United States could benefit from using hearing aids, but only one in four has used them. The NIDCD supports innovative clinical and translational research to lay the foundation for making hearing health care more accessible and affordable. Current research includes identifying barriers to 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 synthesised from brain-computer interfaces.”

“While there is currently no cure for Rett syndrome, treatment today focuses on the management of symptoms, plus medication to treat breathing irregularities and motor difficulties, as well as antiepileptic drugs to control seizures. It is said that occupational therapy, physiotherapy and hydrotherapy may prolong mobility.”

Voice, speech and language

Another aspect of NIDCD research aims to improve the identification and treatment of voice, speech and language disorders such as specific language impairment, spasmodic dysphonia and stuttering. On the NIDCD website, Dr Judith Cooper details further aspects of the ongoing research where voice, speech and language are concerned.

“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. The NIDCD has long supported the NIH Autism Centers of Excellence Program, which funds large research projects, some of which focus on developing effective interventions to help children with ASD better communicate.

“NIDCD-supported research also addresses voice,

speech, and language impairments linked to injury, stroke, and neurodegenerative disorders such as Parkinson's disease and amyotrophic lateral sclerosis (ALS). These communication problems – such as aphasia, dysarthria, and apraxia – often lead to increased isolation and poor quality of life.”

Neurodegenerative disorders – Rett syndrome

Picking up on the mention above by Dr Judith Cooper concerning neurodegenerative disorders, we know there is a further example of this because research around Rett syndrome is conducted by The National Institute of Neurological Disorders and Stroke (NINDS) and other institutes of the National Institutes of Health (NIH).

NINDS seeks out fundamental knowledge about the brain and nervous system and to use that knowledge to reduce the burden of neurological disease. On Rett syndrome, for example, we know that the discovery of the gene for this in 1999 provides a basis for further genetic studies in the field. We find out on the NINDS website that understanding the cause of this disorder is essential “for developing new therapies to manage specific symptoms, as well as for providing better methods of diagnosis.”

Going into further detail, it is worth pointing out that Rett syndrome is a childhood neurodevelopmental disorder that primarily affects females. The first symptom tends to be the loss of muscle tone and other early symptoms can include a slowing of development, diminished eye contact and problems crawling or walking. As the syndrome progresses, a child will lose the use of their hands and the ability to speak. Unfortunately, the inability to perform motor functions is possibly the most debilitating feature of Rett syndrome, interfering with each body movement, including speech.

While there is currently no cure for Rett syndrome, treatment today focuses on the management of symptoms, plus medication to treat breathing irregularities and motor difficulties, as well as antiepileptic drugs to control seizures. It is said that occupational therapy,

physiotherapy and hydrotherapy may prolong mobility. Special equipment and aids such as braces to arrest scoliosis, splints to modify hand movements may be required by some children.

NIH: Supporting basic medical research in the U.S today

Looking at the wider picture, we know that NINDS has a long history of supporting the research and development of gene therapies for neurological disorders and that their work requires a balance of basic, translational and clinical research. The NIH supports most basic medical research in the U.S today, although it is worth mentioning that each NIH Institute and Centre has a well-defined mission with respect to disease, indeed, a number of NIH components support complementary programmes of basic neuroscience research that advance the missions of all concerned.

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Rett syndrome: Research on severe neurodevelopmental disorders

Jennifer J. McComas, PhD and Alefyah Shipchandler from the University of Minnesota discuss the current state of the evidence for communication intervention for individuals with Rett syndrome

Researchers who investigate rehabilitative treatments for severe neurodevelopmental disorders rely on human participants agreeing to serve as the subjects of our experiments. Some families consent to participate because they have experienced something like this: they gave birth to a healthy baby and watched that baby hit developmental milestones for the first six or more months of life, only to observe their child, who has developed fine motor and some early vocal language, go through a period of regression in which they lose motor and communication skills.

Without motor and communication skills, it is nearly impossible to know their cognitive abilities, but most experts report cognition is also severely impaired. Although this condition is rare, affecting approximately one in 10,000 girls born worldwide (it is exceedingly rare in boys), it is nevertheless devastating. The neurodevelopmental disorder, now known as Rett syndrome (RTT), was first described by an Austrian pediatrician¹, but for decades, individuals with RTT were misdiagnosed as having autism due to similarities in behavioural phenotype². In 1999, Huda Zoghbi and her colleagues discovered that genetic mutations in the gene *MECP2*^{3,4}, located on the X chromosome, cause RTT. Systems that experience impairment often include speech, motor skills, breathing, cardiac function,

chewing, swallowing and digestion.

Although extensive research on the genetic basis and medical treatments for RTT in non-human populations has occurred in the past 20 years^{5,6,7,8}, the goal of that research has been a better understanding of the causal mechanisms, potential treatments and cures for the disorder. Far less experimental research has been conducted in the area of treatment of communication deficits. Yet, while families wait for effective treatment of symptoms or a cure, they are in need of empirically validated interventions that will allow their daughters with RTT to communicate their wants and needs.

Persons with multiple disabilities, including severe physical and communication disabilities, often need assistive technology in the form of augmentative and assistive communication (AAC) devices to communicate. Eye-gaze technology that involves an eye-tracking device and a computer-based programme that produces vocal output is an emerging technology for individuals with severe motor impairments⁹ and is increasingly recommended for individuals with RTT^{10,11,12}.

Despite claims of individuals with RTT using eye-gaze technology to converse with their families¹² and to read¹³, there is little published empirical evidence of effective use of eye-gaze devices by individuals with RTT. As such, the National Institute on Deafness and

Other Communication Disorders (NIDCD) within the National Institutes of Health (NIH) in the United States, funded our research project designed to develop a reinforcement-based intervention model for addressing the complex communication needs in RTT. As part of that project, we examined the published peer-reviewed empirical literature on the use of a behavioural intervention to teach or improve communication of individuals with RTT and our findings were somewhat surprising.

A systematic search was conducted in the following electronic databases: PsychINFO, PubMed and Academic Search Premier. In all databases, "Rett syndrome" was inserted into the search field along with one of the following: "behavioural + intervention," "communication + intervention," "educational + intervention," "habilitative + intervention," and "augmentative communication," for a total of five search term pairs.

From the resulting 310 publications, chapters, non-peer-reviewed papers (e.g., dissertations) and non-English articles were excluded. In addition, articles that focused on genetics, reports of general characteristics of RTT, medical interventions and interventions conducted with non-human subjects were excluded. Finally, any article in which communication was not reported as a dependent variable or that did not describe a procedure

| | Bartolotta et al (2012) | Byiers et al (2014) | Elefant, et al (2004) | Evans et al (1999) | Hetzroni et al (2002) | Koppenhaver et al (2001) | Sigafoos et al (1996) | Simacek et al (2017) | Simacek et al (2016) | Smith et al (1993) | Stasolla et al (2014) | Sullivan et al (1995) | Van Acker et al (1995) | Vessoayan et al (2018) | Wigram et al (2005) | TOTAL |
|--|-------------------------|---------------------|-----------------------|--------------------|-----------------------|--------------------------|-----------------------|----------------------|----------------------|--------------------|-----------------------|-----------------------|------------------------|------------------------|---------------------|--------------|
| Total (out of 9) | 3/9 | 6/9 | 3/9 | 4/9 | 7/9 | 4/9 | 7/9 | 9/9 | 8/9 | 4/9 | 6/9 | 3/9 | 7/9 | 4/9 | 1/9 | |
| Context & setting | N | N | N | Y | Y | N | N | Y | Y | N | N | N | Y | Y | N | 6/15 |
| Participants | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | 15/15 |
| Intervention agent | N | N | N | N | N | Y | Y | Y | N | Y | N | Y | N | N | N | 5/15 |
| Description of practice | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | N | 13/15 |
| Implementation fidelity | N | N | N | N | N | N | N | Y | Y | N | N | N | N | N | N | 2/15 |
| Internal validity | N | Y | N | N | Y | N | Y | Y | Y | N | Y | N | Y | N | N | 7/15 |
| Outcome measures/ dependent variables | N | Y | N | N | Y | N | Y | Y | Y | N | Y | N | Y | N | N | 7/15 |
| Data analysis | N | Y | N | N | Y | N | Y | Y | Y | N | Y | N | Y | N | N | 7/15 |
| Conceptualisation | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | 14/15 |

Table 1. Rating of each quality indicator for each article

related to teaching or improving a communicative response was excluded. A total of 15 studies were identified for evaluation.

Next, we evaluated each of the 15 studies using the Council for Exceptional Children (CEC): Standards for Evidence-Based Practice in Special Education¹⁴. In addition, an indicator of conceptualisation underlying the study¹⁵ was included in the review. The CEC’s standards for evidence-based practice contain sub-features of each indicator. For an indicator to be considered “met,” the study needed to address all the relevant sub-features of the indicator. For example, quality indicator five ‘Implementation Fidelity’ includes three sub-features pertaining to adherence, dosage and duration¹⁴.

For an indicator to be scored as Yes (Y), all sub-features needed to be adequately addressed. One rater independently evaluated all 15 articles according to the CEC standards, and a second rater independently evaluated eight of the 15 articles using the same criteria. Inter-rater agreement for the nine indicators was 100% across all articles that were evaluated by both raters.

All 15 studies addressed non-vocal forms of communication and targeted either motor responses or eye gaze as their target behaviours, with some including both. Target communicative responses included unaided responses (e.g., signs, gestures) or technology aided responses that involved either low technology (e.g. pictures, micro-

switches, 2D symbols, 3D objects) or high technology (e.g., speech generating devices [SGD] activated by eye-gaze). Of the fifteen studies, two studies utilised eye-gaze technology^{16,17}.

Results of the evaluation of the nine quality indicators for evidence-based practice described by the CEC (#1-8) and research described by Gersten and colleagues (#9) are presented in Table 1. The ratings of the quality indicators varied widely across the 15 studies. All 15 studies met the criteria for describing participants, all but one met the criteria for conceptualisation and all but two met the criteria for describing the practice. Only one study met the criteria for all nine indicators¹⁸ and 1/3 of the studies (five of 15) met the criteria for at least seven



Image: © Leszek Czerwonka | Dreamstime.com

Young girl with Rett syndrome

of the nine indicators. Four studies (1/4) met criteria for three or fewer of the nine indicators.

In our experience, families affected by RTT have been exceptionally generous with their time and energy in voluntarily participating in research projects, despite the challenges they encounter caring for a loved one with severe multiple disabilities. As researchers, we owe it to these families and to our science to conduct rigorous investigations and disseminate our procedures

and results in a way that is replicable by other researchers. In our role as reviewers for publication outlets and funding recommendations, we must take stock of the body of evidence and demand continuous improvement in the quality of evidence pertaining to treatment for critical skills such as communication.

In summary, within the body of work to date, the claims vary widely pertaining to the utility of high-technology devices that involve eye-gaze for

individuals with RTT. As the field matures, more studies that meet the quality standards of evidence-based practices and research and that improve understanding for whom and under what conditions particular technologies and practices are effective are imperative for continued progress in the field^{19,20}.

The research described in this profile is supported by the National Institute on Deafness and Other Communication Disorders (NIDCD/NIH) Grant No. 1R21DC015021-01A1.

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Note: * Indicates the article was included in the review

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Cutting-edge technology synergy in the personalised nanomedicine space: Focus on 3D printing nanomedicines

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group explains the role of cutting-edge technology synergy in the personalised nanomedicine space, with a special focus on 3D printing nanomedicines

When it comes to understanding cutting-edge technology synergy, let's start by looking at how 3D printing is meeting nanotechnology.

Two-photon polymerization (TPP) based 3D printing technology revolutionised many industries by allowing printing objects at nanoscale resolution. By using a near-infrared femtosecond laser, TPP-based 3D printing technique solidifies photoresist for the assembly of ultra-precise 3D nanostructures. In fact, it is the laser power that determines the final resolution, along with the exposure time and the efficiency of TPP initiators. According to a very recent publication (Zhu et al., 2018), the principal challenge to a broader spectrum of bio-medicine applications of this technology is associated with the ease of aggregation and precipitation of nano-materials when they are used in printable inks, hence demanding complex stabilisation procedures. Most active pharmaceutical ingredients (APIs), especially new chemical entities (NCEs), exhibit poor solubility. Therefore, overcoming solubility issues by using new technologies such as nanotechnology appears promising.

How is 3D printing empowering nanomedicine?

Inkjet printing and drug nanonization procedures have been successfully combined at the research level (Cheow et al., 2015). Similarly, various nanosuspensions have been utilised as inks in two well-renowned research studies (Palo et al., 2015; Pardeike et al., 2011). However, a more recent review (Preis and Rosenholm, 2017) comments that although in all these cases, the active agents have been formulated as a nanosuspension, even more advantages could arise by

incorporating the agent into a nanocarrier, further formulated into an ink for 3D printing of high precision, personalised therapeutics. According to the authors, the utilisation of nanostructures as drug carriers, along with the simultaneous incorporation of a stabiliser in the ink, can facilitate printability.

“3D printing has allowed the generation of a broad spectrum of customised implants, principally spinal and craniofacial implants, as well as, cardiovascular stents. Similarly, this technology has also facilitated the generation of multiple cell types via 3D bioprinting by originating a variety of cell patterns in a restrained space, while preserving cell function and viability within the printed construct.”

Printers designed for bioprinting are usually pressure regulated, instead of thermally or piezo-electrically regulated to avoid damage on thermo-labile ingredients. Nevertheless, more sensitive substances, such as biomolecules, can be affected, even by shear forces. Therefore, the incorporation of these molecules into a nanocarrier can significantly enhance bioavailability and stability during print processing (Giner-Casares et al., 2016).

How is 3D printing supporting regenerative medicine?

3D printing technology is paving the way for personalised medicine by enabling individual configuration (Shafiee and Atala, 2016). 3D printing technology is being widely used to create biofunctional scaffolds, in which nanocarriers are introduced for monitoring and control of stem cell behaviour after transplantation

(Rosenholm et al., 2016). Moreover, the same approach can be used to design personalised drug-eluting implants through the creation of a biomimetic bone-specific environment (Van Cauwenberghe, 2015).

Therefore, 3D printing technology can be used to mimic different biological microenvironments that may potentially function as powerful tools for studying cancer metastasis and assessing drug response sensitivity, among many other applications. Interestingly, fluorescent nanoparticle inks can be used as biomarkers or labels to enhance biomedical imaging techniques. 3D printing has allowed the generation of a broad spectrum of customised implants, principally spinal and craniofacial implants, as well as, cardiovascular stents. Similarly, this technology has also facilitated the generation of multiple cell types via 3D bioprinting by originating a variety of cell patterns in a restrained space, while preserving cell function and viability within the printed construct.

Final remarks

The future landscape for 3D printed nanomedicines is a revealing perspective. The development of highly sophisticated drug delivery platforms and realistic diagnostic systems that enable the delivery of precise and personalised medicine solutions is certainly being energised by the introduction of 3D printing technologies. Printable nanomedicines are expected to have a major impact on the nanomedicine market over the coming two to three years. The regenerative medicine space has been substantially energised with the advent of stem cells. 3D printing platforms constitute promising tools due to their ability to conform structures and devices with atomic-scale precision and accuracy. Fundamental building blocks are able to fold, join, build and grow by themselves, perfectly well-matched to building nanostructures. Binding can be specifically tailored so that customised parts can be combined to bind with each other and construct exotic structures. Novel techniques focus on printing a grid-like 3D structure laden with stem cells to enhance the discovery of personalised nanomedicines is something that has gained an increased amount of attention.

Acknowledgements

I would like to thank all contributors from industry involved with the development and delivery of this article from the TechVision Group at Frost & Sullivan. ■

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Turning radiation damage into an opportunity for nanotechnology

As part of the imaging of nanoscale phenomena, exploring the fundamentals of electron matter interactions to turn radiation damage into an exciting opportunity for nanotechnology is discussed here by Postdoctoral Researcher, Anna Elsukova from the Technical University of Denmark

Imaging nanoscale phenomena in transmission electron microscopy requires the irradiation of our target sample with high-energy (60-300 keV) electrons. The interaction between these electrons and the atoms within the sample provide the signals we use to gain physical knowledge. However, they also inflict damage on the specimen, limiting acquisition and complicating the interpretation of structural and chemical data. Microscopists targeting inorganic/hard materials can generally ignore these complications. In other cases, for example, when studying catalytic reactions or soft matter, a great deal of caution is required.

At the Technical University of Denmark's Center for Electron Nanoscopy (DTU Cen), we pay special attention to electron matter interactions and focus our efforts towards their deep scientific understanding in view of turning them into a useful tool for a variety of applications in nanotechnology. No other project demonstrates it better than Organic Ice Lithography, where we exploit electron matter interactions to trigger the nanoscale transformation of a frozen layer of volatile organic molecules into a solid product.

Organic Ice Resist Lithography (OIRL) is a new approach to electron beam based nanofabrication, developed at DTU Danchip/Cen through the PhD work of William Tiddi, supervised by

Assistant Professor Anpan Han and Associate Professor Marco Beleggia^{[1][2]}. The goal of electron beam lithography (EBL) (Figure 1(a)) is to create a desired pattern in a sacrificial material called resist. The portion of the resist that is irradiated by an electron beam undergoes chemical changes, driven by two competing processes: chain scission and crosslinking (Figure 1(b)). Chain scission is the fragmentation of molecules into smaller units while crosslinking involves molecular units joining together. After exposure, the resist is immersed in a suitable chemical called developer. Chain scission reduces resist solubility; crosslinking does the opposite. Depending on which process dominated during the exposure, either the exposed or the unexposed areas will be dissolved by the developer (Figure 1(a)).

In OIRL, the organic ice resist material is condensed from vapour directly on a substrate held at cryogenic temperature (Figure 1(c)). With all the molecules we have tried so far (1-pentanol, n-nonane, anisole), the exposure process is dominated by crosslinking of the molecules. However, it is not the change of solubility that matters here, but the increase in

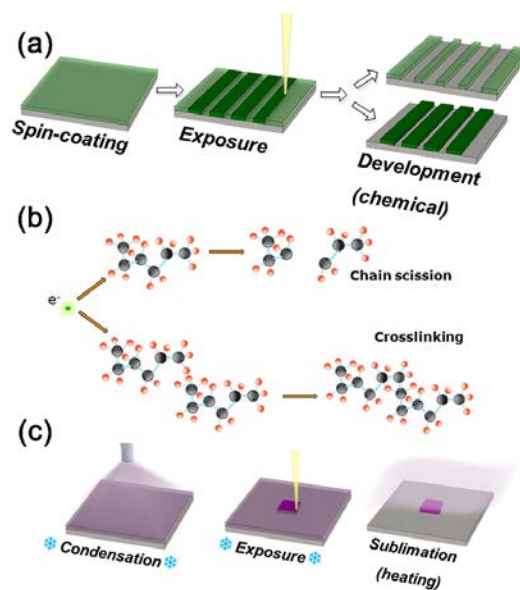


Figure 1: (a) The basic steps of the electron beam lithography process. (b) Schematic representation of chain scission and crosslinking – two parallel chemical processes induced by electron beam irradiation. (c) Basic steps of the organic ice resist lithography process.

the critical sublimation temperature of the exposed areas. Therefore, the unexposed areas are removed simply by heating the substrate to room temperature. This approach offers several advantages over existing EBL methods. Firstly, all process steps take place in a single instrument; repeating multiple cycles of condensation-exposure-heating steps enables the effective and precise fabrication of 3D layered structures. Secondly, it is easy to deposit the resist uniformly on any surface – porous, grooved or curved.

Finally, no chemicals are involved other than the resist precursor; this

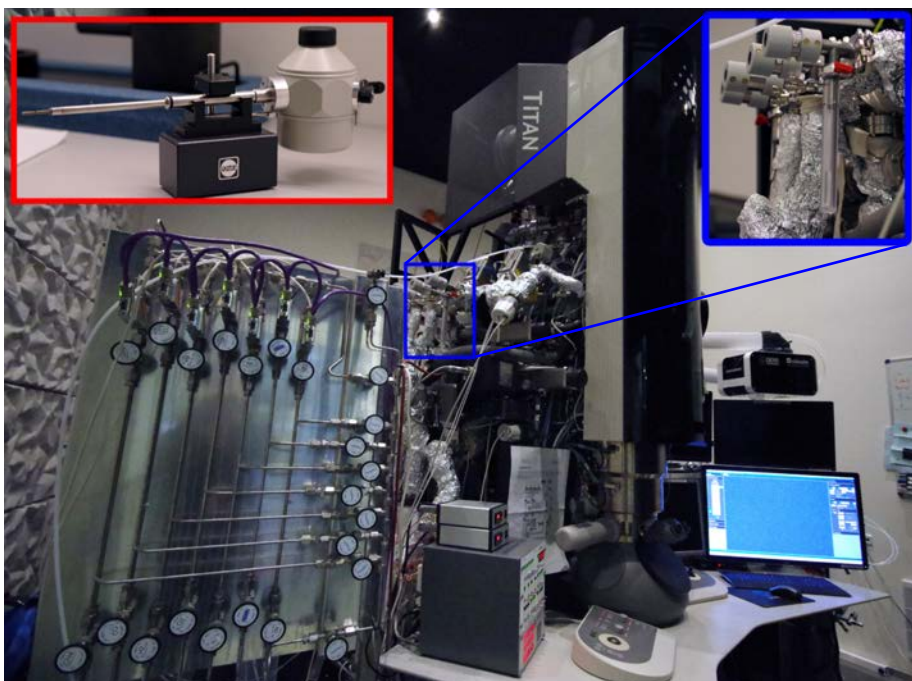


Figure 2: (a) FEI TITAN E-Cell 80-300 ST Environmental TEM, equipped with gas cell and gas mixing system. (Right inset) Glass vial with an organic precursor attached to one of the gas lines. (Left inset) Cryo Gatan TEM sample holder

reduces the residual contamination and chemical pollution of a sample. Our first publication in 2017^[1] showed OIRL in action and demonstrated that simple organic molecules such as 1-pentanol, nonane and anisole can be used as resist materials. The next step was to establish and explore the link between resolution performance of OIRL and the chosen precursor, in particular, its initial molecular weight and the beam exposure parameters.

This is where transmission electron microscopy came in. The optics offered by TEM allows minimising the instrumental limitations imposed on patterned feature size. This strategy was implemented by scientists from Brookhaven National Laboratory who used an aberration-corrected TEM in the scanning mode to pattern sub-4 nm features on EBL resists^[3]. In that case, the TEM was only used for e-beam exposure step.

Our task was more complicated since all process steps had to be carried out in a single instrument. Luckily, at DTU Cen we have an Environmental TEM (ETEM) (Figure 2). The sample in the ETEM is isolated from the column by

two pressure-limiting apertures^[4]. The apertures together with differential pumping lines attached between them which allows imaging the sample under elevated pressures.

ETEM is also equipped with gas mixing manifold system, which delivers a stable pressure stream of the desired gas into the microscope column. To turn the ETEM into an ice lithography instrument, we filled the glass vial with an organic precursor and attached it to one of the gas lines (Figure 2, right inset). The vapour condensed on a substrate mounted on a cryo-transfer Gatan sample holder cooled down to liquid nitrogen temperature (Figure 2, left inset).

After a long process of optimising ice deposition and exposure parameters, we successfully patterned features on n-nonane organic ice (Figure 3 (a)), including 10-nm parallel lines (Figure 3 (b)). Currently, we are focusing our effort on exploring other OIR materials and, most importantly, on understanding why and how OIRL works.

In our upcoming publication^[5], we will present our recent results on pattern-

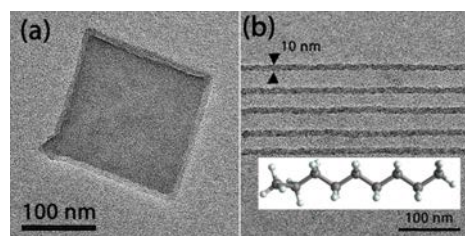


Figure 3: (a) 150x150 nm² square area and (b) parallel lines patterned on n-nonane (inset) organic ice in ETEM

ing linear hydrocarbon OIRs and discuss how the initial molecular weight of the precursor affects the exposure process and defines the feature size of the resulting structures.

We believe that OIRL has a bright future and can bring many benefits to applications that require fabrication of 3D structures, the patterning of complex surfaces and biocompatibility. We are also certain that it will shed light on many yet unanswered questions concerning the interaction of organic matter with the electron beam.

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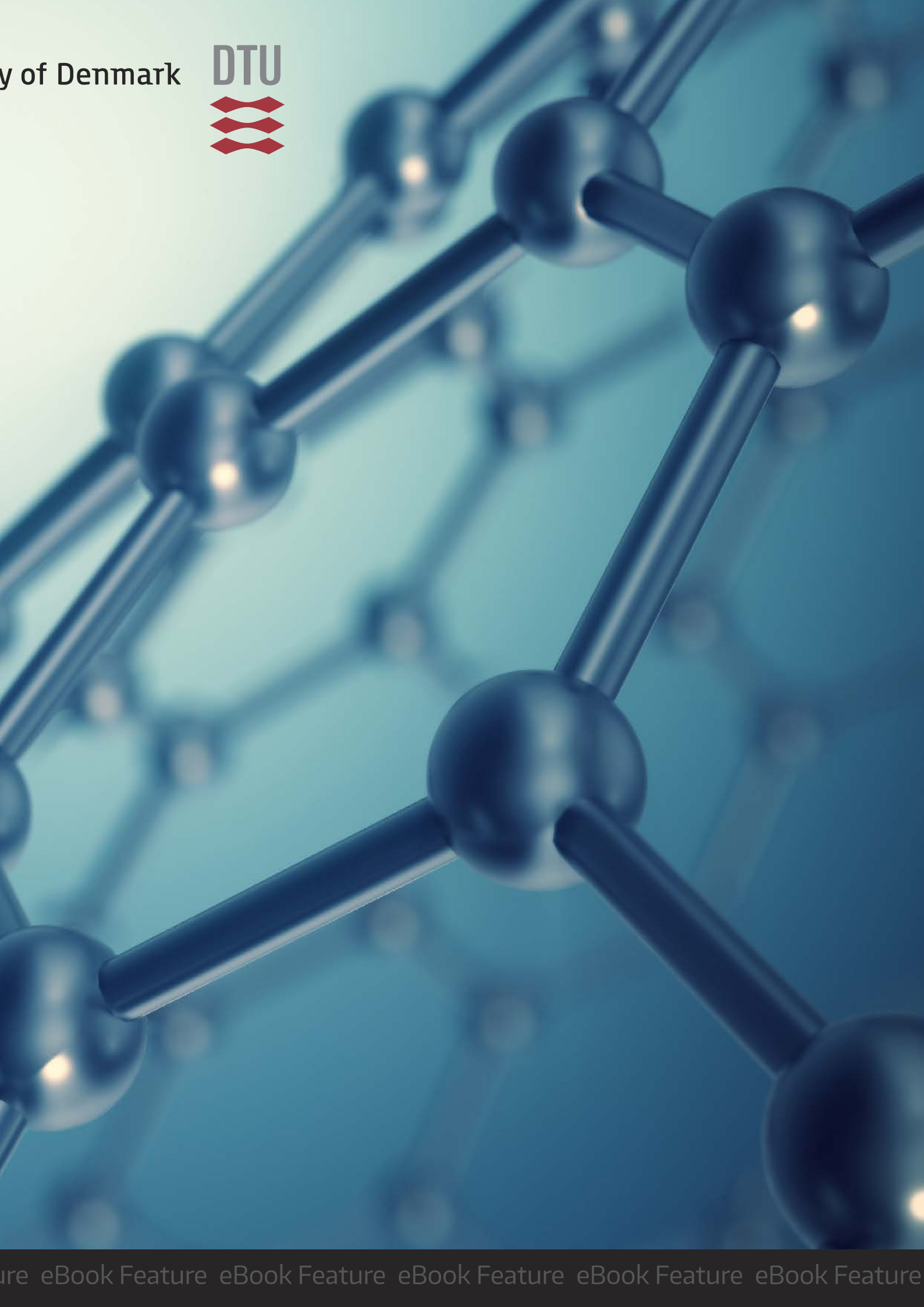
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Nanomaterials: Is there such a thing as nano-risk?

Dr Dimiter Prodanov from IMEC vzw explains if there is such a thing as nano-specific risk in the world of nanomaterials

Nanomaterials are fascinating for the wealth of modified properties which they possess that can be used by the industry. Such desirable characteristics can include an increased strength of the nano-enabled material, its chemical reactivity or altered electrical properties. For example, the light emission of cadmium sulphide quantum dots differs from the one coming from larger particles. Gold particles are another example. They scatter differently with size: if you vary their size, you change their colour.

Deliberately engineered nanomaterials (ENM) are used in a wide variety of applications: from cosmetics and paints to sportswear and semiconductor chips. The use of such ENMs in various applications is an essential component of bottom-up nanotechnology. It should be noted that like any new technology, various nanotechnologies can introduce risks. The prevailing expert consensus at present is that only a few such risks can be considered as “nano-specific” while the predominant part is generic.

While for chemicals there are established regulatory frameworks dealing with the potential risks for the consumers, workers and the environment, this is not the case for nanomaterials. Nanosafety is a growing field, which merits increasing attention by the industry and public authorities. However, so far it is diffi-



Fig. 1: An outlook of the Imec FAB300 clean room facility

cult to distil operational information that can be used to prescribe standards, such as occupational exposure limits of ENMs. Challenges in the traditional chemical risk assessment approach can be traced to the assumption that the hazard and the risk can be quantified absolutely. Since hazard profile data for novel materials are inherently uncertain, the risk can be estimated only in a relative way.

What becomes increasingly clear is that nanosafety cannot be identified with chemical safety. A substantial challenge brought about by innovation is that material development is a moving target, where the lab innovation brings constantly new variations and combinations of materials, often patterned on the nanoscale or con-

taining nanoparticles. Nanoparticles, themselves exhibit a wide variety of morphologies, which makes it meaningless to relate their toxicity to units of mass, as done in the chemical risk assessment. Simply put, there are more questions in the field rather than answers. Therefore, the safety community should build competencies to assess the information gaps and apply the novel risk assessment approaches that are offered by the research community. For example, a broad variety of such tools rely on a ranking procedure to categorise the risk assigning it a certain control band.

The NanoStreeM project has carefully identified available risk assessment tools and performed a thorough gap analysis, which demonstrates the

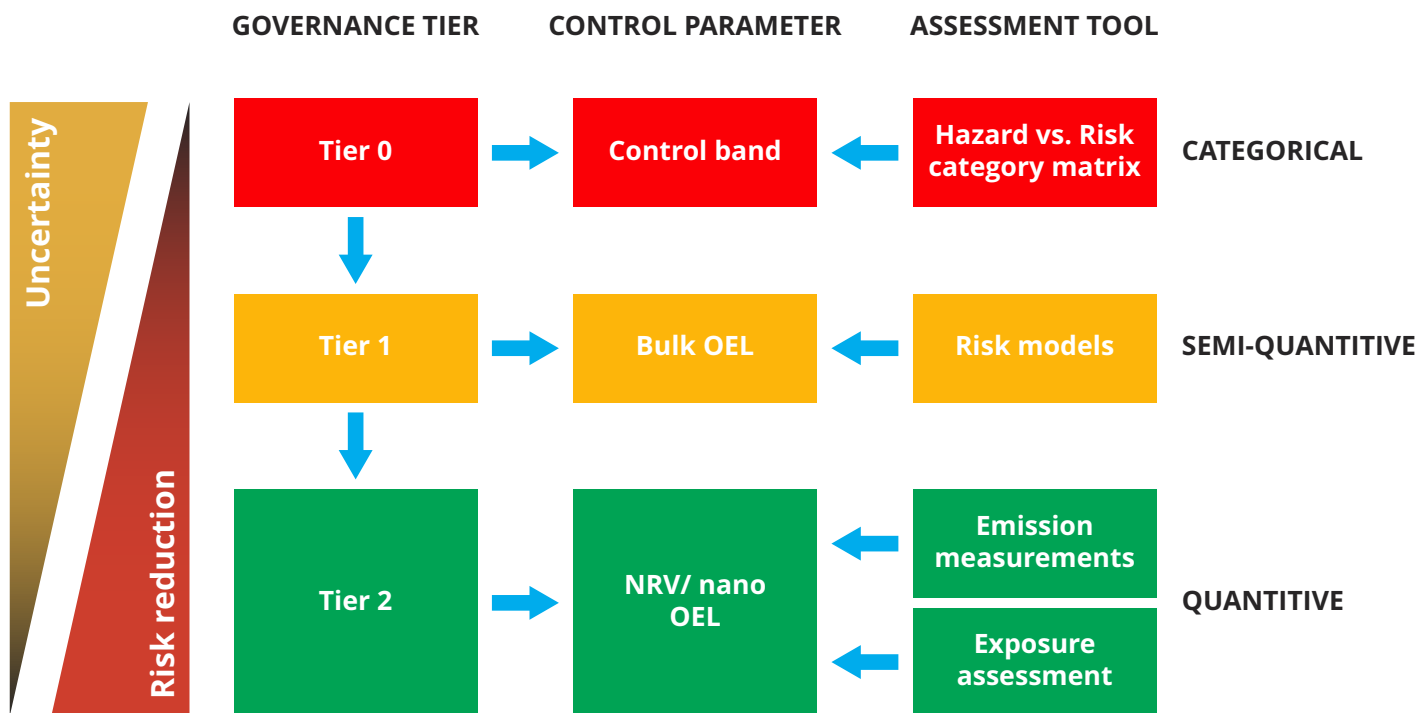


Fig. 2: NanoStreeM tiered risk assessment framework

main advantages and limitations of the different control banding tools. For example, it was found that the ISO Technical Standard ISO/TS 12901-2:2014 needs further clarification to improve its usability. Substantial knowledge gaps can be identified for even widely used by the semiconductor industry ENM, such as CeO₂ and Al₂O₃ nanoparticles. The situation is even worse for materials with promising nanoelectronic applications, such as CNTs and graphene.

To address these challenges, the project developed a general, tiered risk assessment approach suitable for the semiconductor industry. The risk assessment approach developed in NanoStreeM focuses on the specific conditions present in the semiconductor industry – notably almost particle-free working environment (see Figure 1).

The generic NanoStreeM tiered risk assessment approach allows for the use of different, possibly even sector-

specific tools, in combination with emission or exposure measurement field studies. We explicitly account for the uncertainty by allowing for different tools and control strategies to be used, depending on the available information. In such a way, the tiered risk assessment approach has the benefit of being able to adjust to the information gaps, which go hand in hand with technology development (see Figure 2). Secondly, the tiered approach can be used as a roadmap, which guides research efforts into the questions, which reduces uncertainty and thereby, increases the impact on stakeholders.

The approach was described in a [publicly available report](#), while a [more academically oriented book chapter](#) can be accessed on the publisher’s website. The chapter focuses on the most frequently used materials by the semiconductor industry at present, but also on some novel materials, mainly on carbon-based materials which fall under the same paradigm.

Acknowledgement

The NanoStreeM project (Nanomaterials: strategies for safety assessments in advanced integrated circuits manufacturing) receives funding from the European Union’s Horizon 2020 Research and Innovation Programme under grant agreement n° 688794.



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The regenerating spiny mouse and its potential for human therapy discovery

Discovering cures for human diseases or how to recover from damage or trauma to tissues is the fundamental goal of medical researchers, but it is a daunting task. Nevertheless, recent studies have shown the remarkable potential of the spiny mouse in addressing these crucial issues

How can we induce the regrowth of myelin to stop the debilitating effects of multiple sclerosis? How can we induce the regeneration of cardiomyocytes after a heart attack or the regrowth of axons after spinal cord damage?

The classical approach to this regrowth problem in mammals is to study a model organism that can recover from this type of degeneration or trauma and learn how they do it.

Following the hypothesis that regenerative mechanisms are conserved throughout the vertebrates, we could then extrapolate these findings to develop therapies for humans. Traditionally, lower vertebrates such as zebrafish, newts and salamanders have provided model systems with which to study tissue regeneration and many important insights have come from these studies. However, we have recently discovered an adult mammal that can already regenerate several of its tissues and organs, so studying this organism will allow us to speed up the therapeutic discovery process.

This organism is the spiny mouse of the genus *Acomys*. We have shown that it can perfectly regenerate a hole punched through the ear and after removing large pieces of skin. In these instances, the epidermis, dermis, hairs, sebaceous glands, erector pili muscles, cartilage and skeletal muscle

of the panniculus carnosus regenerate.

The skin can also regenerate perfectly after a burn injury, the kidney and spinal cord have greatly reduced fibrosis after damage, which permits improved recovery, and so does the heart after a myocardial infarction.

The spiny mouse can thus regenerate each of the three types of muscle: smooth, skeletal and cardiac and here I describe the circumstances under which this may provide some important avenues for extrapolation to humans.

Smooth muscle: In the dermis, there are two structures that contain smooth muscle cells, namely the vasculature and the muscles that raise hairs when we are cold or frightened.

Cutting out a piece of skin removes both of these smooth muscle tissues (erector pili muscles Fig 1A stained with smooth muscle actin) and in the spiny mouse, the newly regenerated skin contains both of these structures, which have regenerated anew (regenerated erector pili muscle Fig 1B).

The lab mouse (or human) only scars and no hairs are regenerated so there will obviously be no regeneration of these erector pili muscles. This suggests that in the spiny mouse, the regeneration of smooth muscle erector pili muscles is induced by the new hair follicles and unravelling the

molecular mechanisms (for example, which growth factor induces smooth muscle differentiation) and cellular origin (dermal fibroblasts or hair follicle stem cells) will be an important avenue for further discovery. This may lead to ideas for treatments for diseases in which there is smooth muscle degeneration in the lung, the gut or the bladder, for example.

Skeletal muscle: When the full thickness skin is removed, the skeletal muscle layer at the bottom of the skin, known as the panniculus carnosus, is also removed. This type of injury, where a hole is created in skeletal muscle, normally creates permanent damage in mammals because skeletal muscle needs a connective tissue sheath to induce or guide its regeneration. This is known as a volumetric muscle loss.

This defect is not regenerated in the lab mouse but in the spiny mouse, amazingly, the defect is regenerated and embryonic myosins and other myogenic transcription factors are induced again in a recapitulation of development (Fig 1C). Being able to induce the regeneration of a volumetric muscle loss in humans after trauma would be of major significance.

Lab mouse skeletal muscle can regenerate, however, if the connective tissue surrounding the muscle fibres is not removed and the muscle is

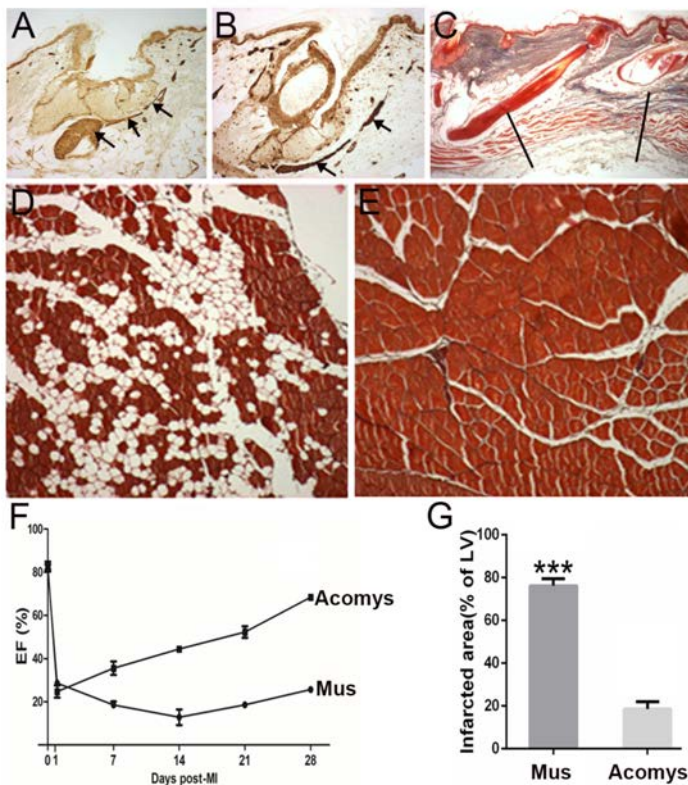


Fig. 1. **A.** Section of a normal hair follicle in spiny mouse skin stained with a smooth muscle actin antibody showing the erector pili muscle (arrows). **B.** Section of a regenerated hair follicle in the centre of a spiny mouse wound stained with a smooth muscle actin antibody showing the regenerated erector pili muscle (arrows). **C.** Section through the regenerated skin (day 35) of a spiny mouse wound showing the regenerated panniculus carnosus skeletal muscle (between the black lines). **D.** Structure of lab mouse tibialis anterior skeletal muscle after five repeated rounds of regeneration. Many muscle fibres have failed to regenerate and instead produced fat cells. **E.** Structure of spiny mouse tibialis anterior muscle after the same five regeneration events. The muscle has regenerated perfectly. **F.** Ejection fraction measurements over four weeks after myocardial infarction in spiny mouse (*Acomys*) and the lab mouse (*Mus*). The *Mus* heart shows no recovery of EF and is permanently damaged by the infarct, but the *Acomys* data shows a good recovery to near-normal EF levels by 28 days. **G.** The size of the scar area in the *Mus* and *Acomys* ventricle wall following an MI. There is clearly a very much reduced damaged area in *Acomys* compared to *Mus*.

injected with snake venom. Under these conditions, the skeletal muscle stem cells, the satellite cells, proliferate and redifferentiate back into myonuclei.

When we repeat this regenerative process five times then the lab mouse muscle starts to fail in its regenerative capacity, probably because it runs out of stem cells and gradually replaces the muscle fibres with fat tissue (Fig 1D).

In contrast, the spiny mouse muscle after repeated rounds of regeneration will continue to perfectly replace myofibres without any signs of fat tissue (Fig 1E).

In the disease of muscular dystrophy, the affected muscles are in a permanent state of regeneration and the myofibres gradually fail to be replaced by more muscle and fat regenerates instead exactly in the case of the repeated regenerating lab mouse (Fig 1D). As a result of the replacement of myofibres with fat, the performance of the muscle in humans declines over time and produces the terrible muscular wasting we see with this disease. Learning how to perfectly regenerate muscle fibres repeatedly as the spiny mouse can (Fig 1E) may have important implications for the treatment of muscular dystrophy.

Cardiac muscle: Following a myocardial infarction (heart attack), the lab mouse and the human heart undergoes a wave of cardiomyocyte cell death and the fibroblasts at the damaged site lay down a collagenous scar. The result is a reduced pumping power, measured as ventricular ejection fraction (Fig 1F).

In an attempt to counteract this loss, the remaining ventricle wall thins and expands, making itself much more liable to a further damage.

Remarkably, the spiny mouse heart after a myocardial infarction rapidly recovers its pumping performance in terms of the ejection fraction (Fig 1F) and there is a vastly reduced scar present at the site of damage (Fig 1G). It effectively regenerates its cardiomyocytes after a heart attack and discovering the molecular basis of this would have a huge impact on human health as this is the biggest killer in the Western world.

We can see that the adult spiny mouse is a remarkable animal model that can regenerate each of its three types of muscle, as well as more complex structures. Discovering the reason for this property may provide some answers to very significant human healthcare problems.



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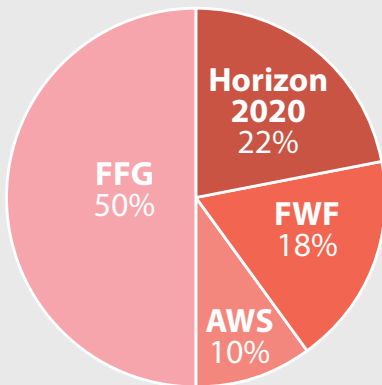
Austria's role in the European Research Area

Christian Naczinsky from the Austrian Ministry of Education, Science and Research explores the country's role in the European Research Area

Once upon a time, Austria was a country at the Iron Curtain. Caught between the East and the West, some called Austria an "Island of the Blessed" and an object of geopolitics rather than an active and mature policy-maker. In research politics, those times also were a period for catching up and slowly adapting. Austrian R&D expenditure was notoriously low, the value of science for society was hardly recognised; universities were inward-looking institutions, driven by in-breeding, with only a few pockets of excellence in between.

Austria's accession to the European Union in 1995 changed the rules of the game in Austrian science and research for good. I still remember the early days of our EU membership very well. For quite some time, those who had been important players in the past continued to argue that accession to the EU made no difference to the Austrian innovation system. They thought of the EU in terms of a Framework Programme for Research that provided roughly €3 billion of research funding per year. The Framework Programme was regarded as a niche for a small circle of specialists

Research Funding



- Horizon 2020
- Austrian Science Fund (FWF)
- Austria Wirtschaftsservice (AWS)
- Austrian Research Promotion Agency (FFG)

Figure 1: Share of Funding in Austria (EU-PM)

Source: EU-PM Report on the performance of Austria in H2020 2018

Note: The grants that are transacted through the three agencies are only part of the budget that the federal government makes available for R&D. According to Eurostat, project financing only accounts for approx. 30% of the total federal funding for R&D in Austria.

who made the effort of collaborating with partners from the other Member States.

All this has changed profoundly in the meantime. Today, the Framework Programme constitutes one of the biggest sources of funding for research projects in Austria, second only to funding by the Austrian Research Promotion Agency (FFG).

The overall relevance of European funding in the Austrian innovation system is limited. Only about 2% of the total amount of public and private expenditure for R&D research funding in Austria stems from the European Union. This fact is linked to the steep increase in public and private R&D expenditure in Austria over the last 20 years.

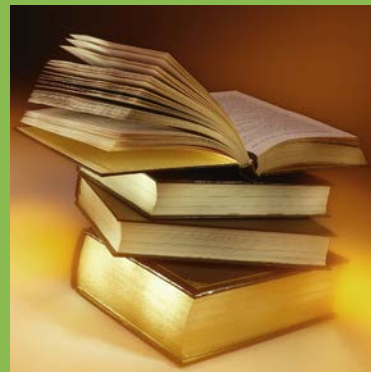
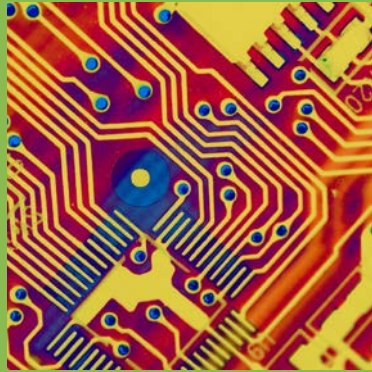
However, for Austrian R&D players, the European Framework Programmes today provides much more than just financial resources. With its relatively small, yet open innovation system, Austria benefits from a competitive knowledge market 50 times larger than its home base. On a broad range of topics, from IT to energy to health or social sciences and humanities, the Framework Programmes invite Austrian researchers to collaborate and compete with their peers across the Union. Over time, new networks of transnational research and innovation teams have emerged out of

such collaborations, built on trust and mutual respect and bearing fruit as new scientific or technological developments that none of these teams would have been able to create in isolation. Under the current Horizon 2020 programme, Austria participates in 1,523 projects and in some areas, such as information and communication technologies (ICT) or transport (TPT), Austrian research teams are among the central nodes of European networks.

For many years, the road to success at European level was paved with national reforms. The Austrian Science Fund had been a beacon of fostering excellence over decades, long before the EU created a corresponding institution in the European Research Council. The University Act 2002 put Austrian universities in a position of growing autonomy and self-governance. Ever since, universities have been striving to develop their own specific mix of disciplines, scholars, curricula, third-mission activities and transnational cooperation. The European dimension is not equally important for every university. Nonetheless, each university reflects on the potential of European collaboration for its staff and for the strategic objectives of its institution.

Another milestone of reform in the Austrian science system was the creation of the Institute of Science and Technology Austria (IST Austria) in 2009. A high level of

Continued on page 165 →



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scientific freedom combined with rigorous competition for the best and brightest minds turned IST Austria into the most successful Austrian institution in winning ERC grants (21 ERC grantees in Horizon 2020).

“Today, the Framework Programme constitutes one of the biggest sources of funding for research projects in Austria, second only to funding by the Austrian Research Promotion Agency (FFG).”

In addition to all this, Austrian research institutions benefit from the development of a European Research Area (ERA), which means a step-by-step approach towards an internal market of knowledge where researchers, knowledge and technologies can move without barriers within the European Union. The creation of ERA requires a constant reality-check on how attractive one's own institution is compared to its competitors in other parts of Europe. Attractiveness leads to high-quality recruitment, excellence in teaching and research and greater visibility, not least also in key metrics that measure the relevance of research institutions.

Currently, Europe is focussing on the ERA reform agenda on the following priority areas:

1. ERA Priority 1: Effective national research systems;
2. ERA Priority 2(a): Jointly addressing grand challenges;
3. ERA Priority 2(b): Make optimal use of public investments in research infrastructures;
4. ERA Priority 3: An open labour market for researchers;
5. ERA Priority 4: Gender equality and gender mainstreaming in research;
6. ERA Priority 5: Optimal circulation and transfer of scientific knowledge and;
7. ERA Priority 6: International cooperation.

Austria is an active partner in Europe when it comes to ERA. Every university translates the ERA reforms into tailor-made activities within its own institution; these activities are part of the Performance Agreements between each individual university and the Ministry of Education, Science and Research. For the ministry, ERA and the European Research Framework Programmes are corresponding and mutually reinforcing dimensions of European research and innovation policy. Funding in itself is not enough in the long run if we intend to make Austria one of the innovation leader countries in Europe. The secret lies in a smart combination of developing institutions and governance systems, while at the same time encouraging researchers and research teams to compete with the best in Europe and in the world. With regard to the latter, the European and International Programmes (EIP) division of the Austrian Research Promotion Agency (FFG) plays a key role: It provides support to all players from the fields of science and business with regard to their participation in EU RTI programmes.

When Horizon 2020 started, Austria set itself the ambitious goal of winning European competitions worth €1.5 billion by 2020. Austrian participants have excelled so far, achieving the third-highest success rate of all Member States and winning nearly €1 billion up to now. Once upon a time, nobody would have been able to predict the path of success that Austria has followed since it became a member of the European Union. May this path lead us further into the group of innovation leaders in Europe. ■

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The prospects for education, research and innovation in Germany

Anja Karliczek, Federal Minister of Education and Research in Germany heads up the policy areas of education, research and innovation. This analysis details the work of the German Federal Ministry of Education and Research (BMBF)

Anja Karliczek is the current Federal Minister of Education and Research in Germany and has been a Member of the German Bundestag (Parliament) since 2013. Between 2017 and March 2018, she was Parliamentary Secretary of the CDU/CSU parliamentary group. Born in April 1971 in Ibbenbüren, Germany, Anja Karliczek is today married, with three children. Between 2003 and 2008, Anja Karliczek studied business at the University of Hagen, distance education university where she impressively gained a degree in business administration. This article will look at the role of education, research and innovation in the country, with some specific examples of the areas the Ministry is supporting.

An excellent and recent example of the Minister's support for encouraging exceptional talent in the education space is when she congratulated Peter Scholze, Professor of Mathematics at the University of Bonn, who was awarded the Fields Medal in August 2018. This is considered as the "Nobel Prize in Maths" and it particularly impressive that he achieved this at the age of only 30.

Congratulating Scholze on behalf of the Federal Government, Federal Minister of Education and Research Anja Karliczek said: "I would like to congratulate you on behalf of the Federal Government and personally. You and your research are drawing talented academics from across the world to Germany. And for that I would also like to thank you." Karliczek wished him success in the future with his important academic work in Bonn, Germany. Federal Foreign Minister Heiko Maas added: "What an outstanding achievement, what a great day for Germany as a place to do research."

The future of research and innovation in Europe

Today, Germany along with France attaches particular importance to the fields of education, research and innovation. The latter, innovation, is the mainspring of prosperity and quality of life, according to Germany's Federal Ministry of Education and Research (BMBF). In recent news, we find out that both countries are exchanging information that concerns their respective national research and innovation strategies, an approach that enables them to act together.

Added to this, the two countries endeavour to act as drivers for the development of a European Research Area (ERA), which is based on excellence and has an impact on an international scale. By way of background, Franco-German research cooperation forums have been taking place regularly since 2002 and continue to play a crucial role in the countries' collaboration.

The agreed priority areas of Franco-German cooperation include information and communication technologies (ICT), the humanities and social sciences, as well as energy research. While the 2018 forum develops these measures further, it is worth noting that cooperation by the two countries at European level looks at areas such as climate research and non-energy resources.

Another area both countries work together on concerns civil security research, indeed, developing and investigating new cybersecurity solutions is essential for ensuring that Germany and France remain fit for the future and it is also a field of strategic importance at the European level. We know that during recent years, research funding by the Federal Ministry of Education and Research

(BMBF) to protect IT infrastructure and systems has helped to make Germany one of the leading nations in the area of IT security. Germany and France intend to safeguard Europe's sovereignty around key enabling technologies, developing reliable software-intensive systems and running security analyses.

Following on from this, we also learn that technological progress and social innovation both go hand in hand. As such, the humanities, the social sciences and economics play a key part in addressing the grand social challenges by giving sound recommendations to policymakers. Together, Germany and France have initiated specific funding measures targeted at these important disciplines.

“An excellent and recent example of the Minister's support for encouraging exceptional talent in the education space is when she congratulated Peter Scholze, Professor of Mathematics at the University of Bonn, who was awarded the Fields Medal in August 2018. This is considered as the “Nobel Prize in Maths” and it particularly impressive that he achieved this at the age of only 30.”

Future of the oceans

Browsing through the Ministry's website, we know that they are giving strong support to research around climate and the environment. Unfortunately, we know that the seas swallow many things that human beings produce, consume and throw away. With the world's oceans filling up with rubbish, the limits of ecological self-cleaning have long been exceeded, we are told.

One concern here is about plastic waste, which accounts for up to 90% of the rubbish in the oceans and on beaches today, and as such, it is a threat to marine flora and fauna. We have all seen the pictures of plastic islands in the sea, marine birds that mistake plastic particles for food or dead sea animals caught up in abandoned fishing nets.

The Federal Ministry of Education and Research (BMBF) calls for concerted efforts and the drawing up of international guidelines so that the oceans can continue to be exploited sustainably. We know that BMBF is working on a pilot that is concerned with Microplastics in Marine Systems together with many other

research funding organisations throughout European countries. The basis for these guidelines is provided for by intensified research because we still know too little about the impacts of microplastics on marine ecosystems. It is worth closing by highlighting the challenges around research in this area. Concerning toxicological effects, the ambition here is to develop a standardised measurement methodology to provide the analytical bases for comparable scientific studies, as well as for monitoring.

An additional aim is to learn how particles spread in the marine environment and what toxicological effects they have on marine organisms. As a start, €7 million will be provided on an international basis. The findings from BMBF funded projects will form a key contribution to a joint plan of action of the countries involved in this important research field.

This is just one example of the many research areas the Ministry is supporting. Their website gives us information about the many research areas they are supporting, such as fighting neglected and poverty-related diseases, sustainability research or even the German vocational education and training system. To find out more about these fascinating areas of research, it is well worth taking time to browse through their impressive website. ■

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Large-scale 3D mapping of forests

Peter Krzystek, Professor for Photogrammetry and Remote Sensing at Munich University of Applied Sciences tells about new investigations into the 3D mapping of forests

Forests cover approximately 31% of the earth's land surface and play an important role as ecosystems, carbon storage and renewable energy resources. For the investigation of adaptation processes and reactions of forest ecosystems to climate change, a permanent monitoring and recording of different forest structure parameters (e.g. tree species distribution, wood stock, dead wood distribution and renewable regeneration) in selected observation areas with high accuracy is required.

In particular, dead trees are of mandatory significance. For instance, around one-third of all animals and plants living in forests rely on dead wood. Furthermore, 11% of all greenhouse gas emissions are sequestered by the world's forests, while 14% of total carbon stocks in forests are contained within dead wood.

Knowledge of dead wood and forest structures in general, is fundamental to understanding, protecting and preserving the biodiversity of our forests. As well as gaining a good understanding of ecological health, comprehensive environmental monitoring of our forests and the structures within, are also important in disaster management. From monitoring entire forests in the case of wildfires to tracking the spread of disease in single and dead trees – gaining accurate information on the status and distribution of these structures over various time scales are vital. This information is used by

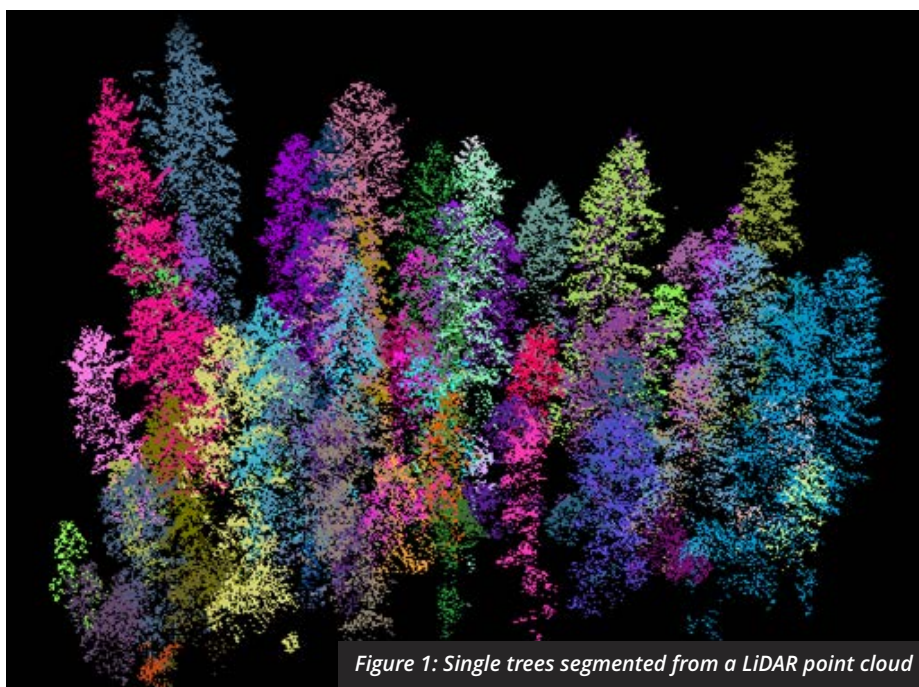


Figure 1: Single trees segmented from a LiDAR point cloud

forest managers, researchers and governmental and inter-governmental institutions.

Modern remote sensing sensors offer completely new possibilities for an extensive and detailed 3D capture of tree populations, making it possible to map at very large-scale. In particular, LiDAR is today an established technique for fast and highly accurate 3D scanning from the aircraft, helicopter or drone where pulses of visible or near-infrared laser light at a particular wavelength are used to create 3D images. These 3D images are typically made up of a high density of data points, known as 'point clouds'. The new full waveform technology, which reconstructs the complete path of the laser beam through the vegetation, makes it possible to map the forest

structures in 3D more precisely. Moreover, digital aerial cameras enable a detailed reconstruction of the forest surface and provide – if fused with LiDAR data – extra spectral information in the infrared range for a characterisation of the tree species. All in all, these new technologies are ideally suited for the automatic and cost-effective collection and characterisation of forest stands.

We have been focusing our recent research at the Munich University of Applied Sciences on developing innovative methods of the 3D mapping of trees, by applying advanced computer techniques such as machine learning and computer vision. We were extremely successful in demonstrating that forest areas can be completely and automatically processed

Figure 2: Mapping of trees species and dead trees

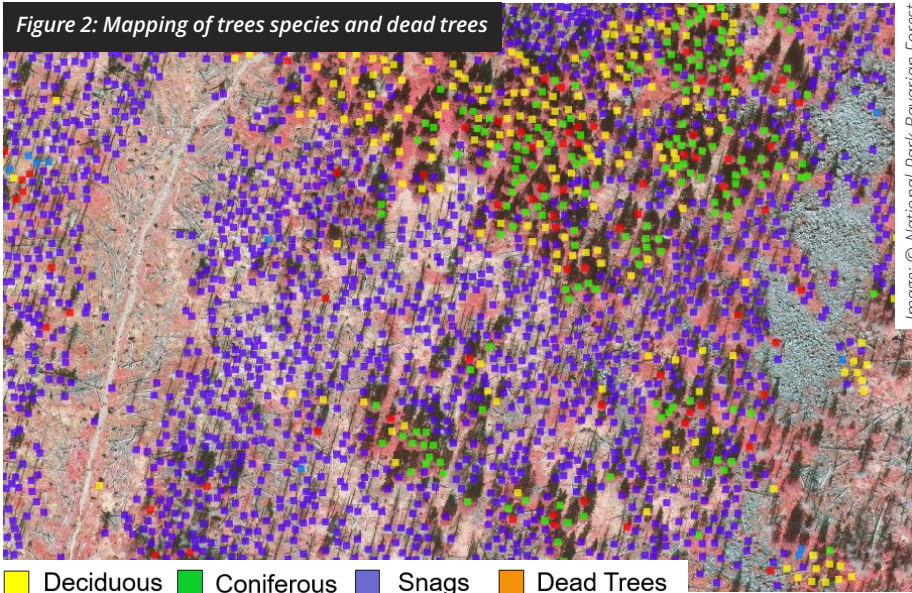
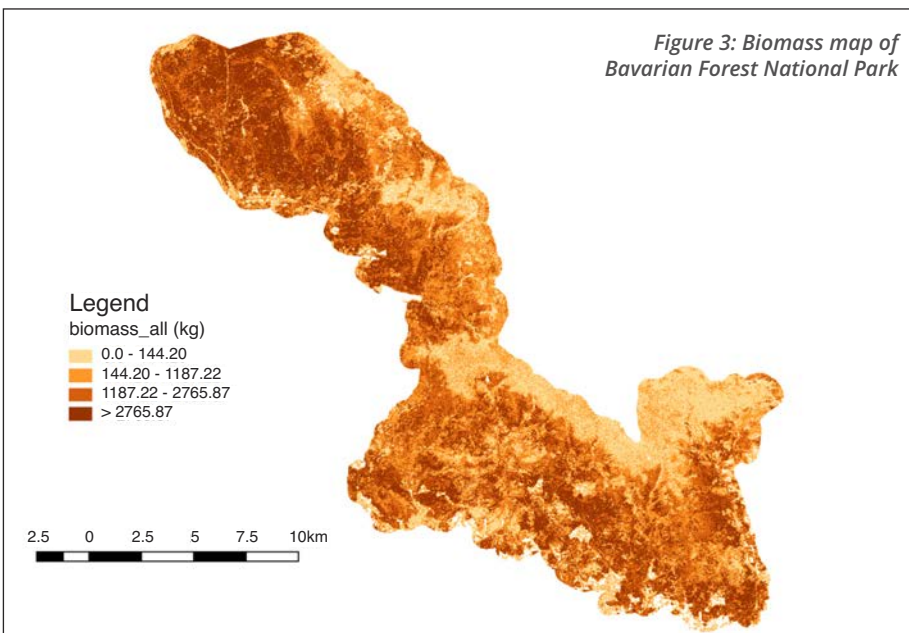


Figure 3: Biomass map of Bavarian Forest National Park



with LiDAR to produce 3D maps of individual trees, even at very large scales. The results of our methods enable an area-wide 3D vegetation mapping and provide precise information about the percentage of tree species, stock of wood, wood growth, wood harvest in forests and biomass.

The key method is a new approach for single tree detection from the LiDAR point clouds, which turned out as the breakthrough idea in 3D forest mapping. The newly patented technique approach takes advantage of a special segmentation technique adapted from image analysis. This technique subdivides the forest area into voxels

or supervoxels, labels every point in the point cloud and groups these points into disjoint tree segments. The new full waveform LiDAR data helps to significantly improve the detection rate. Based on that technique, coniferous and deciduous trees can be classified with excellent accuracy. As well as the classification of multiple tree species could be significantly improved using multispectral data from LiDAR and aerial imagery.

The extension of this technique led to methods for detecting fallen and standing dead trees. In training the computers to recognise fallen trees, we observed that there must be a

minimum number of data points per tree – otherwise, the computer can't see the tree. Standing dead trees – either without or with crown – can be identified with an excellent accuracy of around 90%.

Mapping is critical for forest inventory, conservation and planning and LiDAR technology offers researchers the opportunity to gain much more data in a short space of time. Furthermore, the use of LiDAR is increasing, and the cost is declining. LiDAR sensors are becoming more powerful, allowing even more data points to be obtained at several wavelengths.

Meanwhile, we are able to process huge datasets fully automatically to generate a 3D map of single trees, tree species and dead trees. Follow-up products are, for instance, maps for biomass or CO₂ stock in a forest area. Since it is expected that new 3D measuring techniques will generate more 3D details of forest objects, existing methods need to be extended to take advantage of the higher point density.



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The challenges of nanophotonics in modern optical technologies

Toralf Scharf, Senior Scientist/Faculty Member at École polytechnique fédérale de Lausanne EPFL identifies the exciting challenges of nanophotonics where modern optical technologies are concerned

Nanophotonics is now one of the most exciting fields of research within modern optical technologies. The basic idea is to modify light as an electromagnetic wave at a size level, which is usually smaller than the base length of the light itself, or in other words, its wavelength. Taking this approach has many advantages and challenges. But the secret of high performance sensing, the contrast enhancement techniques known from classical optics, cannot be transferred to the nanophotonics domain. To understand the actual challenges, a step by step discussion is essential.

Small structures will have a limited efficiency because the interaction with a beam of light is limited by the effective size of the structure, which is small. To overcome these limitations, resonant structures can be used that lead to the effective size of interaction becoming bigger than the structure itself. Also, arrays of such structures can be implemented to increase the efficiency by creating larger surface areas.

Such an approach directly leads us to the first situation in question: which is how can we fabricate many elements with nanometre precision on mm size surfaces with high productivity? Today, electron beam lithography is the fabrication process of choice, which can also be parallelised. It is expected that advances in the produc-

tion infrastructure will allow making reasonable sample sizes over the coming years. As all sensing systems are limited by the performance of the detector, the size of the detector is a good measure for optimal sample size. Today, the size of a surface with one square millimetre is considered acceptable for a sensing application. Today's modern optical fabrication technologies, with parallel processing, allow for the realisation of structures with feature sizes down to a single nm. Although nanofabrication is very difficult, the challenge for large surface fabrication can be overcome if an application is found that justifies the effort required.

But let us have a closer look at the second main ingredient needed to make a successful nanophotonics device: the resonant unit. As briefly mentioned above, the efficiency of interaction with incoming light can be increased by working in resonant regimes. The nanosize entity will then have a much larger effective cross-section than its actual size. Resonances that can be used have been known from metals as plasmonic nanoparticle systems for a long time. The incidental light activates the electrons kept in the particles which, in turn, distribute their energy back as scattered light. This is a process that is very sensitive to the environment in which the nanoparticle is set and produces wonderful colours, for example, as can be found in church windows.

But the losses of the mechanism prevent from mass usage. Losses in resonance mean to a large extent that energy is transferred into heat, but this is not the desired effect. Firstly, the investigated sensor concept would need much more driving energy to recover a useful signal. Secondly, the hard-driving leads to heat production, which melts the system down before a measurable signal can be acquired. This is the main reason why plasmonic sensors are difficult to find in real-world applications today. The solution is the use of what is called dielectric resonators. Nanometre size structures build from almost lossless dielectric materials but with more complex internal structure and as such, they are the upcoming stars for nanophotonics sensors. Such carefully designed nanosystems allow for the implementation of resonant features at will, but at the cost of higher fabrication complexity. While plasmonic systems are already efficient as a single layer, dielectric resonant structures need to be designed and fabricated as quasi two-dimensional structures: in the plane and to a certain extent, out of the plane. This is, of course, more complex as the alignment of different process steps at the nanometre lever is required to be successful.

An additional and often underestimated problem is the quality control of the structure. Only time will show how fast the current research projects

achieve the move towards products based in reproducible effects. Our expectation is that in less than five years, high potential products will be introduced on mass markets that have a dielectric nanostructure at the core of its sensor device.

One part of a sensor is the active area but much of design effort is usually spent on extracting the signal. At this point, the interface between nanophotonics and an optoelectronics measurement system has to be realised to have a large signal to noise ratio. While the majority of research project focus on the sensors active area, closing the gap between nanophotonics signals and a measurable quantity is often not considered. The result is, that instruments based on nanophotonics effects are much bigger than conventional sensor systems and also considerably more expensive.

This is, of course, not the idea when working with miniaturised systems. So, what are the considerable approaches needed to overcome this technological gap? In classical optics, one uses many different techniques to increase the signal to noise ratio. The often-applied method is to measure signal variations of an already existing signal. Such variations are often small changes of large signals and it represents complicated techniques in signal processing and data acquisition to achieve reliable results.

The alternative is to suppress a non-useful signal. This means that when no event is happening, no signal is recorded. Such an on-off technique is, of course, extremely sensitive because it compares a small signal to no signal and has technical speaking infinite contrast. Techniques known from technical optics are based on



Toralf Scharf

dark field illumination, polarisation contrast, frequency or wavelength sensitive detection and phase sensitivity. Some of these techniques are already used for nanophotonics but others need to be transferred and new techniques need to be discovered.

One challenging situation appears when disturbances in the close surrounding of the nanostructure in the near field should be made visible to an optical system that is based on a collection with conventional lenses in the far field. Having said this, when working at different wavelengths for excitation and measurement, classical contrast enhancement techniques such as polarisation and phase imaging are very difficult to implement as the scattered light changes the states of polarisation and focusing does not leave a clean polarisation signature to an exciting signal. New ideas like spatial polarisation management are needed to adapt the nanophotonics problem to the macroscopic measurement system.

The complexity of challenges including nanophotonics, micro-optics and systems optics require many competencies for the engineer working on

this. In our project NOLOSS, we are working on the unified education of the next generation optical engineer, to give such a person a background in nanophotonics but also a solid knowledge base to think further and translate optical system approaches into the nanoworld.

Toralf Scharf focuses his research activities at the École Polytechnique Fédérale de Lausanne on interdisciplinary subjects that bring 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 the 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.

Funding

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under the Marie Skłodowska-Curie grant agreement No 675745.

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Horizon Europe: A golden opportunity for research and innovation in Europe

Lidia Borrell-Damián from the European University Association argues the European Commission's Horizon Europe initiative holds great promise for the future of research and innovation in Europe

Horizon Europe holds great promise. It aims to improve the current European Union (EU) Framework Programme for Research & Innovation by making it simpler and enhancing its efficiency. It also has the potential to invest more in Europe's research and innovation, and, therefore, better serve society. However, to make this promise a reality, the programme needs the right policy mix. Horizon Europe must be designed to advance research and innovation by investing in a knowledge-based society.

To do this, it must involve universities across all pillars of the programme, have a budget to meet its ambitions and deliver through new instruments like mission-oriented research and innovation and the European Innovation Council. It must also address the shortcomings of Horizon 2020, including its considerable low success rate and promote Open Access.

The increase of the Horizon Europe budget to €100 billion, as proposed by the European Commission, is a step in the right direction. However, a budget of €160 billion is really what is needed to reach the programme's ambitious goals of reinforcing excellence across Europe. It will take serious resources to fund and strengthen the European Research Council, the Marie Skłodowska-Curie Actions, as well as research infrastructures. Plus, by keeping excellence and competitive funding calls at the centre of Horizon Europe, we are bound to increase efficiency in the programme.

The reinforced policies towards open scholarly knowledge in Horizon Europe will set a good standard to favour Open Science. Both the upcoming open research publishing platform and the European Open Science Cloud will be fundamental for driving the transition to an open, transparent, efficient and sustainable R&I landscape. While this policy objective

is backed through legislative efforts on the European level, such as the copyright reform, national governments need to do their part as a full transition means coordination and alignment between European and national levels.

“Horizon Europe projects should offer the possibility of linking research to education and sharing research results with students. And the hotly-debated idea to create strong networks of European universities could usher in a new dynamic within higher education in Europe, both giving visibility to existing networks and providing incentives for new collaborations.”

In a global context, Horizon Europe is also an opportunity for universities to serve society by addressing the global challenges addressed by the UN Sustainable Development Goals. In this respect, novel instruments like the European Innovation Council and Mission-Oriented research must have as their ultimate objective the generation of business, social, cultural and ecological innovation. Since universities are highly responsive to societal needs, it will be crucial to mobilise and unleash their potential in tackling grand challenges through multidisciplinary, collaborative research projects.

The programme will also offer a chance to minimise discrepancies across the EU and strengthen the European Research Area. It has the potential to enable lower performing countries to increase their research and innovation capacity, closing the gap with higher performing countries from the bottom up. A transversal programme section dedicated to this goal would give Horizon Europe the ability to open new and equal horizons for researchers across the continent. In turn, collaborative research by excellent consortia from high- and less-performing regions will be an opportunity to strengthen the European Research Area.



University of Cambridge

Bringing all of these topics together, investing in stronger links between education and research and innovation will support the development of human talent, which is at the root of Europe's ingenuity and fuels its competitiveness across the globe. Horizon Europe has the potential to foster this and that is why the human factor and the role of universities at the root of the knowledge triangle should be enhanced in the next generation of EU funding programmes.

“The increase of the Horizon Europe budget to €100 billion, as proposed by the European Commission, is a step in the right direction. However, a budget of €160 billion is really what is needed to reach the programme’s ambitious goals of reinforcing excellence across Europe.”

For example, Horizon Europe projects should offer the possibility of linking research to education and sharing research results with students. And the hotly-debated idea to create strong networks of European universities could usher in a new dynamic within higher education in Europe, both giving visibility to existing networks and providing incentives for new collaborations.

A well-funded Horizon Europe that promotes an excellent and open scholarly system serves society's needs, enables lower performing countries to raise the bar and promotes the link between education and research and innovation, is indeed a golden opportunity for Europe. ■

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Cocoboards: Affordable building material made from coconut husks

Dr Frédéric Pichelin, Head of Institute for Materials and Wood Technology at the Bern University of Applied Sciences tells us about an intriguing and affordable building material made from coconut husks, called Cocoboards that can be used to support social housing

In search of inexpensive building materials for the Philippines, researchers from Switzerland and the Philippines have developed an environmentally friendly technology to produce ecological construction panels made of crop residue from the coconut harvest. In cooperation with the Hilti Foundation, they have tested board production on a commercial scale and have installed them in the framework of a social housing project.

Prof Frédéric Pichelin, head of the Research Institute for Material and Wood Technology, Switzerland, is presenting this promising technology.

“The project team is motivated by the idea of developing new products from available resources and then making them available to the local building industry. In turn, this also decreases the dependency of the local market on imported, often expensive and environmentally hazardous materials.”

People in the Philippines are facing an increasing shortage of adequate living space; those with the lowest income, in particular, cannot afford secure housing. The constructions there, usually erected with the simplest of means and materials, are often damaged or destroyed by regularly recurring tropical storms. Today, due to the lack of any locally produced, affordable building materials, expen-



Fig 1. Coco husk and tannin extract used for the production of the Cocoboards

sive or inferior building construction materials are usually imported.

Using coconut husk as a resource for sustainable building material

With an annual production of 15 million tonnes of coconut, the Philippines are the second largest coconut producer worldwide after Indonesia. Roughly five million tonnes of coconut husks are discarded or burnt after harvest. Herein lies a tremendous potential: the husk of the coconut is rich in fibrous materials and therefore, represents a possible source of building materials.

This realisation, together with the quest for environmentally friendly building materials, has led a team of researchers of the Bern University of

Applied Sciences BFH and the University of Applied Science and Arts of Western Switzerland ARC to use milled coconut husk in combination with a natural tannin-based adhesive to produce construction panels. Since 2010, the BFH has been conducting research into the use of crop residues for the production of building materials.

From the laboratory to the market

The research team's primary objective was the development of an environmentally friendly technology for the production of an affordable and natural building material, in this case, a fibreboard consisting of crop residue from the coconut production with a tannin-based adhesive. In doing so, the entire process – from the labora-



tory work up to the delivery of the finished product for house construction – was examined. The project team set up pilot production in the Philippines and monitored the test use of the boards in a local housing programme.

Local production for a local supply

The project team is motivated by the idea of developing new products from available resources and then making them available to the local building industry. In turn, this also decreases the dependency of the local market on imported, often expensive and environmentally hazardous materials. Additionally, the processing of raw materials by locals already familiar with the coconut industry and its market mechanisms will increase local added value.

The market launch is imminent

The project results indicate that the Cocoboards offer considerable potential for the local economy. The panels are fairly easy to manufacture and install and the raw material is available

in a sufficient quantity. People with lower incomes who already work in the coconut industry can actively engage in the value creation as a supplier, producer and customer. In addition to the creation of jobs, this also fosters the acceptance of environmentally friendly building materials and the creation of blueprints for sustainable production, which are two of the United Nations Sustainable Development Goals.

Next steps

Corresponding follow-up projects are in the pipeline, with an emphasis on measures to launch Cocoboards and on an increase in the chain of added value. Priorities include the setting-up of a stable production line for Cocoboards, the supply of raw materials.

Another major issue is the development of a local tannin production. The current main sources of condensed tannins are the heartwood of Quebracho (*Schinopsis lorenzii* and *S. balansae*) and the bark of Black Wattle (*Acacia mearnsii*), mostly produced in South America and Southern Africa. The import of this raw material has a

negative impact on the Life Cycle Analysis of the whole process. A new project has just been launched, with the aim of investigating the potential of local biomass for the production of tannin. Moreover, the water-based extraction process of the tannin extract process should use solar energy, which will have a strong benefit on the grey energy.

To conclude, the whole production of this construction material can be taken as an example of a circular economy in the context of biomass valorization. A waste used until now can be transformed in a fully bio-based and compostable building material that can easily be recycled at the end of its life. If this is possible in a developing country, it should also be possible in our developed countries!



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Funding for research, science and innovation in Europe

Carlos Moedas, European Commissioner for Research, Science and Innovation has ambitious and exciting plans for unprecedented funding for research, science and innovation in Europe, as this analysis from Open Access Government reveals

One of the responsibilities of Carlos Moedas, European Commissioner for Research, Science and Innovation is to ensure that research funding programmes, notably Horizon 2020, contribute to the European Commission's all-important jobs, growth and investment package. While Moedas has many other important responsibilities, it is worth focussing on this aspect of his work that he recently detailed in a speech at the Euro Science Open Forum 2018 during July 2018.

In this speech, Moedas details the European Commission's new framework programme: Horizon Europe. In his view, this is more than a science programme, indeed, it needs to be the cornerstone of a new 'social contract' between citizens, governments and scientists. Referring to the well-known Social Contract book of 1762 by Jean-Jacques Rousseau, Moedas draws our attention to the fact that authority comes from a social contract agreed upon by the people. Moedas then develops his thoughts on this fascinating remark.

"Science is not carried out by governments. Science is the product of the hard work of scientists. Human beings are the true owners of the results of science. This is what Rousseau said 300 years ago. That is why we need to redefine the terms of the social contract between people, science and governments. Because science has changed and so have we."

Moedas goes on to say that a social contract he believes in is one where citizens and scientists are at the heart of public policies. Moedas envisions a social contract that brings people closer to science and where Europeans feel proud of European science. Crucially, he tells us that he wants Horizon Europe to be a cornerstone of this movement. To support this ambition, we find out that the European Commission has proposed a budget

of €100 billion for science and innovation in Horizon Europe, an amount that is unprecedented for them in this respect. The three primary objectives in this vein are Open Science, Open Innovation and Global Challenges he explains.

Looking at, Open Science and Open Innovation, Moedas states that these two pillars are the basis for a social contract where the scientist and the innovator are at the heart of today's digital world. As such, the European Commission is fully behind boosting 'Open Access' and 'Open Data' policies. He explains more on Open Access in his own words.

"Here our message is simple: if you receive public money, you must publish with open access. We cannot continue to allow people to publish where the only way to access the information is to buy it. One of the main rights of the taxpayer is access to the information."

An additional point Moedas raises is that the success of the European Research Council (ERC) must continue – which is why the European Commission has increased their budget from €13 billion to €17 billion. He stresses that this is the largest budget line of the entire Horizon Europe programme.

Added to these points, Moedas underlines the need for radical change when it comes to innovation, which is why the European Commission will set up the European Innovation Council (EIC). This is where innovators tell the European Commission the route they want to take – not the other way around. Moedas develops this radical policy ambition further in his own words.

"This is where innovators tell us the route they want to take. Not the other way around. Innovators will be at



Image: © European Union 2018

European Commissioner Carlos Moedas

the heart of the process and so the subjects of our calls will be open and free of restrictions. We will interview and evaluate the person behind the proposal, and not just the proposal itself. We will bring in project managers to guide every innovator and to help them in their work. What I am saying is we want to finance the innovator, and not the innovation.”

As we bring this article to a close, we must not leave out Moedas’s reflections on Open Science, which he believes will be a major resource for the EIC. He adds that much of the radical innovation we see today comes from basic science. Moedas details this point further before offering his closing remarks about the future of science at the Euro Science Open Forum 2018 event in the U.K.

“We are seeing the most exciting innovations going back to their basic science roots, like CrispCas9 or blockchain. So the EIC, the ERC and universities will need to work more closely in the future to reinforce each other. And from that we will get stronger science and innovation.

“The future of science will shift the lines of authority of European science and create a new connection between the government, the individual and science. Just as Rousseau said all those years ago. This is the basis for a new social contract in which all three are at its heart, communicating and building the future together. We need to do this for our scientists. And we need to do this for the future of science in Europe.” ■

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High-resolution face completion with multiple controllable attributes

New technology is helping computer systems learn to accurately fill in the gaps in high-resolution facial images – and offer users multiple options for customisation

When we look at an incomplete object with some missing parts, our visual system can immediately fill in the gaps and perceive the object as being whole. In psychology, this is known as the law of closure.

Perceptually completing objects seems to be an intuitive task for human observers, but it can be very challenging for a computer system.

We investigate the problem of constructing completion models for facial images both efficiently and effectively and at high resolutions.

Given samples drawn from an unknown data-generation process, the goal of completion models is to learn the underlying data distribution so that when some samples are corrupted, a trained model can recover the missing data and generate completed samples that are indistinguishable from real ones.

Completion models can be applied to various areas, such as dialogue analysis, audio reconstruction etc. Image completion, in particular, is an important field of completion models, not only because it has many practical applications but also because it is a challenging task due to the high-dimensional data distribution of images.

With the rapid development of social

media and smartphones, it has become increasingly popular for people to capture, edit and share photos and videos.

Sometimes, data is “missing” in the pictures or video frames and we need a system that is able to learn ways to generate the missing contents and complete images, with user-chosen constraints, from an initial set of exemplary images.

For instance, faces can be occluded by dirty spots on a camera lens. Users may want to remove unwanted parts from images, such as wheel or dark eye circles.

Finally, before sharing images, many users prefer replacing parts of their faces (e.g. eyes or mouths) with more aesthetic components so that the modified images look more attractive or have more natural expressions.

Image completion is a technique to replace target regions, either missing or unwanted, of images with synthetic content so that the completed images look natural, realistic and appealing.

Image completion can be divided into two categories: generic scene image completion and specific object image completion (e.g. human faces).

Due to the well-known compositionality and reusability of visual patterns, target regions in the former usually

have a high chance of containing similar patterns in either the surrounding context of the same image or images in an external image dataset. Target regions in the latter are more specific, especially when large portions of essential parts of an object are missing (e.g. facial parts in Figure 1).

So, the completion entails fine-grained understanding of the semantics, structures and appearance of images and this is a more challenging task.

Face images have become one of the most popular sources of images collected in people’s daily lives and transmitted on social networks. Much progress has been made since the recent resurgence of deep convolutional neural networks (CNNs), especially the generative adversarial network (GAN). Data distribution-based generative methods learn the underlying distribution governing the data generation with respect to the context. We address three important issues in our work.

First, previous methods are only able to complete faces at low resolutions (eg 128×128).

Second, most approaches cannot control the attributes of the synthesised content. Previous works focused on generating realistic content. However, users may want to complete the missing parts with certain properties (eg facial expressions).



Figure 1: Face completion results of our method on CelebA-HQ. Our model directly generates completed images based on the input contextual information, instead of searching for similar exemplars in a database to fill in the “holes” like traditional methods. Images in the left most column of each group are masked with grey colour, while the rest are synthesised faces.

Top: Our approach can complete face images at high resolution (1024×1024).

Bottom: The attributes of completed faces can be controlled by conditional vectors. Attributes (“Male”, “Smiling”) are used in this example. The conditional vectors of column two to five are [0, 0], [1, 0], [0, 1] and [1, 1] in which ‘1’ denotes the generated images have the particular attribute while ‘0’ denotes not. Images are at 512×512 resolution. All images best viewed enlarged.

Third, most existing approaches require post-processing or complex inference processes. Generally, these methods synthesise relatively low-quality images from which the corresponding contents are cut and blended with the original contexts. In order to complete one image, other approaches need to run thousands of optimisation iterations or feed an incomplete image to CNNs repeatedly at multiple scales.

To overcome these limitations, we introduce a novel approach that uses a progressive GAN to complete face images in high resolution with multiple controllable attributes (see Figure1).

Our network is able to complete masked faces with high quality in a single forward pass without any post-processing. It consists of two sub-networks: a completion network and a discriminator.

Given face images with missing content, the completion network tries to synthesise completed images that are indistinguishable from uncorrupted real faces, while keeping their contexts unchanged.

The discriminator is trained simultaneously with the completion network to distinguish completed “fake” faces from real ones. Unlike most existing works that use the Encoder-Decoder structures, we propose a new architecture based on the U-Net that better integrates information across all scales to generate higher quality images.

Moreover, we designed new loss functions, inducing the network to blend the synthesised content with the contexts in a realistic way.

Additionally, the training methodology of growing GANs progressively is adapted to generate high-resolution images. Starting from a low resolution (i.e. 4×4) network, layers that process higher-resolution images are incrementally added to the current generator and discriminator simultaneously.

A conditional version of our network is also proposed so that appearances (e.g. “Male” or “Female”) and expressions (eg smiling or not) of the synthesised faces can be controlled by multi-dimensional vectors (Figure1).

In experiments, we compared our method with state-of-the-art approaches on a high-resolution face dataset CelebA-HQ. We showed that our system can complete faces with large structural and appearance variations using a single feed-forward pass of computation with mean inference time of 0.007 seconds for images at 1024×1024 resolution. The results of both qualitative evaluation and a pilot user study showed that our approach completed face images significantly more naturally than existing methods, with improved efficiency.

Video: <https://youtu.be/B2vWbRAMkXc>

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Molecular science: The importance of sustainable manufacturing of chiral amines

Francesco Mutti, Professor of Biocatalysis at the University of Amsterdam's Van't Hoff Institute for Molecular Sciences (HIMS) highlights an aspect of molecular science that concerns the sustainable manufacturing of chiral amines

Chirality (derived from Greek "hand") is a geometric property of some molecules, in particular, organic molecules. A chiral molecule is not superposable with its mirror image in the same way as a right hand is not superposable with a left hand. These two "mirror images" of the same molecule are defined as enantiomers. Chirality is at the base of life on Earth, as molecules in pure enantiomeric form compose any living organism. That has important consequences, especially in the production of pharmaceuticals, which impact upon their therapeutic properties via specific molecular interactions with "chiral biological architectures" like cellular receptors, or proteins, or nucleic acids, etc.

Thus, just one enantiomer of a molecule is very often associated with a desired pharmacological activity, whereas the other enantiomer is inactive or has even adverse biological effects. A tragic historical example is the molecule Thalidomide, commonly prescribed as a mixture of enantiomers between 1950 and 1960. One enantiomer possesses the desired anti-depression activity, while the other enantiomer is highly teratogenic. Consequently, it is in many cases of extreme importance to produce bioactive compounds in a single and pure enantiomeric form.

α -Chiral amines, organic compounds

in which the core amine moiety ($-\text{NH}_2$) is connected to a chiral carbon atom, constitute the most widely used intermediates for the production of active pharmaceutical ingredients, fine chemicals and agrochemicals. For instance, about 40% of the chiral drugs sold on the market possess a chiral amine as the structural core. However, efficient chemical synthesis of simpler, non-chiral amines is also of high interest for the manufacturing of polymers, dyes, pigments, emulsifiers and plasticising agents.

Chiral and non-chiral amines are classically synthesised industrially through lengthy and inefficient chemical routes that produce copious amount of waste, consume a considerable amount of energy, require harsh conditions and involve unsustainable transition metal catalysts. Furthermore, as a classical synthesis of α -chiral amines is often not selective because mixtures of enantiomers are obtained and as such, additional purification steps are required.

The Biocatalysis group at the University of Amsterdam (HIMS-Biocat) is working towards solving these challenges in their ERC-StG-2014 project (BioSusAmin), entitled: "The design and development of efficient biocatalytic cascades and biosynthetic pathways for the sustainable production of amines". One of the objectives of the project is the creation of a new class of



Francesco Mutti

enzymes, called amine dehydrogenases, which enable the synthesis of α -chiral amines as single enantiomers as well as non-chiral amines from inexpensive carbonyl compounds.¹ The enzymatic reaction operates under very mild conditions (aqueous buffer, room temperature, atmospheric pressure) and generates a minimal amount of waste. HIMS-Biocat researchers start by analysing the crystal structure of known enzymes with defined properties and performing computational studies. Based on these *in silico* studies, exiting enzymatic scaffolds are rationally mutated through molecular biology techniques to obtain the final biocatalyst that is required for a specific transformation. The ultimate goal of HIMS-Biocat researchers is to create a tool-box of amine dehydrogenases capable of transforming structurally diverse molecules into amines of industrial interest.

Another important aspect is the availability of renewable material for the synthesis of amines. On one hand, amines are scarce in nature. On the other hand, the common chemical precursors for the synthesis of amines (ketones and aldehydes) are mainly obtained by processing and chemical transformations from petrol. Conversely, renewable bio-based molecules almost ubiquitously contain alcohol groups. Hence, the direct conversion of alcohol starting material into chiral and non-chiral amines is a major objective of the BioSusAmin project.

HIMS-Biocat researchers have demonstrated the feasibility of the biocatalytic process by converting a set of structurally diverse alcohols into amines (as single enantiomer) using a tandem combination of two enzymes: one alcohol dehydrogenase with one amine dehydrogenase.² The process possesses the maximum resource efficiency as it converts an alcohol directly to an amine, consuming only ammonia and generating water as the sole by-product. A follow-up study using co-immobilised enzymes demonstrated that the system is economically viable as recycling of the enzymes for few cycles in the batch was accomplished.³ HIMS-Biocat researchers expect that the implementation of their process in flow reactors will permit to meet the economic requirement for industrial applications.

Another advantage of enzyme catalysis compared to chemo-catalysis is the fact that enzymes are generally compatible with each other. Thus, multiple biocatalytic reactions can be carried out sequentially in a single reaction vessel (in vitro) or in a microbial host cell (in vivo) without isolation of intermediates. This approach emu-

lates nature, wherein metabolic pathways are generated by an elegant orchestration of biocatalytic cascades. New metabolic pathways that do not exist in nature can be created by combining enzymes originated from different organisms and/or man-made engineered enzymes.

Following this concept, the BioSusAmin project aims at creating new biocatalytic pathways for the conversion of the starting material encompassing the minimum number of biochemical steps and avoiding intermediate work-ups, such as purification and isolation. In particular, the biochemical steps along the pathway are running sequentially and simultaneously, from one step to the other without stopping. Such an approach permits to significantly reduce waste as well as manufacturing time and maximise profits.⁴

The BioSusAmin project and other related projects will contribute to the development of a new generation of (bio)chemical processes that will reduce the impact of human activity on the environment, will make our society less dependent on non-renewable resources and allow for the reduction of energy consumption in chemical manufacturing.

Increasing resource efficiency is also a fundamental aspect for securing growth and jobs as it will bring major economic opportunities, improve productivity, drive down costs and boost competitiveness. In this context, a biocatalytic solution to chemical problems can play a pivotal role. In summary, BioSusAmin and other related projects underpin the quality of life in many areas, such as the sustainable manufacture of chemicals, healthcare, energy, environment and the creation of new job opportunities.

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Science and research funding in Germany

Open Access Government provides an overview of the German Research Foundation (DFG), the self-governing organisation concerned with funding and supporting science and research in Germany and beyond

The German Research Foundation (DFG) is a self-governing organisation concerned with science and research in Germany, covering all branches of science and the humanities. As an association, its varied membership consists of research universities in Germany, as well as scientific associations and the academies of science and the humanities plus non-university research institutions.

Funding for research

In terms of where it receives its funding, the DFG receives most of this from the federal government and the states. In a recent press release from DFG, we discover that during 2017, they awarded funding to around 32,500 research projects with a volume of nearly €3.2 billion – which represents an increase of roughly 1,000 projects and €120 million, in comparison to 2016. The was included in DFG’s annual report, which also features journalistic articles presenting a number of selected research projects.

DFG President, Prof Dr Peter Strohschneider and Secretary General, Prof Dorothee Dzwonnek in the foreword of this annual report comment that: “The international focus of the report takes account of two factors: firstly, the fact that scientific inquiry can benefit enormously from global dialogue and cooperation and, secondly, the fact that in some areas of the world, conditions are becoming more difficult for the free choice of research topics and methods...Research funding that is oriented towards these freedoms and independent of political, economic and social demands is therefore becoming increasingly important.”⁽¹⁾

Selecting the best research projects

DFG’s primary task is to select the best projects by researchers at universities and institutions across the country, on a competitive basis and to also to fund such

projects. Higher education institutions or individuals are welcome to put forward proposals in a specific field of curiosity-driven basic research as they choose and added to this, interdisciplinary proposals are also taken into consideration.

“Funding excellent science without regard to extra-scientific factors is something that the DFG believes in very strongly. The same is true where the equal treatment of men and women is concerned, as well as the broad representation of the scientific disciplines in the self-governance of the organisation, something that enables the diversity and originality required for exceptional research to happen.”

In what can only be described as a multi-layered decision-making process, a proposal made to the DFG is evaluated by voluntary reviewers in accordance with scientific criteria. On the basis of such an expert review by elected members of a review board, they assess a proposal and the final decision on a proposal is made by a grants committee. By using this process, DFG funding guarantees quality-based differentiation in the country’s research system. In this spirit, it is said that DFG is a cornerstone of Germany’s strength as a research location but looking at the wider picture, we are told that it also helps to shape the European Research Area (ERA).

A prize for two alternatives to animal experiments

In a concrete example of research in Germany that the DFG is supporting, we find out in recent news that Prof Dr Ellen Fritsche from the Leibniz Research Institute for Environmental Medicine at Heinrich Heine University Düsseldorf and Dr. Hamid Reza Noori from the Max Planck Institute for Biological Cybernetics in Tübingen will be presented with the Ursula M. Händel Animal

Welfare Prize by the DFG during November 2018 in Berlin, Germany.

The prize, worth €50,000 each, is being presented for the seventh time and it is awarded to researchers who improve animal welfare in research in line with the principles of the 3Rs: Replacement, Refinement and Reduction, something that DFG Vice President Prof. Dr. Katja Becker, who will present the Prize in Berlin comments on: "As a research funding organisation, the DFG has a natural and fundamental interest in the consistent implementation and refinement of the 3Rs. The quality of research results is directly linked to the responsible treatment of research animals." ⁽²⁾

Early career support

One area of the DFG's work worth a look at concerns the importance of support for early career researchers. As such, the DFG awards the best researchers with funding and provides them with the means and freedom necessary for success in their work. We know that one of the DFG's key objectives is the advancement of early career researchers. Programmes which provide appropriate support at every phase of their qualification are, therefore, provided. In addition, the DFG is particularly committed to the early independence of researchers. The recruitment of talented scientists and academics from home, as well as abroad for German research is also a part of this key objective.

Funding excellent science without regard to extra-scientific factors is something that the DFG believes in very strongly. The same is true where the equal treatment of men and women is concerned, as well as the broad representation of the scientific disciplines in the self-governance of the organisation, something that enables the diversity and originality required for exceptional research to happen.

Interdisciplinary cooperation

We know that the DFG lends its support to all areas of science and the humanities and in particular, promoting interdisciplinary cooperation among researchers. Cooperation between researchers from all areas of science, as well as the formation of internationally

visible priorities at universities and non-university research institutions, is a key element of what drives the DFG's work.

In this vein, the DFG places special emphasis on scientific collaboration within the ERA. Knowledge-oriented research is strongly encouraged, as is the interaction of scientific findings within the private sector and other notable institutions, such as academies of music, museums and hospitals plus public-private partnerships.

Policy advice

Finally, one aspect of the DFG's work we must mention concerns their role in providing scientific policy advice. The DFG provides a voice of science in political and social discourse, indeed it takes part in political decision-making processes in which it can lend its scientific expertise. The DFG gives recommendations around fundamental issues in science and the responsible application of scientific findings in society. The DFG's regulations on good scientific practice provide internationally recognised guidelines for this very purpose. ■

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Advancing the thermal management and safety of batteries by calorimetry

Dr Carlos Ziebert at IAM-AWP's Calorimeter Center of KIT outlines how research and testing in calorimeters is essential to improve the thermal management and safety of batteries

Established in 2011, the Calorimeter Center 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 and post-Lithium batteries on material, cell and pack level under quasiadiabatic and isoperibolic environments for both normal and abuse conditions (thermal, electrical, mechanical).

“In the future, battery calorimetry will be also needed to assess the thermal and safety properties of advanced materials such as solid state batteries or other systems, which could replace Lithium such as sodium or magnesium. This has to be started already now on the smaller scale level and to be continued to ensure that the cells can be up-scaled and remain safe.”

In addition, the Calorimeter Center contains differential scanning calorimeters (DSC), thermogravimetric analyzers (TGA), laser flash analysers (LFA) and extremely sensible Tian-Calvet calorimeters which provide thermodynamic parameters, such as heat capacity, thermal conductivity or formation enthalpy on the materials level. With these facilities and the established



Figure 1

technical and methodological expertise in place, the IAM-AWP is now – seen worldwide – one of the few institutions that investigates both the thermodynamics and the safety of batteries and their materials.

Safety comes first

Safety comes first – this is the mission of the Center's head, Dr Carlos Ziebert. For a breakthrough of the electrification of transport and for the energy transition using stationary electrochemical storage, the safety of the

Lithium-ion cells is one of the most important prerequisites, because an uncontrollable temperature increase (so-called thermal runaway) can cause ignition or even explosion of the battery with simultaneous release of toxic gases.

Thermal runaway is, of course, something that nobody wants, especially in an electric car or another electric vehicle and its causes and effects can be very diverse and complex. Thus, it is fundamental to investigate the ther-

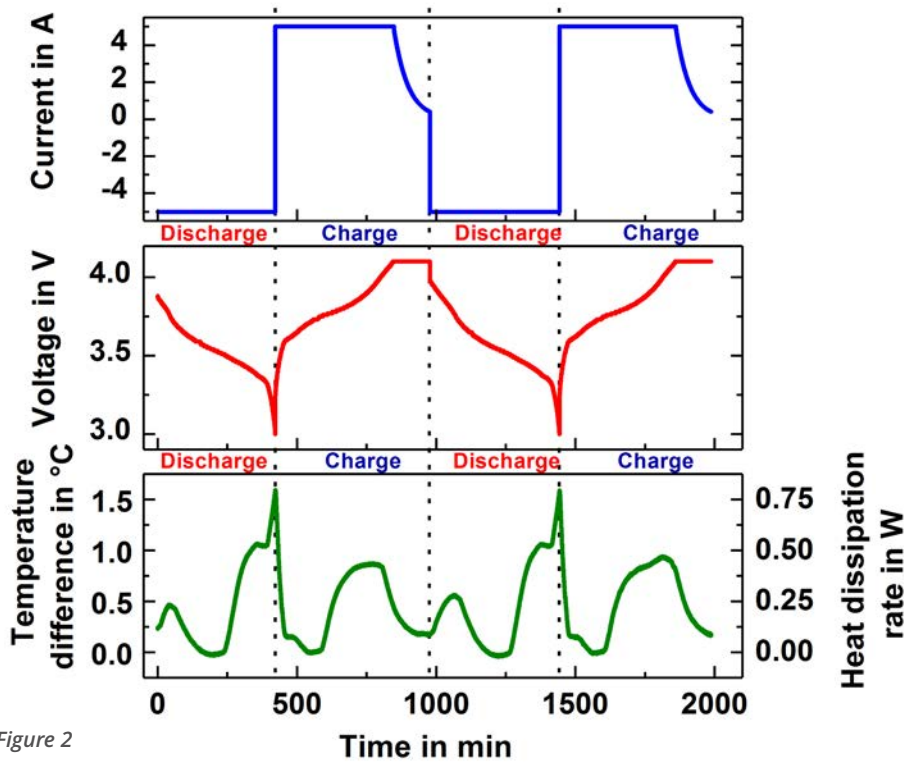


Figure 2

mal effects in close connection with the material and cell development for advanced and post-Lithium systems.

Looking at the current state of the Li-ion technology, we know that the range of properties is still significantly dependent on the respective operating and ambient conditions present. The influence of ageing on safety is another critical factor for commercial applications today. Even the regular use of batteries leads to heat release which makes good thermal management necessary. The heat effects are caused by electrochemical reactions, phase transformations, mixing and Joule heating processes. The active materials can initiate highly exothermic reactions by an internal or external short circuit or by mechanical actions induced by accidents, which can be followed by the thermal runaway. To avoid this, the system must be designed optimally with respect to the material and cell level. In addition, both the battery and thermal management systems must be optimised. Therefore, the complete scientific and technical

understanding of the thermal effects is of the utmost importance.

The benefits of battery calorimetry

Calorimetry – or the process of measuring heat data during chemical reactions – allows the collection of quantitative data required for optimum battery performance and safety. This data is important because you need to know how many watts a cell will produce under certain conditions. These data are essential for battery management, thermal management and safety system design. Combined with multiscale electrochemical-thermal modelling, they provide a powerful tool for thermal runaway prevention and ageing prediction.

Sophisticated battery calorimetry combined with thermography allows finding new and quantitative correlations between different critical safety and thermally related parameters. The temperature, heat and internal pressure evolution can be studied while operating cells under conditions

of normal use, abuse or accidents. Such abuse tests without a calorimeter have two main disadvantages:

- The maximum safe temperature is underestimated (i.e. the cell would be perceived to be less hazardous) and;
- The thermal runaway consequences would be understated in terms of severity and speed.

Moreover, a test in the calorimeter is much more sensitive than a hotbox test and reveals the entire process of the thermal runaway along with the different stages of exothermic reactions.

Measurement of thermal data

Fig.1 shows two of the Accelerating Rate Calorimeters (ARC) at the IAM-AWP Calorimeter Center. The cell is inserted into the calorimeter chamber, which has heaters and thermocouples located in the lid, bottom and side wall. These adjust the required ambient conditions, which can be either isoperibolic or quasiadiabatic. Under isoperibolic conditions, the temperature of the calorimeter chamber is kept constant and the temperature change at the surface of the cell is measured. This reflects the ideal conditions of a single cell or an edge cell in the pack. In this case, the cell temperature reaches its initial temperature again after each cycle (s. Fig. 2). In the quasiadiabatic mode the heaters in the calorimeter chamber follow immediately any change of the cell temperature preventing the heat transfer to the chamber. This simulates ambient conditions for a cell in a pack, where the densely packed neighbouring cells greatly reduce the heat release to the environment and leads to a continuous increase of the cell temperature with every cycle, as

can be seen in Fig. 3. Such data make it possible to optimise continuously charge and discharge management and to analyse ageing processes in the cells. By measuring the specific heat capacity and the heat transfer coefficient the measured temperature data can be directly converted into generated and dissipated heat data (s. Fig.2), which are needed for the adjustment of the thermal management systems.

“Thermal runaway is, of course, something that nobody wants, especially in an electric car or another electric vehicle and its causes and effects can be very diverse and complex. Thus, it is fundamental to investigate the thermal effects in close connection with the material and cell development for advanced and post-Lithium systems.”

Safety testing

Apart from thermal data under regular use the battery calorimeters provide thermal stability data on materials level, e.g. of anodes, cathodes or electrolytes or their combinations and safety tests on cell and pack level by applying:

- Electrical abuse: External/internal short circuit test, overcharge test, overdischarge test;
- Mechanical abuse: Nail test and;
- Thermal abuse: Heat-Wait-Seek test, ramp heating test, thermal propagation test.

As a result of the different tests quantitative and system relevant data for temperature, heat and pressure development of materials and cells are provided. Currently, the thermal propagation testing is becoming a very hot topic, because a standard-

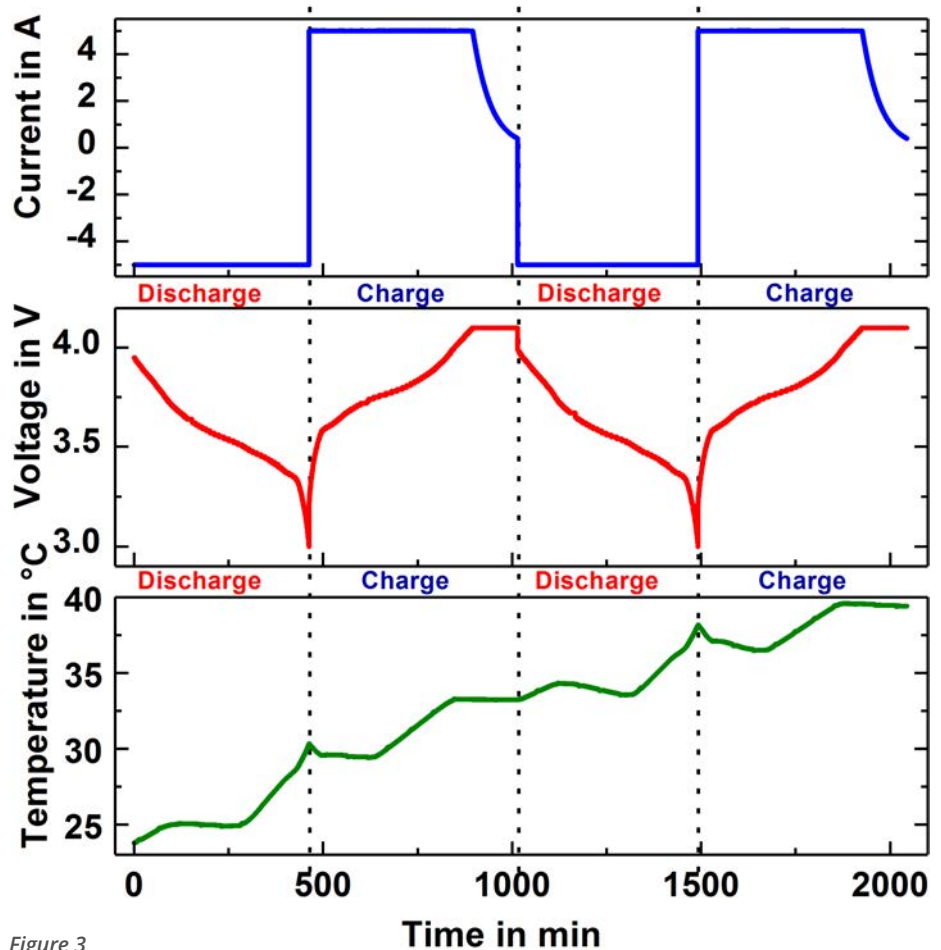


Figure 3

ised procedure is needed to develop and qualify suitable countermeasures, such as heat protection barriers. For example, a global technical regulation (GTR) on electric vehicle safety is being developed by all relevant stakeholders.

In the future, battery calorimetry will be also needed to assess the thermal and safety properties of advanced materials such as solid state batteries or other systems, which could replace Lithium such as sodium or magnesium. This has to be started already now on the smaller scale level and to be continued to ensure that the cells can be up-scaled and remain safe. Does there are still enough challenges that have to be overcome and we hope that the Calorimeter Center will help the European Industry to make further progress in the battery field,

which is urgently needed to reach a low-carbon future, to foster European leadership and to create new jobs.



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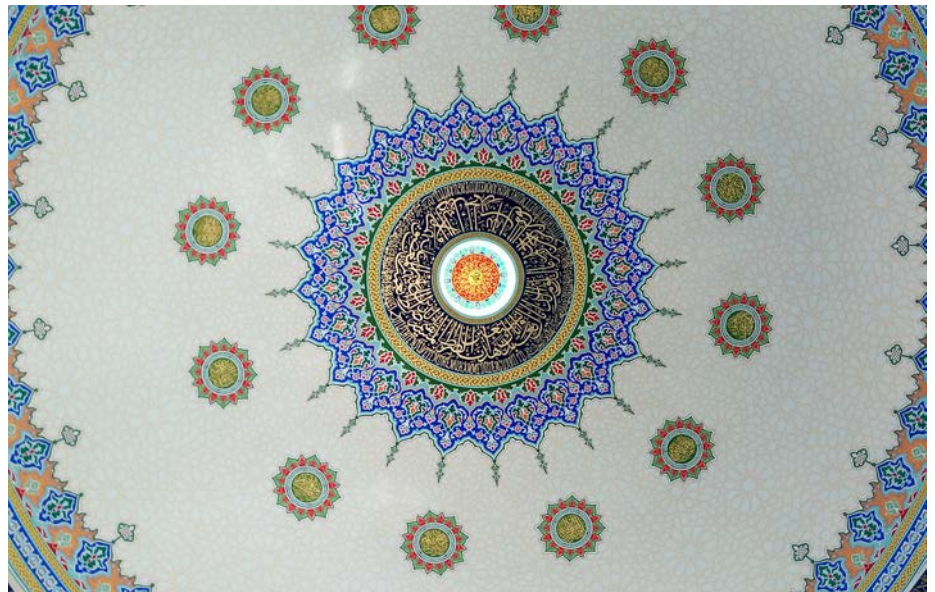
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GOVERNMENT

Religious elites and societal organisation in south-eastern Europe

Dr. rer. pol. Jochen Töpfer of the Free University of Berlin, Institute for East European Studies outlines how region can play a role in modern society

The relationship between traditional religion and processes of modernity is a central issue in contemporary public discussions, as well as in debates within the field of social sciences. The latter shall ask about short-term incidents like topics such as Islamist terrorist attacks, anti-Islamic populism, and new developments in the Arabic world, which prevail in the daily news, give an empirical basis, and integrate them into long-term concepts. Overall, there is a strong relevance of a scientific analysis of religion in pluralist society today.

The research project `Religious Elites and Societal Organization in South-Eastern Europe` includes two central issues. The first one is to detect types of attitudes regarding the societal order within the religious elite of south-eastern Europe without a normative background. Thus, this part of the project also has no thesis and seeks to find out the perspective of the religious sphere in an explorative way. Several major branches of Christianity and Islam are traditionally rooted in this region, so the second part asks for the integrative as well as the conflict-afflicted potentials of religion in multi-religious societies. Do these attitudes have rather integrating or separating consequences for society? And how important is religion at all in building identity today? Are reasons for so-called `religious conflict` located exclusively within the religious sphere,



or rather caused by external factors as political power arrangements? The selection of cases is based on the specific differences in the structure of the religious field and comprises Albania, Macedonia, and Slovenia.

Why south-eastern Europe?

In order to represent the traditional religions and religious communities with a large amount of followers in Europe adequately, central types of attitudes of religious dignitaries towards the triangle religion – politics – population in multi-religious societies of south-eastern Europe are in focus. Here, Christianity with its major branches (Roman-Catholic, Orthodox, Protestant), Islam (mostly Sunni but also Shiite), and other religious communities are represented since centuries. Since the collapse of socialism in 1989 and the beginning of transfor-

mation of the societies in Eastern Europe, religion experienced a recovery and was able to enhance its influence over wider parts of society and politics.

Why religion today?

Today, we as Europeans experience a strong revival of religion in the public and political sphere as daily news indicate (terrorist attacks in the name of a religion, `Anti-Islam` movements that become violent, and the reaction of democratic politics). Additionally, above-mentioned remarks show that religion was brought back to the political arena recently by political actors in south-eastern Europe. Hence, religious dignitaries are able to influence the (positive and negative) political decision-making of parts of the population. Over the 20th century, they lost their function as economic and political power-elite but can be regarded today as value-elite.

The existence of attitudes towards the societal order originates also from considered world religions themselves: a major characteristic of them is the claim to handle reality in its entirety (‘Ganzheit’) – hence, they follow a holistic program.

How to catch attitudes adequately and consider subjectivity

In order to determine these attitudes adequately, an innovative qualitative method¹ is applied which refers explicitly to the internal frame of reference of the respondents, called Q-method. It is designed for explorative approaches; e.g. a data collection in areas of society which were rarely subject of scientific analysis before. The method takes into account the subjectivity of the researcher and of the respondents: Therefore, no questions for the interview are pre-formulated, which would ask just for the acceptance of models of the researcher among the religious elite. In a first step, a scientific content analysis of speeches and public statements of religious dignitaries in Albania, Macedonia, and Slovenia was conducted. Extracting 36 central statements regarding the topic, the researcher in a second step presents these to the religious dignitaries in focus, who are the origin, and asks for a grading and a comment of them.

The Q-method needs a relatively small number of respondents (20-40) in order to explore types of attitudes within a group in focus. Although the field work is not completed, results of a first analysis show two central types of attitudes: rather modern and progressive views prevail in a first group of respondents, while conservative attitudes can be located just in a minority of cases whereas the overall potential for religious conflict is rather small.

Goals

After a quantitative and qualitative analysis of all three societies and a comparison of attitudes, the results shall answer the questions: Which discourses dominate within religious communities in south-eastern Europe towards the society, the state, and other religions? And, how far do these perceptions correlate with current societal arrangements? Identifying discourses in the framework of the project does not mean you need to focus on short-term issues or scandals – rather, long-term conceptions of society are of interest.

The specific goals of the project are manifold and can be classified along four groups: theoretical as well as empirical objectives following current debates in the social sciences, links for further research, and the generation of applicable recommendations for policy makers (and responsible persons in the religious sphere).

The overall goal is the detection of attitudes towards the above-mentioned triangle of religion – state – society from the perspective of religion and more precisely of religious dignitaries. From the point of view of the scientific discipline of sociology of religion, there are only very few empirical studies asking for the attitudes of religious elites towards the societal order in the multi-religious sphere of south-eastern Europe. Beyond external ascriptions – which discourses can be revealed by the application of the Q-method? Where are convergences and divergences – among different religions, states, or communities? Do these attitudes foster cultural and political integration or exclusion in the societies under scrutiny?

Results from the empirical study are able to bring about conclusions also

for the development of existing theoretical models in branches of science as ‘religion and politics’ or ‘religion and conflict’ that are of importance to a wider public audience. The first contribution in the area of religion and politics is the capture of the actual spectrum of attitudes of religious elites and a comparison with classification about the relationship of religion and politics. In the area of religion and conflict there is the need to ask whether religion is an important element of basic distinctions between social groups and to analyse here the differences and convergences in intra- and interreligious comparison. Additionally, patterns for analysing sources of societal conflict can be specified.

The third point is the strong connection to further research. On the empirical side, a basis is produced for the quantification of the results. To what extent are the attitudes and discourses represented among religious people or the whole population? Additionally, the types of attitudes found in south-eastern Europe can be surveyed in other societies of the continent in order to see their distribution.

¹ Contrary to its rare application in Social Sciences, there’s extensive scientific literature on Q-method available. See also the International Society for the Scientific Study of Subjectivity (ISSSS).



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Image-based sensing enables adaptive micro air vehicle missions

Wolfram Hardt, Professor at Chemnitz University of Technology gives insight into high-performance image processing for adaptive unmanned micro air vehicles (MAVs)

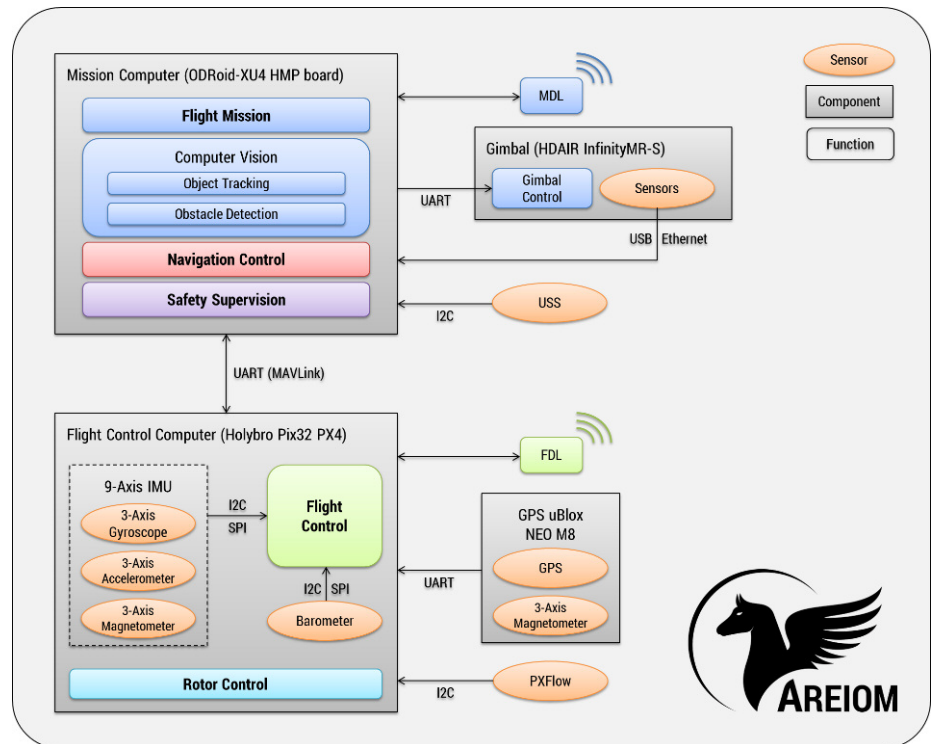
Unmanned micro air vehicles (MAV) are used by professional pilots for a huge range of industrial applications, for example, when inspecting buildings and infrastructure. For collision avoidance and flight control, MAVs are equipped with sensors of varied types. The number and type of sensors are limited by size and weight restrictions. But high-performance applications as autonomous or adaptive MAV missions require intelligent real-time sensors for:

- Classification of the actual flight context;
- Determination of the actual mission status and;
- Mission-dependent MAV actions.

“Our new approach implemented on the Areiom-platform enables adaptive MAV missions due to image-based sensing. By means of this promising technology, MAV can be used in a much more flexible, safe and efficient way in urban environments.”

The typical sensor paradigm of the quantization of some physical, measurable phenomes as light, speed or distance is much to restricted for this kind of complex sensing applications.

The computer engineering group at the Chemnitz University of Technology has developed a new approach for this kind of sensing application, based



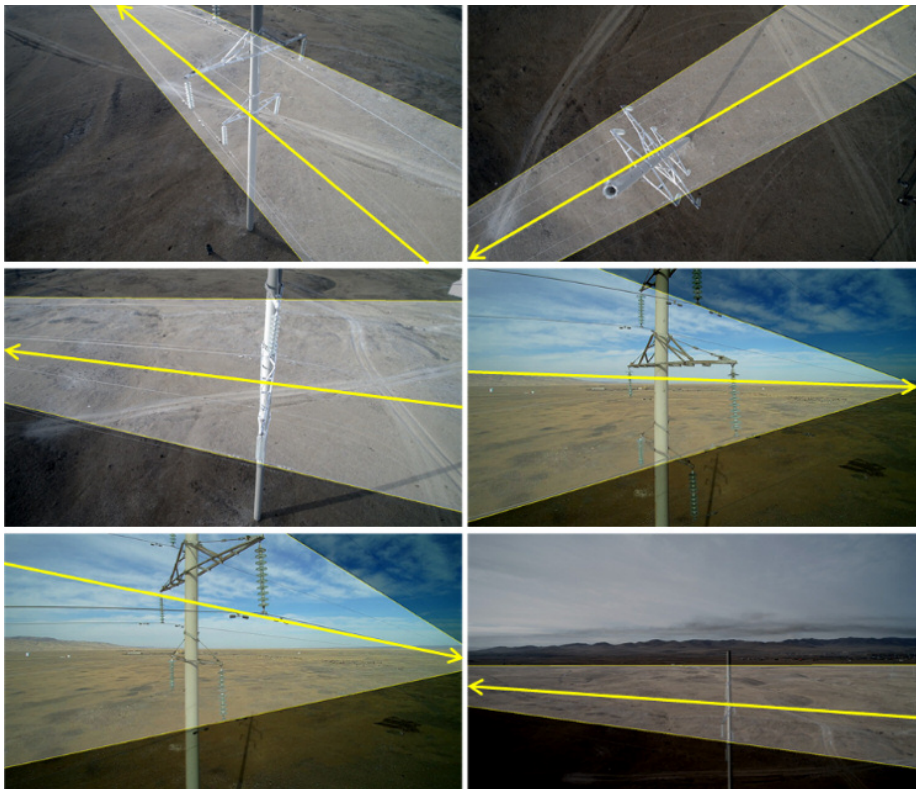
on real-time image processing. An additional, free movable camera is added to the equipment of the MAV. Weight, interfaces and costs can be determined exactly beforehand. With high-performance image processing in place, we implement various feature point detection algorithms to classify the actual flight context, to determine the mission status and to fire mission dependent MAV actions.

The implementation is based on the Areiom platform, which defines five separated architecture levels for specific MAV tasks, especially three control levels for handling the rotors, the fight parameters and the navigation functions are distinguished.

Additional architecture levels are introduced for safety supervision and the flight mission. Finally, sensors, gimbal and additional features tell us that the detection camera as an intelligent sensor can be connected by standard interfaces.

Standard functions are implemented on the named control layers. The newly introduced flight mission layer offers computation resources for adaptable flight missions. Based on adaptability, autonomous missions for applications of limited complexity are implemented successfully.

For the first class of applications, that is the inspection of industrial high



Real-time heading direction sensing-based on image processing

voltage power lines and isolators, we implemented image-based sensing. While the MAV mission is active, we analysed a 1080p/30 fps video stream in real-time to determine the heading directions (HD). HD is important for sensing information needed by the MAV to follow the high voltage power line. Firstly, several filters as line detection, edge detection and Hough transformation are applied. Secondly, we compute the line intersection point. From this, the HD value is determined.

Our approach of image-based sensing is very flexible, can be easily adapted to a huge range of further feature points needed for adaptive MAV missions. Thus, a new level of sensing is introduced. Mechanical problems due to sensor mounting or weight restrictions are complexly eliminated. Once the MAV is equipped with the sensing camera, the setup is fixed. All feature point detection algorithms for sensing

are implemented in software and mapped directly the Areiom platform.

“Unmanned micro air vehicles (MAV) are used by professional pilots for a huge range of industrial applications, for example, when inspecting buildings and infrastructure.”

Standard filter functions are implemented as a library, so the combination of filters and special feature point detection tasks are evaluated in our laboratory. Test flights for evaluation are performed in our indoor flight centre (IFC). This allows for the controlled evaluation of image-based sensing and adaptive MAV missions. With direct cameras, the MAV can be viewed from three different perspectives. This allows detailed flight and mission analysis.

For image-based sensing, we provide projections of original flight situations within the IFC. Thus, the flight context,



Prof Dr Habil. Wolfram Hardt, TU Chemnitz

the mission status and all MAV actions can be validated efficiently.

Our new approach implemented on the Areiom-platform enables adaptive MAV missions due to image-based sensing. By means of this promising technology, MAV can be used in a much more flexible, safe and efficient way in urban environments.



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Machine learning: An unexplored horizon in Arctic science

Joseph Cook, Vice President of the UK Polar Network (UKPN) Committee explores why machine learning is an unexplored horizon in Arctic science

Machine learning has become a disruptive force in many sectors, underpinning the technology that protects us from scam emails, calculates our credit scores, detects financial fraud and powers self-driving cars. Machine learning enables deep insights to be drawn from datasets that are too large or too complex to be digestible by humans. In this article, I will argue that it also has huge potential in the field of polar science.

Machine learning is an umbrella term for a large family of algorithms that share a common principle – they “learn” how to extract value from a dataset by being shown examples. The examples are known as the “training data”. The algorithm explores the training data looking for statistical relationships between variables that it can use to make predictions about other data. A simplistic example is an algorithm designed to identify certain objects in images – apples, for instance.

The training set will contain many images that the researcher labels as “apple” or “not-apple”. The algorithm examines each example and decides for itself what are the characteristics of apples it can search for in other images. With every example it sees, the algorithm’s criteria are refined. Then, the algorithm can use those same criteria to decide whether apples are present in any image. This is an example of “supervised learning” which means that the training data includes labels as “correct answer” targets for the algorithm. In this example, there are just two labels, but in reality, there may be many.

The alternative is “unsupervised learning” where an algorithm decides for itself how to group the data into distinct classes. The power of these methods comes from the algorithm developing its own criteria for separating data and making predictions. The lack of

explicit programming and the ability to iteratively churn through huge datasets makes machine learning a particularly powerful tool for extracting value from “big data”.

Polar science is awash with “big data”. One particularly important source is optical remote sensing – our “eye in the sky” instruments on drones, planes and satellites that provide measurements of reflected light that we can use to identify features and objects on the Earth’s surface. Every pixel in every satellite image contains information about reflected light at several wavelengths (colours), adding up to a huge volume of data – ideal territory for mining information using machine learning.

With access to a reliable and sufficiently large training set, a “supervised classification” algorithm could be trained to scan through satellite imagery across the cryosphere and assess the composition of each individual pixel – assigning labels such as dry snow, wet snow, ice, melting ice, ice with dust, ice with algae, water, crevasse etc – providing the science community with automatically generated, highly detailed maps of the surfaces of glaciers, ice sheets, sea ice and snow fields that can be used to assess glacier change or predict safe routes for ice cap crossings, for example.

One of the strengths of machine learning is that the pipeline from data collection to classification can be automated, meaning the process can easily be repeated at regular intervals, limited only by the frequency that the relevant satellite or aircraft instrument passes overhead.

Between 2016 and 2018, I have been using these techniques to map the surface of the Greenland Ice Sheet from custom-built drones and from space (using data



Image: © Rolex/Marc Latzel

from the European Space Agency's Sentinel-2 satellite). My specific aim was to quantify how much of the ice surface was covered by algal blooms and other particulates that have an accelerating effect on ice melt rates and use machine learning algorithms to evaluate changes over space and time. I trained supervised classification algorithms on reflectance measurements made at on-ice camps on the Greenland Ice Sheet (Figure 1), so that the algorithm could “learn” to identify subtly different features of the surface. This is just one application of one type of algorithm – there are countless others making up a huge unexplored opportunity space bridging machine learning with polar science.

While machine learning is a powerful addition to the polar scientist's toolbox, there are also limitations. Firstly, training data is relatively scarce. To generate a suitable training set for classifying snow and ice surfaces based on composition, our eyes in the sky rely upon feet on the ground. Scientists still need to visit field sites and make very detailed measurements of the ice surface composition and optical properties along with reflectance measurements that replicate those made by the relevant satellite instruments. This is the only way

to generate the initial labelled training data set required by the algorithms. Field science can be expensive and time-consuming; however, as the technology is adopted more widely and a standard protocol for gathering this data is established, sharing between groups will allow a central repository of training data to grow.

“Machine learning is an umbrella term for a large family of algorithms that share a common principle – they “learn” how to extract value from a dataset by being shown examples. The examples are known as the “training data”. The algorithm explores the training data looking for statistical relationships between variables that it can use to make predictions about other data.”

The second challenge is that satellite measurements can be obscured by cloud – sometimes limiting the available data to a few images per season. For this reason, some researchers have been making equivalent measurements using planes and drones that fly beneath the cloud base. Another hurdle is computing power. Applying complex algorithms to huge datasets exerts a major computational load and may require

Continued on page 195 →

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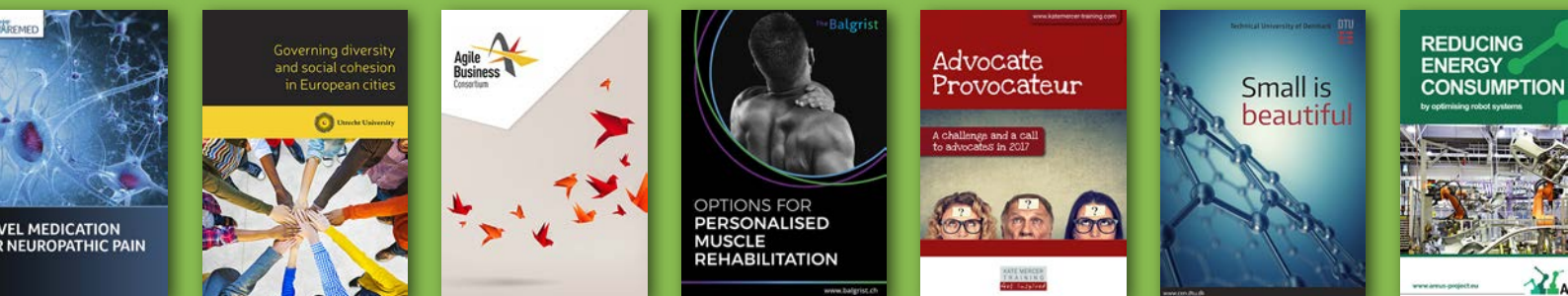




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← Continued from page 193

access to high-performance computing (HPC) clusters, which can often be awkward, expensive and may require specialist support from a research software engineer. However, the current boom in cloud computing services and access to remote servers such as the Amazon Web Services or Microsoft Azure are making computational heavy lifting achievable from a home laptop. A great example is the Google Earth Engine, which is already optimised and organised for geospatial data analysis via an interactive Javascript console running in the web browser or a downloadable Python API (Application programming interface).

As these technologies develop and as the availability of training data increases, machine learning will increasingly influence polar science and be an ever more powerful and accessible strategy for geospatial data analysis across the cryosphere.

Dr Joseph Cook is a polar scientist with interests in applying machine learning to polar science. He is a postdoctoral researcher on NERC's Black and Bloom project, a Rolex Laureate, World Frontiers Forum Pioneer and co-founder and director of the cryosphere

focused science communication organisation "Ice Alive". He is also currently Vice President of the UK Polar Network. Please see www.icealive.org or <http://tothepoles.wordpress.com> for more information or www.github.com/jmcook1186/ for related codes and notebooks. ■

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The Antarctic notothenioid fishes: An especially interesting and unique marine species flock

Arthur L. DeVries, from the University of Illinois provides a comprehensive insight into a unique marine species flock, the Antarctic notothenioid fishes

At one time the Antarctic Ocean was home to a temperate fish fauna which included sharks, rays and bony fishes (teleosts). About 20 million years ago the Antarctic waters began to cool and all the temperate fishes died out, except for a bottom-dwelling fish that probably looked like a northern hemisphere sculpin. This hypothetical ancestor gave rise to a group of closely related fishes that survived the cooling waters, which today are known as the notothenioid fishes: (a sub order Notothenioidei nested within the modern bony fishes (Perciforms). Some of the shared features of this group are the lack of a swim bladder making them negatively buoyant in seawater, paired pelvic and pectoral fins positioned one above the other and just distal of the opercula and mostly benthic species.

This suborder includes eight families most of which are found in the Southern Ocean south of the Antarctic convergence. Members of five of the eight families are primarily confined to the narrow shelf region of the Antarctic continent. The families include the Nototheniidae, Channichthyidae, Bathydraconidae, Artedidraconidae and Harpagiferidae. They make up about 90% of the fish biomass of the shelf and the populations of some of the species are huge. The other three families (fig 1) are confined to the

waters of the sub-Antarctic islands and the Patagonian region of South America.

When the waters surrounding the Antarctic continent began freezing – a novel trait evolved in some of the progeny of the notothenioid ancestor – which permitted them to avoid freezing; this trait was a blood-born glycoprotein which had antifreeze properties. This antifreeze glycoprotein (AFGPs) lowered its blood freezing point a few tenths of a degree below the freezing point of seawater (-1.9°C). The antifreeze trait allowed them to survive and diversify into many species which filled the ecological niches vacated by the extinction of the temperate fish fauna. Presently, there are a variety of body morphs. Some of the nototheniids and harpagiferids resemble north temperate bottom dwelling thorny sculpins (Cottids).

Other species of the notothenioid family are like smelt and salmonids in body form with a fusiform shape. The nototheniid, *Trematomus borchgrevinki* inhabits the waters at the underside of the fast ice and finds refuge in the platelet layer and has a body form similar to a codfish. The two nototheniid fishes, *Pleuragramma antarctica* (Antarctic smelt) and giant Antarctic toothfish, *Dissostichus mawsoni* inhabit the water

column and are neutrally buoyant even though they lack a swim bladder. They have achieved neutral buoyancy by reducing mineralisation of their skeletons and scales and accumulating lipids which are less dense than seawater. The smelt accumulates sacs of clear lipid under its skin and between its dorsal vertebral spines. Neutral buoyancy adaptations allow these two species to cruise through the water column expending energy only for directional swimming rather than swimming to counteract sinking.

Channichthyids, often called crocodile fishes because of their large mouths as adults are sit and wait predators and can gulp and swallow a fish half their size. The most amazing trait found in this family is the lack of red blood cells and hence hemoglobin the oxygen transport pigment. Oxygen taken up at the gills is transported only as dissolved oxygen in their hemoglobinless blood.

However, they have evolved adaptations to partly overcome the lack of hemoglobin such as larger gills for a larger gas exchange surface to absorb oxygen, a larger blood volume with a larger heart and the absence of scales which allows some gas exchange through the thin skin. Despite these adaptations, they do not tolerate stress like their red-blooded relatives

Adaptive Radiation of Antarctic Notothenioid Fishes

➤ Major groups of fish taxa disappeared at ~40 mya.

➤ Rise of the notothenioid fishes :
 ➤ ~45% of all species in Southern Ocean;
 90-95% of fish individuals on continental shelf.

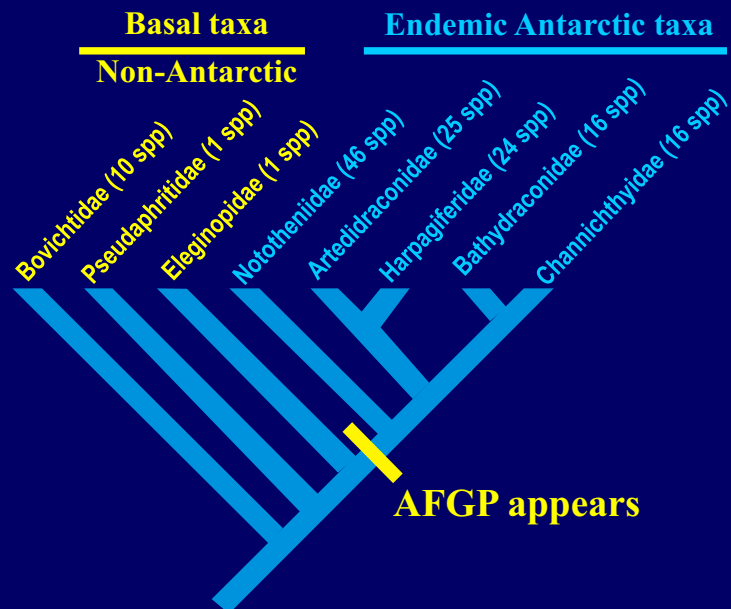


Figure 1. Cladogram of Antarctic fishes of the Suborder Notothenioidei and characteristics of the group

and are therefore at a physiological disadvantage relative to the other notothenioids.

However, they have been able to survive for millions of years because the cold Antarctic Ocean contains more oxygen than warm temperate waters because oxygen solubility is greater in cold water than warm water. The presence of one species of the channichthyid species in 12°C waters of Tierra del Fuego exemplifies the creativity of evolution as this one species can tolerate temperatures well above those ice fish species endemic to the Antarctic Ocean which fail to survive at temperatures higher than +6°C. Although this South American fish appears to exist near its physiological limit, it does attest to its evolutionary success despite having to compete with many coexisting red blooded species, such as salmonids and other non-Antarctic fish species.

The notothenioid group is an excellent example of a marine species flock. That is, a closely related clade of species that arose from a common ancestor and underwent an adaptive radiation that gave rise to a variety of species with unique morphological and physiological characteristics that allowed them to successfully invade and fill most of the underutilised ecological niches that were vacated by the extinct temperate fauna. Because they are closely related the similarities and differences in some of their biochemical, physiological and morphological traits can be more easily compared without having to deal with a phylogenetic signal that would be present if they originated from unrelated ancestors.

Thus, a clearer picture can be gleaned from comparative studies of their morphological, biochemical, physiological adaptations and the underlying

genomic changes that gave rise to them. This marine species flock is like the African Rift cichlids which also arose from a common ancestor and evolved into hundreds of species which exhibit morphological, behavioural and reproductive differences and utilise different ecological niches in the fresh water lakes.

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Why funding fruit fly research is essential for the biomedical sciences

Andreas Prokop, Head of the Manchester Fly Facility, explains how fruit fly research generates knowledge important for understanding many human diseases

For 30 years I have been studying the nervous system of the fruit fly *Drosophila melanogaster*, the tiny insect that hovers over our fruit bowls in summer (Prokop, 2016). You may wonder why anybody would invest professional time or public money in something that seems more of a private hobby than serious research. But I am not alone: the fruit fly has been intensively studied for over 100 years and worldwide over 10,000 scientists are currently estimated to engage in fly research; and their work has great impact: nine (arguably ten) researchers have received a Nobel Prize in 'Physiology or Medicine' for their work in *Drosophila* – the last one as recently as 2017 (Fig. 1). As I will argue here, the biomedical sciences would be very far behind their current status quo without research in fly or other simple organisms, such as the nematode worm *C. elegans* or baker's yeast.

Why the fly? A historical perspective

Kick-starting genetics

Mere serendipity set in motion the long-lasting interest in the fruit fly: in 1910, studies on evolution by Thomas Hunt Morgan led to the almost accidental finding that genes lie on chromosomes. This started the era of genetics – with *Drosophila* research leading the field unravelling how genes are organised, become mutated or interact with each other (Allchin, 1997; Brookes, 2001; Kohler, 1994).

Genetics as a tool

In the middle of the 20th century, researchers started to use *Drosophila* genetics to address the essential question of how genes work and determine biology. In the same way, as mutations in humans cause inherited diseases that tell us something about the biological relevance of those genes, mutations can be used in *Drosophila* research as a tool to dissect and understand biological processes. The fly was ideal because genetic

manipulation techniques were well established, its generation cycle of only 10 days allowed fast progress, and the ease of keeping big numbers of flies facilitated systematic 'mutational screens' to search for new genes that contribute to biological processes (Fig. 2). *Drosophila* became "a boundary object par excellence, residing in the interstices of two major disciplines, genetics and embryology" (Keller, 1996).

Together with the advent of molecular biology (to decipher and manipulate genes) and advances in biochemistry (to study the protein products of genes), fly research turned into a gold mine for discovery. For example, genes that mediate embryonic development, nervous system function or even the ability to learn were discovered and studied, pioneering fundamental understanding of those processes (Mohr, 2018).

"Fly research turned into a gold mine for discovery... genes that mediate embryonic development, nervous system function or even the ability to learn were discovered and studied"

A translational path to humans

Through parallel work in vertebrate animals, in particular the mouse, it became increasingly clear that fundamental concepts discovered in the fly seemed to apply to all animals: genes studied in mammals turned out to be very similar in structure and function to their fly equivalents; in some cases, it was even shown that genes from fly and mouse were interchangeable. The scale of this 'evolutionary conservation' became clear when the human and fly genomes were sequenced and compared. Ethan Bier and colleagues reported at the time that 77% of 714 distinct human disease genes matched unique *Drosophila* sequences (Reiter et al., 2001). The fundamental truth behind this statement was unequivocally documented by a systematic study



Fig. 1: Researchers awarded the Nobel Prize for work on *Drosophila* in 1933, 1946, 1995, 2004 (only marginally for fly work), 2011 and 2017.

in yeast using 414 strains with lethal mutations, of which almost half could be ‘cured’ by introducing the equivalent human gene (Kachroo et al., 2015; Leslie, 2015). Therefore, the fundamental processes of biology and the genes involved are ancient; organisms that shared their last common ancestor a billion years ago have maintained many of these fundamental functions to astonishing degrees. This concept of ‘deep homology’ explains the above mentioned Nobel laureates: through their work, they have laid foundations for a fundamental understanding of biological processes which can explain to us what goes wrong in human disease and pave the translational path into the quest for cures.

The importance of *Drosophila* research is undiminished

The last decades have brought new strategies for research in mice and other vertebrate animals that have now turned also these organisms into true boundary objects. The fairly recent advent of CRISPR technology is seen as the magic silver bullet that has

finally closed the experimental gap to research in smaller invertebrate models. However, I would argue that this is a dangerous misconception likely leading to increased research costs, the unnecessary use of animals and a slow-down in scientific advance.

“In the middle of the 20th century, researchers started to use *Drosophila* genetics to address the essential question of how genes work and determine biology. In the same way, as mutations in humans cause inherited diseases that tell us something about the biological relevance of those genes, mutations can be used in *Drosophila* research as a tool to dissect and understand biological processes.”

Hugo Bellen was cited to have said: “You get 10 times more biology for a dollar invested in flies than you get in mice” (Levitan, 2015). To illustrate this point, keeping 400 fly stocks requires one stand-alone incubator and £100 a month to pay for food vials and four to six hours of work (Fig. 3); maintaining the same number

of mouse strains readily accessible would take at least £12,000 a month and a vast housing facility.

Furthermore, CRISPR technology certainly has enormously accelerated mouse research, but it is also well established in *Drosophila* and has enhanced the possibilities of fly research to the same degree. Many more arguments can be listed (Prokop, 2015), but I would like to focus here on one last, enormously important aspect: the fact that biology is complex.

Thus, to understand inherited diseases, it is often not sufficient to gain important knowledge of the affected genes and their products; it requires an understanding of the usually complex functional networks in which they operate (Prokop, 2016). An important strategy to unravel complex genetic networks is the simultaneous manipulation of two or more genes in the same individual – a task that is routinely performed in a fly laboratory, but enormously laborious and time-consuming in mice.

"Work in fly gives access to flexible experimentation, where try-and-error is a feasible strategy to overcome the challenging enigmas posed by biological complexity."

Furthermore, experiments, even if based on well-informed rationale, often fail. In fly, such failure is unfortunate but can be easily absorbed, since time and money invested are usually low, with alternative experiments being set up in a matter of days or weeks rather than months or beyond. Hence, work in fly gives access to flexible experimentation, where try-and-error is a feasible strategy to overcome the challenging enigmas posed by biological complexity.

Conclusions

Understanding biology is the lifeblood for translational research into human disease and, as I have argued here, *Drosophila* research is a powerful generator of such understanding. Certainly, the fly is NOT a mini-human. For example, it cannot be used to study arthritis or fibrosis, but it can be used to understand fundamental concepts of extracellular matrix regulation underlying those problems. In the context of Alzheimer's disease, flies are unsuited to study personality loss but can be used to address the still unresolved

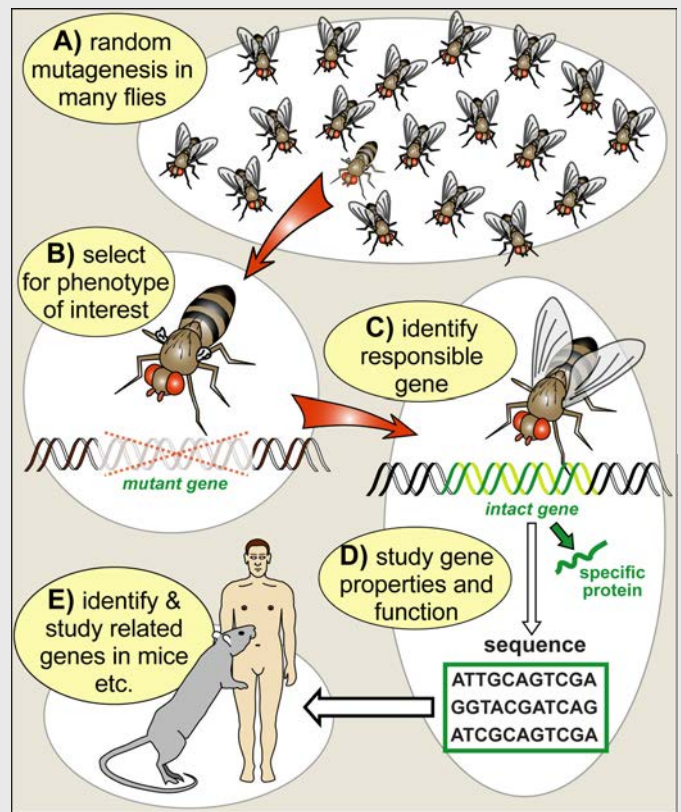


Image: © Andreas Prokop, Sanjay Patel, Joshua Heafield

Fig. 2: Flies as an efficient starting point of a translational pipeline towards medical research

important question of how this condition triggers nerve cells to die. In any case, the choice of experimental models should always be carefully justified. Consequently, funding panels should, in my opinion, more often question the uses of higher animals where fundamental concepts could be pioneered more efficiently in simpler models – thus spending research money responsibly and speeding up the discovery process. ■

The author, Andreas Prokop, is Professor for Neurobiology at The University of Manchester. As academic head of the 'Manchester Fly Facility' he drives a science communication initiative advocating the wider awareness of [fly research](#). Part of this initiative is the '[drosos4schools](#)' project aiming to establish *Drosophila* also as a powerful teaching tool in school biology lessons. The author would like to thank Tom Millard for his helpful comments on the manuscript.

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Fig. 3: Maintaining and handling flies in the laboratory. (A) A ~10 cm high vial containing flies. (B) 400 different fly stocks kept in one incubator. Genetic crosses are performed under a stereo microscope (C) on CO₂-dispensing porous pads (D) to carefully inspect the immobilised flies (E).

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Developmental biology: Electrogenic cells in a gymnotiform fish

Graciela A. Unguez, PhD at Professor of Biology at New Mexico State University argues that electrogenic cells in a gymnotiform fish retain a skeletal muscle transcriptome, but they are not muscle cells in this fascinating example of developmental biology

Embryological, molecular and genetic studies in vertebrates have revealed a highly conserved process of generating skeletal muscle cells. In all species of mammals, birds, fish, reptiles and amphibians studied to date, precursor cells are induced to differentiate to form skeletal muscle by the activation of a small number of core myogenic regulatory factors (MRFs) belonging to the MyoD family of transcription factors¹⁻⁴. All four MRF members, i.e., MyoD, myogenin, myf5 and MRF4/myf6, have been isolated and studied in different vertebrate embryos.

Although the number of copies of these MRFs and their temporal expression patterns during muscle differentiation can differ considerably between species, it is clear that formation of skeletal muscle cells requires MRFs¹⁻⁴. Parallel studies using different vertebrate systems are providing fundamental knowledge of the transcriptional and signalling mechanisms of the MRF-dependent myogenic programme.

Reports that some MRFs are detected in non-contractile cells like the electrical conductive cells of the heart (or Purkinje fibres) in birds and frogs⁵, the myoid cells of the thymus and myofibroblasts in mouse⁶⁻⁷ and the electrogenic cells (or electrocytes) of the electric organ (EO) in electric fish⁸ are considered rare exceptions. We inves-

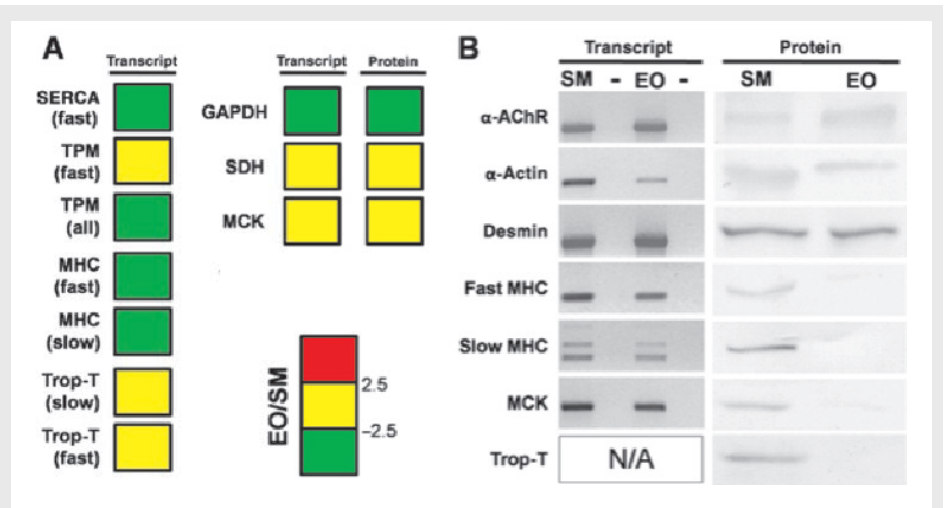


Figure 1. Some muscle genes exhibit post-transcriptional regulation in *S. macrurus* myogenic tissues. The abundance of contraction-associated and metabolic transcripts was determined in EO relative to skeletal muscle (SM) by quantitative RT-PCR. The expression of metabolic proteins was determined in EO relative to SM using western blotting. Coloration indicates a higher abundance in EO (>2.5 times, red) or in muscle (>2.5 times, green), or a similar abundance in the two tissues (<2.5 times difference between EO and SM, yellow).

tigated the transcriptional regulation of the electrocyte phenotype by MRFs in the gymnotiform *Sternopygus macrurus*. Specifically, we determined the expression profiles of target muscle genes with MRF binding sites tested for activation by MRFs.

Our analysis showed similar levels of these muscle transcripts in EO and skeletal muscle (Fig. 1)⁹. The detection of transcripts for these contraction-associated genes in EO was unexpected given that protein expression studies using mammalian antibodies against muscle creatine kinase, troponin-T and all isoforms of sarcomeric myosin heavy chain failed to detect these proteins in EO lysate (Fig. 1) and mature electrocytes (Fig. 2)⁹.

We have also performed an expression analysis using qRT-PCR informed by deep RNA sequencing of transcriptomes of muscle and EO tissues from adult *S. macrurus*¹⁰. Our data showed that:

- Components associated with the homeostasis of the sarcomere and sarcomere-sarcolemma linkage was transcribed in EO at levels similar to those in muscle; and
- MRFs associated with activation of the skeletal muscle programme were not differentially expressed between these tissues.

Together, these data indicate that the down-regulation of the muscle pheno-

type in EO is not predominantly controlled at the transcriptional level by MRFs. Instead, electrocytes in *S. macrurus* appear to have evolved from striated muscle cells wherein the muscle programme may be under the regulation of non-coding RNAs (long non-coding RNAs, microRNAs) to repress the gene expression that gives rise to the contractile phenotype.

Funding sources: This research supported by NIH grant 1SC1GM092297-01A1 and NSF INSPIRE Award CNS-1248109 and HHMI Science Education Program, Grant 52008103.

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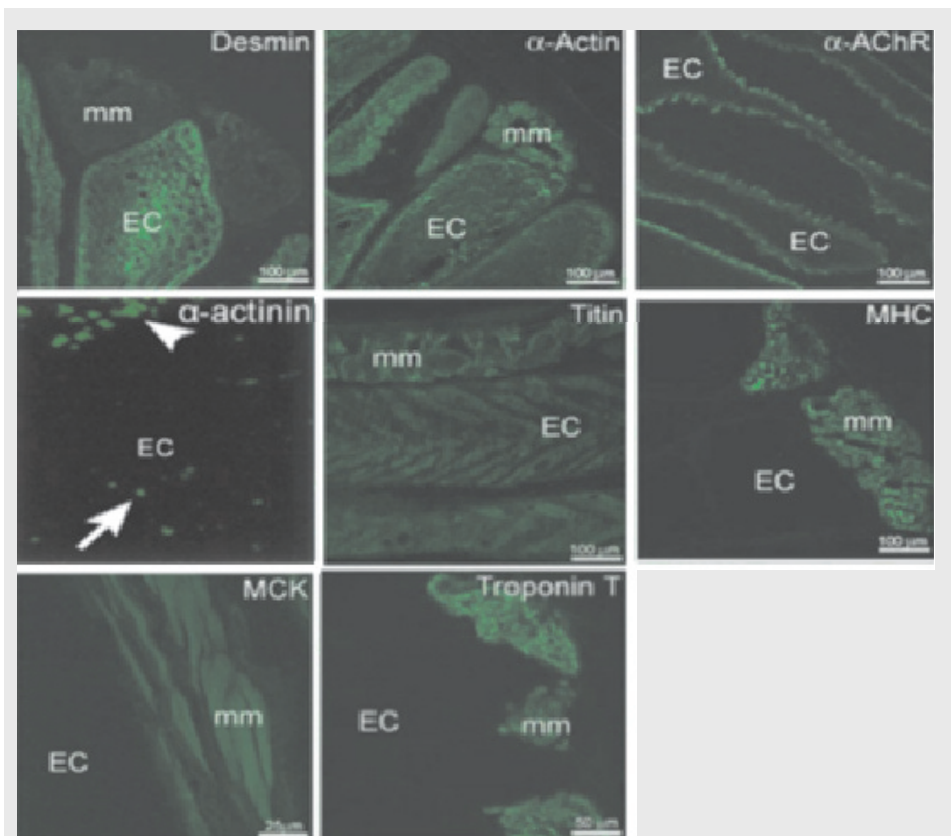


Figure 2. Muscle proteins in electrocytes of *S. macrurus*. Immunolabeling for muscle proteins (green) reveals staining of electrocytes (ECs) (arrow in α -actinin panel) for desmin, α -actinin, α -acetylcholine receptor (AChR), α -actinin, and titin but not for myosin heavy chain (MHC), muscle creatine kinase (MCK) or troponin-T. mm, skeletal muscle fibers.

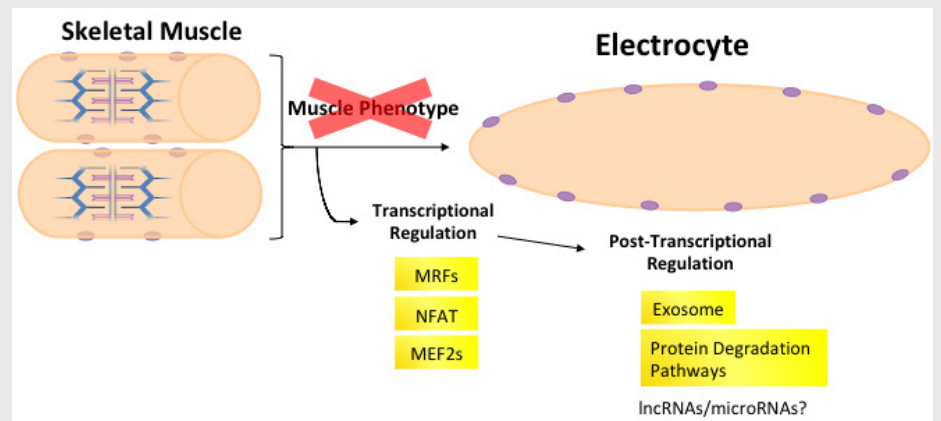


Figure 3. Overview of expression of transcripts associated with regulation of muscle gene expression in muscle and EO of *S. macrurus*. Electrocytes are large, cigar-shaped, multi-nucleated and do not contain sarcomeres, but express all transcripts that code for sarcomeric proteins, muscle-specific transcription factors, and protein-degradation genes at levels similar to those in muscle.

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All About Discovery![™]
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Promoting excellence in U.S. STEM education

The important mission of the National Science Foundation when it comes to fostering excellence in undergraduate science, technology, engineering, and mathematics (STEM) education for all students in the U.S. is placed under the spotlight by Open Access Government

The mission of the Undergraduate Education (DUE) division within the National Science Foundation (NSF) is to “promote excellence in undergraduate science, technology, engineering, and mathematics (STEM) education for all students.”¹

It is worth noting that this division falls under the work of the Education and Human Resources (EHR) division, the aim of which is nothing but the achievement excellence in U.S. science, technology, engineering and mathematics (STEM) education at every level and in all settings (both formal and informal). The thinking behind this is to foster the progress of a well-prepared and diverse workforce of engineers, scientists, technicians, mathematicians and educators. “The purpose of these activities is to enhance the quality of life of all citizens and the health, prosperity, welfare and security of the nation”, they add on their website.

One important goal of the Undergraduate Education (DUE) division is to get the next generation of STEM professionals ready and to retain and attract more Americans towards STEM careers, we discover. Going into further detail, capacity-building strategies in this vein are four-fold:

1. To identify the means to prepare and support teachers who can challenge and inspire students in the STEM disciplines and provide them with effective strategies and materials for learning;
2. To invest in research on learning, to facilitate the translation of research into practice and to foster supportive learning environments and STEM pathways by various means including networking, partnerships, alliances and collaborations.

3. To make sure that the STEM community is broadly representative of America’s geographic regions, individuals, types of institutions and STEM disciplines plus;

4. To identify effective ways (formal and informal) to address the STEM knowledge requirements of adults, to help them be both informed and active citizens, as well as productive members of the workforce.²

“NSF INCLUDES was conceived as a sustained effort, a recognition that a problem as complex as the need to broaden participation in STEM requires a long-term, collaborative approach. After laying the groundwork through pilot projects, NSF INCLUDES is taking a significant step toward creating a national network with these new awards.”

Funding to advance STEM graduate education training

In terms of a concrete example of how the mission of the Education and Human Resources (EHR) division is put into practice, we need to look no further than a recent news story that details funding announced to advance STEM graduate education training.

Announced in early September 2018, we discover that the National Science Foundation’s (NSF) Innovations in Graduate Education (IGE) programme awarded \$5.8 million to fund 12 new projects. These projects will pilot, test and validate innovative approaches in STEM graduate education.

Jim Lewis, NSF acting assistant director for Education and Human Resources offers his thoughts on these new investments in terms of how they will help to respond to the needs of the STEM workforce.

“These investments by NSF will help us identify advances in graduate education that address current and future STEM workforce needs. We have an opportunity to test innovative strategies in STEM graduate education to underscore the importance of interdisciplinary and broader professional training. Our goal is to identify educational methodologies and elements that will result in scientists that are ready to meet grand challenges in science and engineering.”

One point to add here is that the projects discussed above encompass many divergent areas in graduate education, but what they all have in common is that they aim to investigate approaches that could be scaled for use at other institutions throughout the U.S. It is worth noting that current research areas place the spotlight on graduate students’ professional identities, advancing community and industry engagement, “human-centred thinking” in engineering education and strategies that encourage diverse student success in the STEM disciplines.³

You can learn more about the projects discussed [here at this link](#).

Leadership in science, technology, engineering and mathematics (STEM)

Looking at recent news from the Undergraduate Education (DUE) division, we find out that the NSF announced new awards in early September that represent the next major step for its programme, NSF INCLUDES. This endeavour concerns the development of a national network to enhance the country’s leadership in science, technology, engineering and mathematics (STEM) by broadening participation in these disciplines.

We know that the U.S. innovation economy requires skilled STEM workers to maintain the country’s status as a global leader in this area. This is very much supported by NSF Director France Córdoba, who explains the thinking behind this programme.

“NSF INCLUDES was conceived as a sustained effort, a recognition that a problem as complex as the need to broaden participation in STEM requires a long-term, collaborative approach. After laying the groundwork through pilot projects, NSF INCLUDES is taking a significant step toward creating a national network with these new awards.”

For many years, the NSF along with its partners have sought to create opportunities in the STEM disciplines for all U.S. residents, no matter who they are or where they come from so that they benefit from access to education and employment. We end this article on this vital point, in the words of Córdoba.

“NSF INCLUDES addresses populations largely missing in the current science and engineering enterprise. Their inclusion is essential in helping the U.S. maintain its position as the world’s leader in innovation. Through NSF INCLUDES, we are funding researchers and others who have great proposals that would move the needle.”⁴ ■

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Environmental undergraduate research: Creating a generation of citizen scientists one local problem at a time

On environmental undergraduate research, Professors Tom Landerholm and Kelly McDonald discuss their plan to focus all of their students on the research needed for a local river to recover

When we as citizens look around the world today there are many concerns that make us pause. The growth of populations, socio-political strife, the destruction of the natural environment, exposure to toxic materials at home, at work and to those we love. We see these changes everywhere, from local regions with unique ecologies and politics to competing needs for large swaths of oceans and rainforests, to changes in global economics and climate.

When we as scientists look around the world today we understand that now is not the time to pause. These many concerns lead to an increased need for evidence-based policy, citizen scientists and environmental stewardship. Towards this, STEM leadership across the globe calls for training students at every level in the way that working scientists and engineers do business and with a sense of stewardship. Thus, creating a new generation of citizens capable of exploring, monitoring and remediating our impacts on the world. Yet today, and not for the first time, we are faced with reduced science budgets and an increased politicising of science. So, how do we navigate through these unsettled waters? How do we tackle so many problems with so few resources? How do we give new generations the tools to address the problems of the 21st century?

The SIRIUS Project: A model for doing real science in any classroom

California State University, Sacramento is creating a model that balances these competing needs, called Sustainable Interdisciplinary Research to Inspire Undergraduate Success. This is a model for sustainable science performed at relatively low cost. This is science aimed at local, regional or global problems performed as part of the standard training for every STEM student. To do this, all students must be encouraged to inquire and discover, understand the relevance of their work beyond the classroom, fail and repeat their work – just like a working scientist.

The SIRIUS Project began by redesigning biology classes to collect and analyse real data about the American River that runs through our campus. This urban river has been listed as ‘impaired’ since the 1970’s. We started our students with monitoring changes in ecological relationships, bacterial diversity and toxicology along the river. Following a classroom model called Course-based Undergraduate Research Experiences (CUREs), we integrated twelve courses along these three threads from our intro series through our advanced courses. Importantly, few courses modified their entire semester. Most developed a module encompassing a few weeks, usually changing concepts that they

were already trying to teach into river investigations.

Since then, we have added six courses in Chemistry, Geology and Environmental Studies that allow us to collect abiotic data (temperature, pH, potential toxin levels, etc.) to go with our biological data, to compare surface water with groundwater reservoirs and to add human risk assessment to our toxicology studies. Our next goal is to incorporate all of the STEM disciplines at Sacramento State and our four local community college campuses. More STEM disciplines mean more interdisciplinary engagement and better solutions to the problems we face. Engaging all STEM undergraduates in Sacramento will give our scientist-teachers more than 6,000 pairs of hands each semester to work towards a resolution. But even this may be too narrow a view. What might the students training in policy, law, recreation studies, etc. add to the work of SIRIUS? What problems do other communities face that could be studied and, perhaps, resolved by their local educational institutions?

A diversity of inputs leads to better solutions

Scientific American (2014) points out that: “Decades of research by organisational scientists, psychologists, sociologists, economists and demographers show that socially diverse groups (that



 SACRAMENTO STATE

is, those with a diversity of race, ethnicity, gender and sexual orientation) are more innovative than homogeneous groups.” An important aspect of the SIRIUS Project is our specific goal to train 100% of our STEM undergraduates to do research. The traditional training of researchers involves apprentice-style training in the laboratory of an established investigator. However, limited resources mean that there is inequality in the distribution of these opportunities. Most occur after hours or during summer breaks, a time when many undergraduates must work. Most go to students who have financial help from families, excel academically and already know about the benefits of research. This has severely limited the diversity in STEM, from the professorship down to each graduating class. Hence, redefining these opportunities is critical to this innovative diversity.

Help getting started and the sky is now the limit

SIRIUS is a project that can, essentially, be replicated by any college or university. Once the CUREs are established, the research can evolve and be sustained with normal course budgets. Each institution must assess their needs and seek funding to establish their CUREs. At Sacramento State, a primarily undergraduate institution, our biggest needs were in training faculty to design and implement CUREs and in retrofitting teaching laboratories with equipment to carry out the relevant science. The Division of Undergraduate Education at the National Science Foundation (NSF) provided the time and resources for training faculty and the Major Research Instrumentation program at NSF and the Undergraduate Education Program at the W.M. Keck Foundation in Los Angeles, CA provided grants to purchase equipment.

Now our only question is: How many colleges, teachers and students does it take to change the world?



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Transforming chemical discovery and innovation

The National Science Foundation's Division of Chemistry (CHE) aims to be a global leader in transforming chemical discovery and innovation, as Open Access Government finds out

The Division of Chemistry (CHE) supports research in chemical sciences and works to advance education through strategic investment in developing a globally-engaged chemistry workforce that reflects the diversity of the United States.

It encourages chemists to lead multi-disciplinary efforts to expand human knowledge and address societal problems, both short and long-term. The CHE also has a major role in communicating the value of chemistry to the public.

As part of the National Science Foundation (NSF), the CHE has awarded millions of dollars to support research initiatives in all 50 states. California has the received the most funding, with \$173.9 million distributed to 251 projects.

Recent research backed by the CHE has helped scientists at the University of Oregon and Oregon State University to detect previously unknown triggers for toxicity in nanomaterials caused by an automated system designed to speed up their delivery for testing in fish.

In the early days of nanotechnology, toxicologists' hand-delivered microscopic nanoparticles using pipettes for exposure to zebrafish. Based on that approach, the four-member research team found that individually, the widely used mix of inorganic nanoparticles and surfactants - compounds that reduce surface tension in liquids to improve mixing - were not toxic.

However, automation - using devices similar to inkjet printers to rapidly inject materials employing small amounts of surfactant to control the size of the delivered droplets - created a synergistic, or multiplying, the effect that triggered toxicity. In testing, there was an 88% mortality rate among zebrafish embryos.

While it is not yet clear if the new-found toxicity could pose a threat to human health, the research, which was published in the journal ACS Nano, has been described as a "wake-up call" that could ultimately help the cutting-edge field of nanotechnology to advance.

Study co-author Jim Hutchinson of the University of Oregon's Department of Chemistry & Biochemistry says: "Years after showing that these materials were the most benign and among the least toxic materials that we've ever seen, we did these experiments with the surfactants and found that, in this case, they were toxic.

"With an annual budget of \$7.5 billion, the NSF supports around a quarter of all federally supported basic research conducted in America's colleges and universities."

"This isn't the first time that people have seen mixture toxicity, but it does remind us that two safe things mixed together doesn't mean the mixture is safe."

Elsewhere, CHE-backed researchers at New York University (NYU) recently discovered new molecular properties of water.

Liquid water is known as an excellent transporter of its own autoionisation products - the charged species when a water molecule (H₂O) is split into protons (H⁺) and hydroxide ions (OH⁻). Indeed, life itself would not be possible without this property.

For nearly a century, it was thought that the mechanisms by which water transports H⁺ and OH⁻ ions were mirror images, except for the directions of the hydrogen bonds in the process.

However, state-of-the-art theoretical models predicted a



fundamental asymmetry in the mechanisms. If correct, this could allow systems to be tailored to favour one ion over another – but the experimental proof was hard to come by because of the difficulty in observing the two iconic species.

A team at NYU, led by Professor Alexei Jerschow successfully demonstrated the asymmetry with a novel experiment whereby water was cooled to its so-called temperature of maximum density - a point just above freezing at which asymmetry was expected to be strongest.

Using nuclear magnetic resonance methods, the researchers showed the difference in lifetimes of the two ions reaches a maximum value (the greater the lifetime, the slower the transport). By accentuating the difference in lifetimes, the asymmetry became clear.

“The study of water’s molecular properties is of intense interest due to its central role in enabling physiological processes and its ubiquitous nature,” says Professor Jerschow.

“The new finding is quite surprising and may enable deeper understanding of water’s properties as well as its role as a fluid in many of nature’s phenomena.”

Other projects backed by CHE funding have ranged from the discovery of a previously unknown mechanism in DNA that governs whether viruses that infect the body will quickly kill their hosts or remain latent inside the cell to the synthesis of a new epilepsy medication that replaces the precious metals rhodium and dichloromethane with the much greener cobalt and methanol and the discovery of new fatty acids in vegetable oils - the first such discovery since the 1970s.

The CHE’s work certainly supports the wider aims of the NSF, which was established in 1950 to “promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence”.

With an annual budget of \$7.5 billion, the NSF supports around a quarter of all federally supported basic research conducted in America’s colleges and universities. ■

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Chemistry: The growing body of work on signaling within bacterial communities

Emily Weinert, Assistant Professor of Chemistry at Emory University discusses an aspect of chemistry that concerns the growing body of work on the human microbiome

The varied nature of bacterial interactions with humans, playing essential roles in many aspects of human health, as evidenced by the growing body of work on the human microbiome,¹ causing millions of cases of antibiotic-resistant bacterial infections each year,² and the role of bacteria in crop and environmental health, has illuminated the need for an improved understanding of bacterial physiology. In particular, understanding the mechanisms by which bacteria sense their environment and alter cellular pathways to maximise survival has the potential to identify new chemical signals and macromolecular signalling cascades that can be targeted to modulate bacterial phenotypes, including growth and competition. However, our knowledge of the chemistry underlying many of these processes is still very minimal, despite the fact that understanding these pathways dictates our ability to rationally develop new methods to alter bacterial phenotypes.

To advance our knowledge of bacterial chemical sensing and signalling networks, extensive studies are needed to identify small molecules and proteins that bacteria use to respond to their environment. In addition, identifying other proteins involved in the signalling pathway and mechanisms of intercommunication between different sensing/signalling pathways is necessary to generate a holistic view of bacterial cellular function.

Without this fundamental knowledge, it is extremely challenging to predict how bacteria will respond to external stimuli, especially with regards to understanding what other pathways might interact, potentially muting or amplifying the phenotypic response. Generating this complex picture requires many types of experiments, from whole-cell methods that identify global effects, such as RNAseq and proteomics, to *in vitro* studies using purified components that allow for a molecular-level understanding of sensing mechanisms.

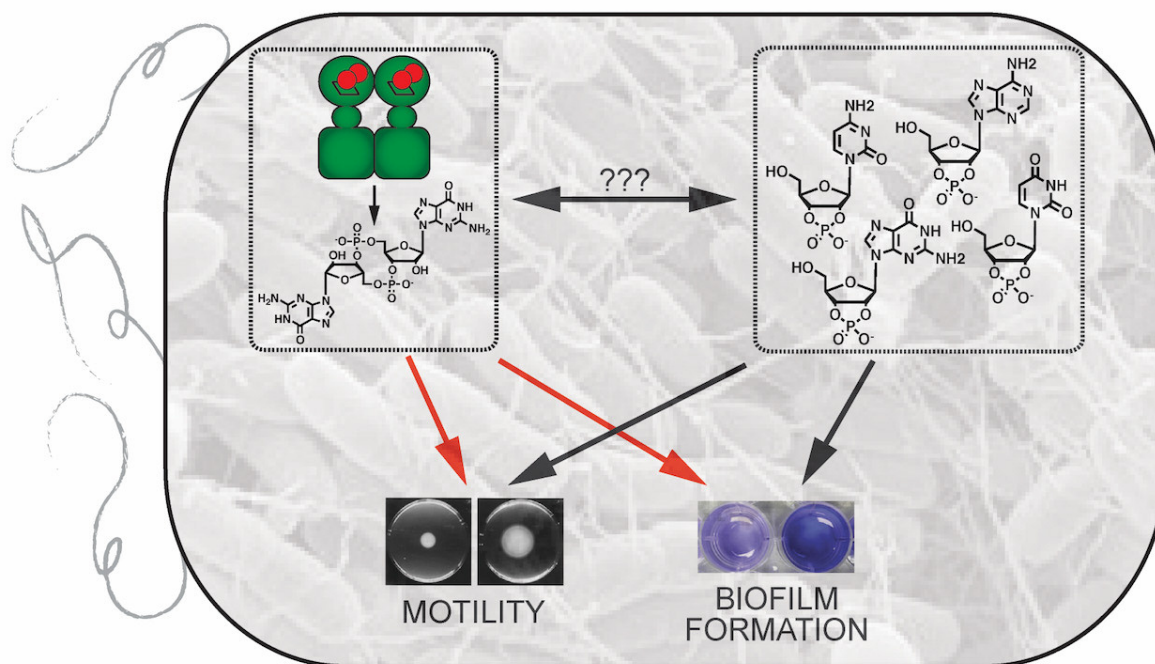
“Besides the potential identification of targets for the development of new anti-bacterial treatments, these types of studies can also provide insights into previously unexplored mechanisms of signal transduction and bacterial signalling pathways, improving our fundamental understanding of bacterial signalling.”

In my group, we are working to elucidate new bacterial signalling pathways using either a putative bacterial protein or small molecule as our starting point. To do so, my group has undertaken two interconnected projects involving previously understudied bacterial signalling pathways: 1) the mechanism and role of oxygen-sensing by diguanylate cyclase-containing globin coupled sensor (GCS) proteins and 2) the metabolism and cellular effects of 2',3'-cyclic nucleotide monophosphates (2',3'-cNMPs). By focusing on two differ-

ent cyclic nucleotides found in bacteria, we can link results from our studies and provide insight into not only the individual pathways but the interlinked responses as well.

Towards this end, my group has focused on understanding signal transduction and downstream signalling for diguanylate cyclase-containing GCS proteins that serve as bacterial O₂ sensors, since diguanylate cyclase produce cyclic dimeric guanosine monophosphate (c-di-GMP), a bacterial second messenger that controls biofilm formation.³ Working with a soft rot-causing plant pathogen, *Pectobacterium carotovorum*, we have demonstrated that the GCS protein controls O₂-dependent motility, virulence factor production and the rotting of a plant host, highlighting the importance of GCS signalling for controlling key bacterial phenotypes.⁴ To understand how GCS proteins function, we have used a variety of biochemical, spectroscopic and microbiological techniques to show that O₂ binding causes conformation changes that alter GCS oligomerization and diguanylate cyclase activity.⁵

Furthermore, we have identified interfaces and residues involved in transmitting the O₂ binding signal, which provides a starting point for developing tools to alter GCS activation. By providing key insights into signal transduction within GCS proteins, this work has improved our



understanding of heme-based sensors and ligand-dependent signal transduction and has highlighted GCSs as potential new targets for antibacterial therapies.

Building on our interest in bacterial nucleotide signalling pathways, another project is focused on 2',3'-cNMPs in bacteria and has allowed us to begin to identify proteins involved in 2',3'-cNMP metabolism and downstream effects. The presence of 2',3'-cNMPs in cell extracts was reported in the 1960s,⁶ but the results of those studies were discounted as artefacts of the extraction procedure shortly thereafter.

While quantifying 3',5'-cNMP levels in various rat tissues, we discovered 2',3'-cNMP isomers in rat organs, mammalian cells and *Escherichia coli*,⁷ providing an intriguing starting point to delve into the cellular chemistry and signalling of these nucleotides. By identifying the enzyme responsible for producing 2',3'-cNMPs in *E. coli* and developing (bio)chemical tools to regulate 2',3'-cNMP levels, we have demonstrated that these rediscovered cyclic nucleotides are generated during

cytoplasmic RNA degradation and regulate bacterial biofilm formation and motility,⁸ suggesting potential interplay with c-di-GMP signalling pathways, which also regulate those phenotypes.

Our ongoing studies are focused on dissecting the cellular machinery related to 2',3'-cNMPs, elucidating novel RNA decay pathways and highlighting novel stress-sensing pathways within prokaryotes, which may allow the 2',3'-cNMP pathways to be engineered to control bacterial proliferation and virulence.

By identifying new molecules, proteins and pathways involved in bacterial signalling, the field can provide insights from the molecular to the organismal level, highlighting key bacterial phenotypes controlled by small molecules and the interplay between bacterial signalling pathways. Besides the potential identification of targets for the development of new anti-bacterial treatments, these types of studies can also provide insights into previously unexplored mechanisms of signal transduction and bacterial signalling pathways, improving our fundamental understanding of bacterial signalling.

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The challenges ahead in chemical sciences

Open Access Government lifts the lid on the greatest challenges facing those working in chemical sciences in the UK, as well as the opportunities ahead and a glimpse at promoting heterocyclic chemistry of every kind

The Royal Society of Chemistry in the UK believes that the chemical sciences are essential in today's changing and complex world, in that they are essential to our daily lives and will be vital in our response to some of the biggest challenges we face.

Looking at one aspect of their work, we know that there are many divisions & interest groups within the Royal Society of Chemistry, which can be defined as, vibrant communities of individuals with interests across the spectrum of chemical sciences. These divisions advise on areas of science policy and support the development of research and training within their

field. One of many examples of this is the Heterocyclic and Synthesis Group, which like the other interest groups, is member-driven and exists for the wider chemical science community as well as the Royal Society of Chemistry.

The Heterocyclic and Synthesis Group aims to promote heterocyclic chemistry of every kind by means of scientific meetings. They believe that heterocyclic chemistry is interpreted in its broadest sense and that their Interest Group is closest to mainstream synthetic organic chemistry. In their view, the following themes have been prevalent in recent years:

- The synthesis and reactivity of heterocycles including mechanistic studies;
- Practical applications of heterocyclic compounds;
- Total synthesis and;
- Heterocyclic intermediates and reagents. ⁽¹⁾

Challenges and opportunities in chemistry

Picking up on the theme of challenges in the field of chemistry, some of these were explored in a recent interview with the Royal Society of Chemistry's past-president, Professor Sir John Holman, who spoke to deputy chief executive, Paul Lewis. When it comes to the greatest challenges for the UK's chemistry community during the next couple of years, Sir John Holman draws our attention to preparation for the outcomes of the UK leaving the European Union (EU). He adds that research today is becoming more interdisciplinary in nature and that boundaries between the traditional science subjects are blurring. He develops the latter point, as well as outlining future opportunities in the field.

“The Heterocyclic and Synthesis Group aims to promote heterocyclic chemistry of every kind by means of scientific meetings. They believe that heterocyclic chemistry is interpreted in its broadest sense and that their Interest Group is closest to mainstream synthetic organic chemistry.”

“This is fantastic for scientific research and is leading to new fields of study that are already making ground-breaking progress in tackling global challenges such as energy production and antimicrobial resistance. We need to make sure we represent the chemical sciences in the broadest possible terms, while still upholding exemplary standards of professional practice.

“As well as challenges, we have huge opportunities in front of us. We've recently announced an exciting “Read & Publish” agreement with leading U.S. university MIT, to support them towards their open access goals, as we do for partners in a growing number of countries around the world. As a not-for-profit publisher, our aim

is to build a sustainable, long-term model to both disseminate chemical science research and information, as well as continuing to support our purpose-driven activities.”

Professor Sir John Holman says that he looks forward to seeing a step change in the approach of the chemistry community in supporting diversity and inclusion, which he believes can be done by building a fully inclusive pipeline of future chemical scientists. This, he believes, will open up more routes into chemistry for those from diverse backgrounds. He explains more on this point, plus his hopes for the future of pushing forward the fantastic opportunities that can be found in the field of chemistry.

“Diverse teams produce better science and it would be fantastic to see our community taking a lead in this area...I am now very much looking forward to working with our incoming president, Professor Dame Carol Robinson. Carol's career path – from technician to the top level of academia shows what can be achieved by opening up to all, the fantastic opportunities available across the chemical sciences.” ⁽²⁾

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Antimicrobial resistance challenged by flexible heterocyclic chemistry

Prof Colin J Suckling OBE DSc FRSE, Research Professor of Chemistry at the University of Strathclyde shares his expertise on antimicrobial resistance (AMR) and how this is challenged by flexible heterocyclic chemistry

Antimicrobial resistance (AMR) is a buzz-tag these days. Everyone has heard of superbugs or the antibiotic apocalypse. But few people are lucky enough to have the opportunity to do something about it with their own work. When Roger Waigh and I started the Strathclyde Minor Groove Binders (S-MGBs) project seeking new anti-infective compounds more than ten years ago, we did not plan or expect that our project would develop to involve collaborators worldwide and have significance for human and animal health with applications to treat bacterial, fungal and parasitic diseases. Nor did we expect that AMR would become so topical and political. We were, however, aware of the clinical need for new anti-infective medicines and of the scientific challenge of finding new strategies with a good chance of success. Prompted by the scientific literature and interactions with some small pharmaceutical companies, our S-MGB project took shape.

Roger and I knew that bacteria, for example, have many mechanisms by which they can become resistant to antibiotics. It, therefore, seemed sensible to us to attack them at several places at once so that if resistance to one attack arose, there would still be effective mechanisms lethal to the bacteria. Biologically, the target that determines everything, in the end, is

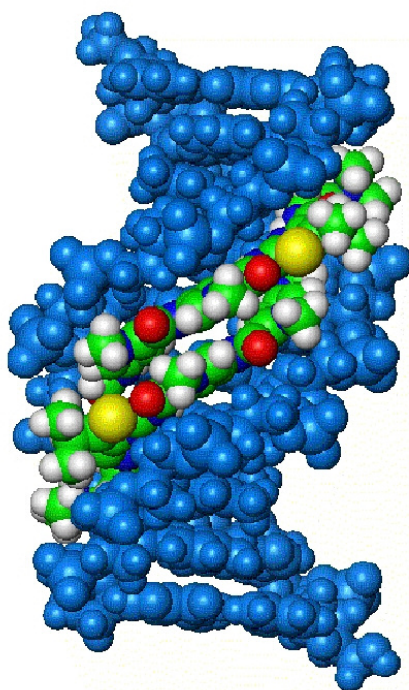


Figure 1. The double helix of DNA (blue) with two molecules of an S-MGB (green, white, red, yellow) bound in the minor groove. This model that came from spectroscopic studies supported our original detailed design concepts for the S-MGB project.

DNA. DNA had already been widely used as a target for anticancer drugs with some limited success and clearly had the potential for us. The second primary input was the group of heterocyclic compounds known as minor groove binders because they locate in that part of the DNA structure known as the minor groove (Figure 1).

Minor groove binders were first discovered as compounds made by

bacteria (some *Streptococcus* species) and they were shown to have a range of unselective biological effects including antibacterial and antiviral activity; one such compound was called distamycin. It was well established in the drug discovery game that an unselective naturally occurring compound could be transformed into an effective selective drug by carefully modifying its structure using the great flexibility available in heterocyclic chemistry. Although not anti-infective compounds, a landmark example of such structural transformation was the discovery of ACE Inhibitors, a class of drug used widely to treat high blood pressure and heart disorders.

Our challenge, therefore, would be to take the structure of distamycin and modify it to obtain compounds that would selectively kill infectious agents, be they bacteria, fungi, parasites or others, but not be toxic to the patients, be they human or animal. This is what the S-MGB project has been about. It is a risky strategy and one that the pharmaceutical industry would not readily take up itself. On the other hand, in my opinion, it is important that academic laboratories do not simply mimic what is done in industry and accept challenges with greater risk. Roger has now been retired for some time but I'm sure from our results now that he would be glad that we took the risk.

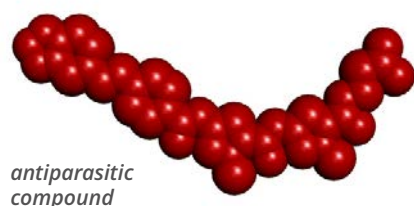
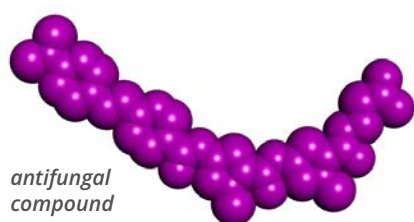
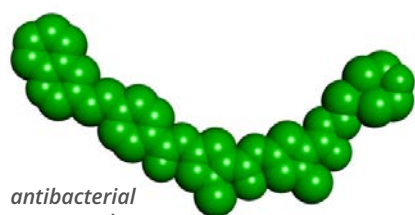


Figure 2 Three of the most important S-MGBs. Top (green) an antibacterial compound, middle (magenta) an antifungal compound, bottom (red) an antiparasitic compound. The detailed structural changes including shape and the specific atoms involved (not shown in this representation) give rise to the activity and selectivity.

What Roger and I both understood well at the start of the S-MGB project was that by making small changes in the structure of a minor groove binder we could substantially alter their biological properties. Over the years it has become clear that the basicity of an S-MGB and its shape, in particular, can have major effects on the biological activity causing changes in anti-infective potency, toxicity to

mammalian cells and solubility for formulation as a medicine. All three of these properties are at the top of the profile of requirements for a successful new drug. Figure 2 shows representations of three of our most important compounds. It is clear that they are all basically the same shape but that they have differences in detailed structure, most notably at the two ends.

I've selected the antibacterial, antifungal and antiparasitic activities in Figure 2 because in each case we have found compounds that meet or are close to meeting the requirements for a clinically useful compound. Indeed, in the antibacterial case, our most advanced compound has reached a Phase 2 clinical trial for the treatment of infections caused by *Clostridium difficile*. This trial is being sponsored and managed by our partner company, MGB Biopharma. The antifungal work is in partnership with Dr Mike Bromley at the University of Manchester (with funding from the MRC) and my former PhD student, Dr Fraser Scott, now at the University of Huddersfield. It's not well realised that the need for new antifungal drugs is as pressing as that for antibacterial drugs.

The antiparasitic S-MGB is a very promising compound for the treatment of animal African trypanosomiasis, a disease that affects cattle in sub-Saharan Africa leading to severe health and economic problems. We're working in partnership with Professor Mike Barrett at the nearby University of Glasgow in a major project that also involves the University of Edinburgh and is funded by BBSRC and GalvMed.

It's clear from the previous paragraphs that we need expert and supportive collaborators to make the S-MGB project work and to get ever closer to the market for new anti-infective drugs and the benefits they will bring. What heterocyclic chemistry brings is a flexible conceptual framework together with a practical technology to make the new discoveries possible. Our contribution as chemists is to bring both aspects into play using our skills and insight. This is where the fun is in working out the S-MGB project is and where the reward is in terms of its outcomes.



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The European Commission roadmap: Towards a More Comprehensive EU Framework on Endocrine Disruptors

Alberto Mantovani of Italy's Istituto Superiore di Sanità assesses the European Commission's efforts to develop a comprehensive and concise regulatory framework for endocrine-disrupting chemical substances

In June, an important public consultation took place: the European Commission (EC) sought feedback on its roadmap, *Towards a More Comprehensive EU Framework on Endocrine Disruptors*.

Endocrine-disrupting (ED) chemical substances alter the functions of the hormonal system and consequently cause adverse effects. As we already discussed in previous articles on Open Access Government, ED are a hot issue in the global scenario of chemical safety, due to multiple hazards, widespread exposure and the numerous uncertainties that hinder risk assessment and management.

The EC has acknowledged that ED are a main issue to protect human health and environmental quality since at least 2004 (the launch of the first EU Environment & Health Strategy). Nevertheless, the EC has been much criticised by stakeholders, such as environmentalist organisations and some Member States (for example, France and Sweden) because of its perceived slowness to take action.

Such criticisms were largely justified, even though ED are relevant to a broad range of regulatory fields (pesticides, biocides, environmental contaminants, food packaging, cosmetics, occupational health, etc.) Thus,

taking effective and consistent action toward ED may be rather complex.

Nevertheless, in the last three years, the ED issue has started to move at an increasing speed, spearheaded by the new regulatory framework of pesticides and biocides.

The new Communication from the EC sets out the ambition to provide a comprehensive, yet concise, EU framework on ED, describing key issues, taking stock of present achievements and outlining concrete steps for the future.

The Communication received 44 comments from institutions, associations and individual scientists. Some comments were quite strong, as – in my opinion – they failed to recognise that this Communication represents a step forward.

Unfortunately, most comments came from a narrow group of countries of Central and Northern Europe, as a significant part of the EU seems to be weakly involved in the debate.

We (the Italian National Health Institute, Dept of Food Safety, nutrition, veterinary public health) considered that overall, the roadmap can be a good (yet slow-coming) compromise among different driving forces. Our comments came from a careful read-

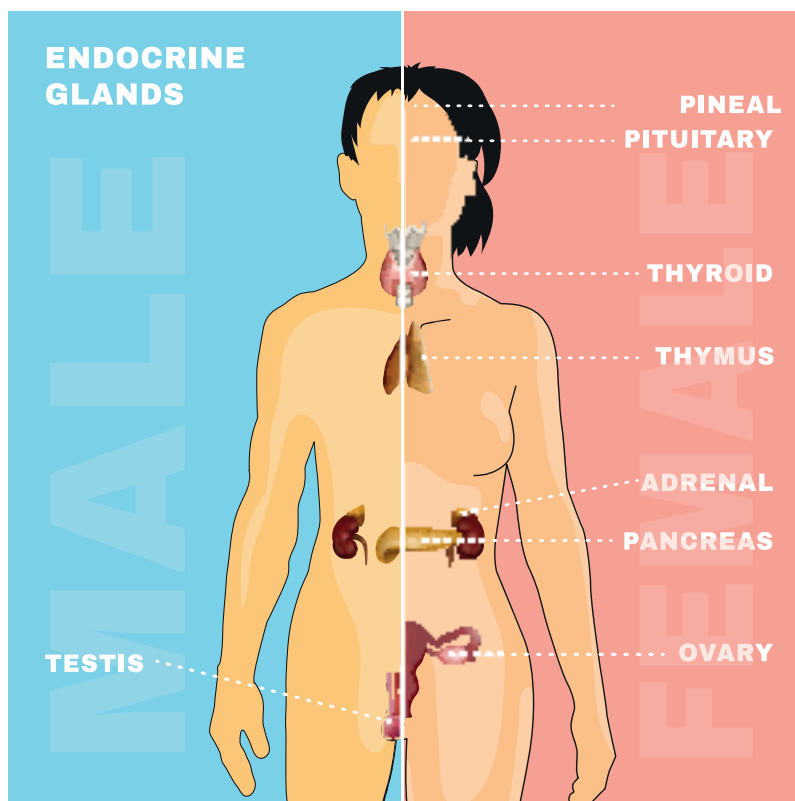
ing of the draft text because a devil might hide in the details.

In the section 'Problem the Initiative Aims to Tackle' (page 2 of the Communication), one point states: "Science on endocrine disruptors progresses quickly, but there are a number of scientific aspects that are not entirely understood."

The main research issue of concern for health services and citizens is the potential (and plausible) role of ED in some major public health issues such as cancer (breast, thyroid, testis) or diabetes and metabolic syndrome.

In our opinion, pointing out the potential involvement of ED in major public health problems, and the need for a science-based answer to the related concerns will strengthen the relevance of the actions foreseen in the roadmap for the benefit of all EU citizens, beyond the domain of chemical regulation.

Even more important, in the same section we strongly recommend avoiding the wording "extraordinary complexity" in regard to the concerns raised by ED: it seems to recall a hopeless situation which might only be dealt with either through straight precaution or by overlooking the problem. The consistent message of the roadmap should be that more



science, science providing effective inputs into the regulations and policies targeted to protection goals are expected to minimise the ED-related risks for health and environment.

Coming to 'What Does the Initiative Aim to Achieve and How' (page 3), we consider that there is a missing element between the two (well-defined) goals namely, addressing knowledge gaps and linking science and regulation. This additional goal can be identified as a robust and consistent testing and assessment strategy for ED, ensuring the adequate power to predict hazards for health and environment and reducing uncertainties. By making full avail of knowledge and technologies, testing can also be more efficient, ie, more cost- and time-effective, hence, delivering earlier responses to the requests by regulators, policy-makers and the public.

In fact, the development of more predictive, more efficient and uncertainty-lowering strategies is the main link between research and regulation, as well as a requirement for imple-

menting the EU regulation on chemicals REACH.

A further goal states that "the EU legislative framework is adequately implemented and remains fit for purpose" (page 3). Under this respect, the roadmap has to make avail of the essential concept of "One Substance – One toxicology": the same criteria for hazard identification/characterisation must be used throughout the different regulatory schemes.

In practice, the same substance may fall under different legislative domains, for instance: pesticide, biocide, industrial intermediate and water contaminant.

Irrespective of specific decisions related to legislation and exposure, this substance should be consistently identified as ED or non-ED across the different regulatory domains.

A more general point is the recognition of ED as a global health topic, as endorsed also by the United Nations Environmental Programme (UNEP). The EU currently has a leading role in

the regulatory action on EDC and a tight collaboration with OECD on the development of testing strategies.

Further to OECD, the EU roadmap should look toward broader international cooperation with countries that are major players in the global market, as well as in most research fields (including toxicology); yet these countries still have a limited presence in the international debate on ED. Examples include Russia, China, Brazil and India or world areas such as the Middle East or sub-Saharan Africa. Making use of its agencies (ECHA, EFSA), the EU could play a significant role in more inclusive international action on EDC.

Last but not least, a critical aspect is to define the level of evidence that is sufficient to trigger action. This is an important issue for all stakeholders and should have due visibility in the roadmap.

Research is slowly but steadily tackling the many uncertainties that lead to postponing regulatory decisions: the time comes when regulators have adequate information and tools in order to make science-based decisions to protect the public and the environment. So, when is enough, enough?



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Surface science: A rich interdisciplinary research field

Julien Scheibert & Alain Le Bot, researchers at CNRS/Ecole Centrale de Lyon detail tribology as a rich interdisciplinary research field, focussing on material contact interfaces

“Now people focus on big problems, and if you go for a big problem you need to be interdisciplinary”, claims Ted Brown¹, founding director of the Beckman Institute for Advanced Science and Technology, one of the first interdisciplinary research centres created worldwide. More than 25 years ago, the idea behind the Beckman Institute was criticised by the defenders of well-separated academic disciplines. Today, interdisciplinarity has become the mantra of many research institutions and funding agencies across the world.

Interdisciplinary research fields, like complex systems sciences, cognitive sciences or cybernetics, require expertise from diverse academic disciplines to address common questions and achieve common goals. And indeed, interdisciplinarity appears as the only viable way to tackle complex problems like sustainable development, public health or climate changes¹. While the previously mentioned challenges are currently under the spotlight, both in the media and in the political world, other interdisciplinary fields have not been sufficiently recognised so far. Our scope in this article is to shed some light on the field of tribology (the sciences of solid surfaces in contact) as a rich interdisciplinary field, which may have a lot to offer to those better-recognised research domains.

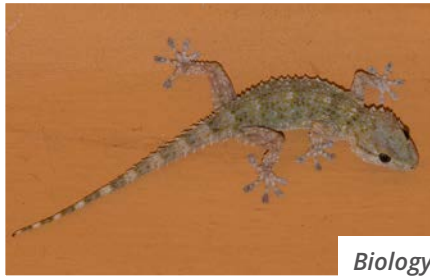
What is the common point between the San Andreas fault, a car on a highway, a hip prosthesis and downhill ski? They all involve a frictional contact interface, respectively between two portions of the Earth’s crust, between the tyres and road, between the head and cup of the prosthesis and between the ski and snow (figure). And the properties of their future behaviours (the date of an earthquake, the braking efficiency, the lifetime of the prosthesis or the ski speed) crucially depends on the details of the interactions between the

two contacting bodies^{2,3}. Unfortunately, our current understanding of the coupled effects of the many phenomena occurring at a solid contact interface is frustratingly limited, so that tribology remains a formidable challenge, both from fundamental and applied standpoints⁴.

Imagine a world in which we could predict landslides or earthquakes hours in advance, ensure lifetime warranty on a joint prosthesis, avoid skid during emergency braking, or drastically reduce the friction and thus energy losses in engines. All those advances would certainly contribute to progress towards a safer, healthier and more sustainable way of life. Reaching such ambitious goals will require the combined efforts of experts coming from many disciplines to disentangle the many elementary processes that can occur at a contact interface.

Tribology actually lies at the frontiers between mechanics, materials science, physics and chemistry: the mechanical loading applied to the interface not only deforms elastically the materials in contact but also induces irreversible processes like microstructural changes, plasticity, viscous losses or wear; those dissipative processes, together with frictional sliding inevitably heat up the vicinity of the interface, triggering a variety of thermally-induced mechanisms, including for instance phase changes, both in the solids and in the lubricant separating them and chemical reactions. All those phenomena are coupled in a complex feedback loop that is far from being understood. Breakthroughs in tribology thus cannot be expected unless material scientists, physicists, chemists and mechanical engineers gather in common laboratories and closely collaborate.

The breadth of the applicative fields of tribology (figure) is even wider than those four fundamental underlying



Biology



Geosciences

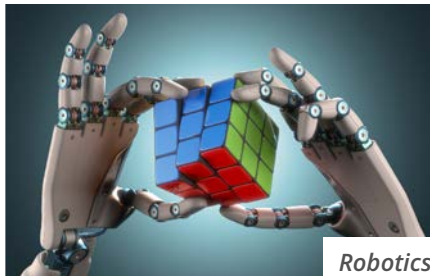


Engineering



Leisure

TRIBOLOGY



Robotics



Medicine

disciplines. For instance, acousticians will be invaluable to understand and reduce the large variety of noises that are induced by friction, like the squealing of a door or the rolling noise of tyres; geologists are necessary to uncover the mechanisms underlying earthquakes and improve mitigation of the associated risks; biologists, neuroscientists and roboticists are required to better understand the sense of touch and create robots with either human-like tactile skills or gecko-toe-like adhesive capabilities.

As one can see, a solid contact interface can be considered as a true interdisciplinary laboratory, while the outcomes of tribology-related studies are expected to lead to a large variety of breakthroughs, both from the fundamental and applicative standpoints, with major societal impact. Unfortunately, interdisciplinary fields suffer from a consistent lower funding success rate⁵ and tribology is not an exception. To remedy this problem, specific research assessment strategies are required that would circumvent the dominant, discipline-based organisation of the scientific communities. Governments, research funding agencies and scientists: it is time to turn the interdisciplinary mantra into a real success story. ■

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Brexit and space

Leyton Wells, ESPI research fellow at the European Space Policy Institute (ESPI) explores the issues around the space sector in light of the UK's Brexit

On 23rd June 2016, it was announced that the British public had decided through the referendum that the United Kingdom would be initiating the procedures of leaving the European Union (EU), aptly titled Brexit. Little over two years into the withdrawal process, and a great deal of uncertainty still remains over the final outcome – however, it is the UK government's position that Brexit means leaving the single market, customs union and the European Court of Justice (ECJ).

These three pillars of Brexit and of course a non-EU membership status, will most likely have significant implications for the future of the UK space sector – and with no clear vision of the UK's future relationship with the EU and a final trade deal, the status of UK-European space activity is a question for both political institutions and the private space industry.

Access and participation to EU funded space programmes: Galileo

A major component of UK-European collaboration in space ventures is facilitated through the European Space Agency (ESA). However, although ESA is an independent institution from the EU and membership of one is not a precondition, seemingly disconnected from the Brexit issue, the EU contributes around one-third of ESA's overall budget and acts as ESA's primary procurer. This is of significance for the UK space sector in particular as the EU funded space programmes conducted through ESA will preferably be contracted to the EU Member States which are also members of ESA.

For this reason and because the UK will obtain a third-party status to the EU and no longer be placing funds in the EU space budget, concerns over access to and participation with EU funded space programmes like Galileo, Copernicus, or future potential Space Situational

Awareness (SSA) and GovSatcom projects are in the limelight. Whilst it is conceivable that an agreement could be formed so that the UK can contribute payments into such programmes, it is foremost a political issue regarding security and the status of third-party participants.

The matter of UK access to and participation with the EU funded space programmes is most apparent and encapsulated within current speculations regarding Galileo. The Galileo programme itself is a constellation of satellites to provide Europe with an independent navigation system equivalent to that of the US's GPS, costing about €10 billion. To this point, the UK has played a large role in Galileo's development and operation, contributing 14% of its funding and 17% of the work. So far, Britain has been awarded the contracts to construct the "brains" of every Galileo satellite, hosts the Galileo Security Monitoring Centre and a UK based company, CGI, is responsible for the encryption service on the Public Regulated Service (PRS) – the security sensitive military grade component of Galileo.

In terms of participation, it is highly unlikely that UK companies will benefit from any future development contracts. The UK has already been sidelined from the recently approved batch of ESA procurement contracts for Galileo as an agreement for Britain's continued participation is yet to be confirmed. In regard to access, the EC has stated that Britain will be excluded from one of the key aspects of Galileo, the PRS once it becomes a third-party and a foreign entity.

While it is foreseeable that Britain can retain access to the services of Galileo, access to and operation of the restricted military elements will depend entirely on agreements for future UK-EU security relations. In response to discussions of removing the UK from these

components, the UK has envisaged creating its own independent Galileo equivalent, or even partnering with Australia – signifying the importance of Britain’s past and current investments in a positioning, navigation and timing system for military capabilities.

Ironically, after having been resistant against the Galileo programme in its initial phase, the UK is now making a clear demonstration of the high strategic value of this investment for Europe.

The UK’s industrial position

As already outlined, non-participation in EU funded space programmes pose risks to certain sections of the UK space sector. Though beyond this, leaving membership of the single market, customs union and the ECJ present additional concerns in the absence of a defined future relationship and trade deal with the EU. It is important to note the UK space sector is export orientated, with 50% of satellites entering into the single market and tariff-free trade with the EU Member States advantageously keeps construction costs down.

“The matter of UK access to and participation with the EU funded space programmes is most apparent and encapsulated within current speculations regarding Galileo. The Galileo programme itself is a constellation of satellites to provide Europe with an independent navigation system equivalent to that of the US’s GPS, costing about €10 billion.”

Furthermore, leaving the customs union could lead to some serious disruptions to space component supply chains, with the possibility of time-consuming and bureaucratic procedures imposed at the borders. There is also a human aspect to these potential restrictions – the space sector is heavily dependent on international collaboration and the associated movement of expertise – and so limitations on not just the transfer of equipment, but also access to talent, can have a detrimental effect on the prosperity of the UK space sector.

As well as this and unless a dedicated agreement is quickly settled with the EU, the UK will no longer benefit from the availability of funding received from EU Research and Innovation Framework Programmes

during the next MFF, which could have knock-on ramifications which will impact small and medium-sized space companies greatest if the void is not independently filled by the UK.

The UK has successfully managed to play a prominent role and to position its industry at the forefront of the European space sector thanks to an active and steady participation in European programmes through both ESA or the EC. However, except in the field of secured space telecommunications where it has deployed the Skynet series of satellites, it never seemed to raise high ambitions in this sector on a purely national basis.

Following Brexit, the UK will need to further clarify its national space policy. As discussed above, the continuation of R&D efforts and funding might be the most urgent issue and UK continued contribution to ESA programmes is a major asset and can provide for this until further agreements are found with the EU.

However, since the EU is procuring most of the European public space infrastructures and in particular those implying the highest volumes of production, the UK space industry might be facing a difficult situation to keep the critical mass and secure its competitiveness if deprived of getting access to this market. ■

“ESPI Briefs” No. 24, published in July 2018. Available for download from the ESPI website: www.espi.or.at

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Research into the Universe: A focus on stellar clusters

Nate Bastian, Professor of Astrophysics at Liverpool John Moores University draws our attention to stellar clusters, a fascinating aspect of research into the Universe

Stellar clusters, groupings of stars held together by their own gravity, have a long history of being used to study a variety of astrophysical phenomena. Clusters are attractive probes of galaxy formation and stellar evolution as they are traditionally thought to be relatively simple systems, i.e., all the stars within a cluster have the same age and chemical composition (within some small tolerance).

Many clusters survive to extremely old ages, bearing the imprint of their formation for billions of years. Hence, clusters can be used as either benchmarks or signposts, yet our understanding of these deceptively simple systems continues to advance in leaps and bounds.

“While the process of cluster formation takes millions of years, we can build up large samples of clusters in nearly every stage of their birth, from starless dense cores of gas/dust within giant molecular clouds, to a collection of young stars still embedded within the larger gas cloud...”

The traditional view of stellar clusters is that there are two distinct types. Open clusters are relatively young (between being newly born and a few billion years old) objects that belong predominantly to the disc of the Milky Way. These tend to be low mass, low-density objects, usually with just a few hundred or thousand stellar members.

The Galactic cluster NGC 6139 is a classical globular cluster, with an age greater than 10 billion years



Image: © ESA/Hubble & NASA

Globular clusters (GCs), on the other hand, are ancient objects (ages greater than ten billion years) with extreme masses and stellar densities, containing hundreds of thousands to millions of stars. These tend to be associated with the bulge or the halo of the Galaxy.

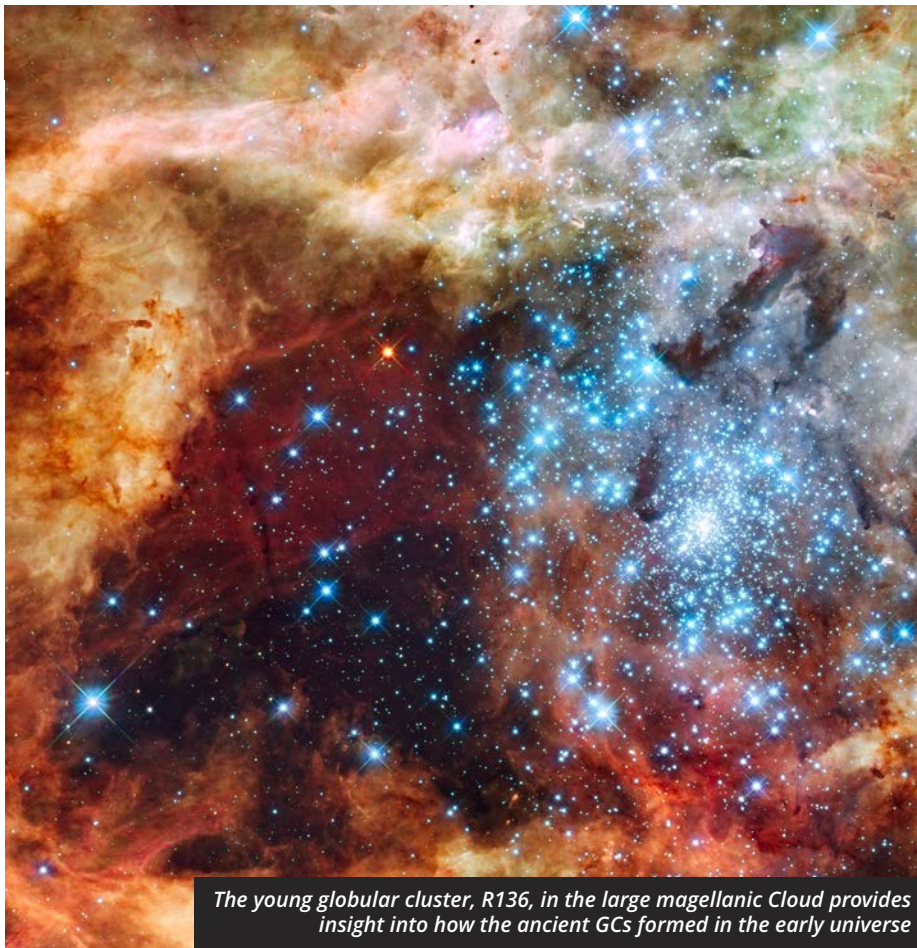
However, our notion of stellar clusters, their formation and their fate, has undergone a radical change in the past two decades. In recent years, it has become clear that globular clusters, once thought to only have been able to form in the special conditions of the early Universe, are still forming today. These extreme objects, known as Young Massive Clusters (YMCs), were originally discovered by the Hubble Space Telescope in galaxy mergers undergoing huge bursts of star-formation. They have now been found in nearly all star-forming environments and appear to be scaled up versions of the open clusters known in the Galaxy. In fact, even within our own galaxy, we

have begun discovering clusters with GC-like masses, but with extremely young ages (less than a few million years old).

This discovery has opened an entirely new window into GC formation and their evolution. The ancient GCs formed early in the Universe, meaning that the early stages of their lives are extremely difficult to study in detail, even with the most powerful telescopes available today. However, due to their proximity (in nearby galaxies), YMCs can be studied in exquisite detail and we can take what we learn from them and apply it to the ancient GCs.

While the process of cluster formation takes millions of years, we can build up large samples of clusters in nearly every stage of their birth, from starless dense cores of gas/dust within giant molecular clouds, to a collection of young stars still embedded within the larger gas cloud and finally to a fully

Image: © NASA, ESA, F. Paresce (INAF-IASF, Bologna, Italy), R. O'Connell (University of Virginia, Charlottesville), and the Wide Field Camera 3 Science Oversight Committee



The young globular cluster, R136, in the large magellanic Cloud provides insight into how the ancient GCs formed in the early universe

exposed stellar cluster made up of stars that have destroyed the parental gas cloud through their extreme feedback from winds, ionising photons and supernovae.

With this kind of sample in hand, we can start addressing fundamental questions such as: Why do some galaxies form very massive clusters, while others do not? How do the properties of clusters relate to that of the host galaxy? Can we use GCs (both young and old) to trace the formation of their host galaxy? Have GCs undergone multiple epochs of star-formation within them, or are they truly the single-aged populations that we have always thought they were?

This last question is particularly relevant due to another recent discovery about globular clusters, namely that they appear to have multiple populations of stars within them, with each

population having distinct chemical abundances. Some stars display the typical chemical patterns observed in field stars, i.e. stars that are not located in stellar clusters. However, in some GCs, we find that the majority of the stars have anomalous abundances, with a chemical pattern unique to massive clusters (i.e., enhanced in helium, nitrogen and sodium while being depleted in oxygen and carbon). These patterns are not found in stars outside clusters.

The origin of these multiple populations is still under debate and many models have been put forward. The details of the models differ between the authors, but what they have in common is that they all invoke multiple epochs of star-formation within each cluster, challenging our fundamental notions about stellar clusters.

But the YMCs offer a direct way to test

the models. We can search for older clusters that are forming new stars or for those containing the large required amounts of gas needed to form further generations of stars. This has now been done and to the disappointment of the theorists, no such cases were found amongst the hundreds of young massive clusters surveyed. This means that clusters, even the most massive ones, are made up of stars of all the same age. This is a puzzling conclusion, as it means that the origin of the multiple populations is still entirely unknown.

However, YMCs themselves may lead us eventually to the answer, as abundance studies of the stars within them have delivered a further surprise. There is a strong trend between the age of the cluster and the degree of chemical abundance variations present, with older clusters having much larger spreads than younger clusters. What this exactly means is still uncertain, but it suggests that the multiple populations may have more to do with how the stars and clusters evolve rather than how they formed.

Sources of external funding: The Royal Society University Research Fellowship, and The European Research Council Grant (ERC-CoG-646928-Multi-Pop).



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ESA's Earth Explorer Aeolus satellite lifted off on a Vega rocket from Europe's Spaceport in Kourou, French Guiana, on 22 August at 21:20 GMT (23:20 CEST).

Enhancing the competitiveness of the European space sector

Jan Wörner, Director General of The European Space Agency (ESA) speaks to us about his priorities for enhancing the competitiveness of the European space sector

SPACE POLICY & RESEARCH

In this inspiring interview, Jan Wörner, Director General of The European Space Agency (ESA) shares his thoughts on the statement concerning enhancing the competitiveness of the European space sector by supporting investments in the actors of the sector. Along with the European Union (EU), ESA jointly defines a number of objectives. One of these points is to strengthen the global competitiveness of the European space sector which applies to both industry and science.

“Here at ESA, we believe that Europe has a very strong base when it comes to industry and being competitive and I believe that this should be on a global scale rather than just being European-wide. Therefore, we are developing different instruments that concern how we can really support such competitiveness.

“One example of this concerns the area of space safety, in particular, debris removal and servicing. We are taking a new approach and as such, we have formulated a list of ESA-owned satellites which we believe should be deorbited. We now ask industry to come up with ideas: firstly, on how to deorbit the satellite, and secondly an idea on how to do maintenance on it.

“This radical change of approach should generate ideas from actors around us, (for example private companies) on how to concretely do maintenance and servicing in space. Based on these inputs, ESA will formulate a proposal for its Member States to be turned into reality. There will be a very specific way of financing, we will ask industry to be very active and attach a strong business case to each proposal. This approach is totally different from the one that we normally take, and it is a step forward as part of enhancing the competitiveness of the European space sector.”

The conversation then moves to explore Jan’s thoughts on how ESA continues to ensure that space delivers smart growth, highly qualified jobs and solutions for many current challenges in many areas including climate change, energy, transport and agriculture. Firstly, we find out about the ESA’s traditional instrument whereby they are developing satellites where data can be utilised by different users. Jan provides one example of the satellite Aeolus launched in August 2018, that aims to measure wind speed, which he explains to us in more detail.



Jan Wörner, Director General

“Firstly, if you know about the wind speed on earth, on a global scale you have very important information for climate change and other areas. This is because as we know and expect, the Gulf Stream may be affected by climate change, so to know about wind speed globally is very important. What we are doing with this example of Aeolus, is providing data to the public, as well as scientists.

“Secondly, even with just some basic ideas about what could be done, we are doing this with ESA Business Incubation Centres where we are offering companies the chance to create their own business. We give the support with regard to some minor funding, but more importantly access to our technologies, experts and to the net of Business Incubation Centres in Europe.

“So, there is a network now: so, let’s say that new entrepreneurs in the UK, for example, can have direct access through this net to ESA knowledge and be linked to other ESA Business Incubation Centres and companies. These strengthen the competitiveness of individual companies and therefore, space can deliver all of this, data and through ESA, it can develop companies and highly qualified jobs, of course.

“We cannot solve challenges, but we can tackle them, and we can give information about what can be done which means not only observing the global challenges such as climate change but providing some instruments to overcome issues of the past. For instance, solar cells were developed by space activities because there was a need to have energy in spacecraft. A future generation of solar cells are needed right now, for example for the mission to Mercury, high-efficient solar cells were developed, so all of these are spin-offs from the ground. So, we have the direct use of data but also the indirect use of technology.”

Jan proceeds to provide an additional example that concerns a camera on board a spacecraft to take photos of this tiny comet. The comet is dark, so the camera can distinguish between different shades of grey and this technology can be used on earth for early forest fires detection. So, the satellite images can be used by the fire brigade to help assist with early forest fire detection, fire propagation and details of the wind speed to find out where the fire will move to. These consist of what ESA calls Big Data, and Jan adds that a company in East Germany can develop a whole business based on the development of this exciting development in camera technology.

Staying on this note of positivity, Jan keenly details the extent to which ESA has been instrumental in the development of a globally successful European space sector. To illustrate this, Jan provides an important yet non-technical example. When it comes to a space mission, most people are fascinated with this he explains, such as landing on a comet, flying to the planet Mercury or landing on Titan.

“Space missions are fascinating. Fascination is something which happens in our brain which is already a positive move in the difficult times we live in. If you go to the next step and think about why you are fascinated, then many people understand that somebody had an idea or a dream and succeeded in realising it through this mission – this I call inspiration. The second step is that it does not happen in all brains, unfortunately, but it does in many.

“The last step is to say by what he or she has been doing and okay, I can do the same and have a dream, as Martin Luther King did. I can have a dream, think



Image: © ESA/Novespace

ESA participated in the Kid's Weightless Dreams campaign organised by Novespace and Rêves de Gosse giving children with disabilities the opportunity to experience weightlessness and lunar gravity on a parabolic flight. Eight children from five ESA member states – UK, France, Germany, Belgium, and Italy – boarded the Zero-G Airbus A310 in Bordeaux on 24 August.

In addition to experiencing weightlessness, the children were also involved in science demonstrations. These included lighting a candle, mixing liquids of different densities, playing ping-pong with bubbles of water and working a fidget spinner to demonstrate the effects of microgravity.

Joining the children were ESA astronauts from their corresponding member states who have flown in space. Tim Peake (UK), Frank de Winne (BE), Maurizio Cheli (IT), Thomas Reiter (DE), Claudie Haigneré (FR) and Jean-Francois Clervoy (FR) were on board to assist and mentor the children and answer their questions.

about something and realise it, whether that is in space or other areas – it does not matter. This is changing the whole of society in a positive sense in that we all need dreams and we have to develop something for our globe which I call motivation businesses and individuals.

“This idea goes far beyond space into every field and I am personally a part of this chain because when I started out as a civil engineer, I was inspired, fascinated and motivated by the space activities of the 1960s. While I am not a space expert, I did something in a different field to create new material to build something that was good for society so that is my personal driver.”

Finally, Jan adds that all ESA programmes have direct and intensive industry support to make them ready to take an idea to market, so the intention here is to encourage public-private partnerships.

“What I would like to say is that in all of our programmes, we are trying to have really intensive and direct industry support to make them ready for the market, not to just do something for us. Therefore, we are trying to have Public-Private Partnerships in all our programmes. In communication satellites, more than 50% of the money is coming from industry and we are doing it now in exploration.

“On exploration, we are offering industry the chance to go to the International Space Station and do their

own microgravity research, but they have to pay for that. This, however, helps the company develop, for example, to do new medicine or 3D cancer tests. Cancer in microgravity is developing differently because of the 3D effect and therefore, you can check medicine in 3D much better.

“We are saying that there should be some kind of financial investment of industry in exploration and we are doing this in earth observation where we have a Public-Private Partnership to really stimulate industry to get money from earth observation. So, we now have specific components to inspire industry to work in space – that is for those already working in the field as well as for the non-space sector.

“3D printing is an area that was not invented in or for space, but now we are trying to put this in space in terms of the companies who are strong in Additive Manufacturing (AM).”

Jan Wörner **Director General**

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The priorities for energy and climate change in Finland and beyond

In this special interview, Kimmo Tiilikainen, Minister of the Environment, Energy and Housing speaks to Open Access Government about his government's priorities for energy efficiency and climate change in Finland and beyond

Finland's Kimmo Tiilikainen, Minister of the Environment, Energy and Housing spoke to Open Access Government about his government's priorities for energy, environment and climate change in Finland and Europe. As the interview begins, the Minister shares his thoughts on the extent to which efficient energy use is an excellent way to save money and the environment, as well as to mitigate climate change.

"Energy efficiency is a necessary part of Finland's fight against climate change and it is also a very attractive part because you can save on energy and avoid the harmful effects of energy production. From consumers to enterprises, energy efficiency can pay itself back very quickly, often within a couple of years.

"I would like enterprises in Finland to become more interested in energy efficiency because it is a necessary part of climate policy."

The conversation then turns to detail Minister Tiilikainen's views on [the European Union's 2030 Energy Strategy](#), which includes European Union (EU)-wide targets and policy objectives for 2020 up to 2030. In June this year, we know that the compromise reached on the Energy Efficiency Directive (EED) will set a common, non-binding energy efficiency target for 2030 of at least 32.5% compared to the baseline scenario. The EU Member States will be obliged to increase their annual energy savings by 0.8% for the period 2021–2030.

In June, Minister Tiilikainen explained his views on the voluntary energy efficiency agreements between the state, local authorities and business and industry, which aim to generate much of the required energy savings by 2020. "Efficient implementation of these agreements

in companies and municipalities will play a key role in Finland's future ability to meet its obligations under the directive", he said.

"When the amount of renewable energy used increases, it is important that we have a market that will provide electricity on demand. And a flexible and functioning market are both important steps in that."

Minister Tiilikainen then tells Open Access Government about his satisfaction concerning these voluntary energy efficiency agreements and explains that an improvement that was made to this policy during June 2018. Going into more detail, the Minister explains that it raised the ambition at the EU level concerning both renewables (32% of energy use) and improvements in the annual energy savings obligation of 0.8% to the final energy use of Member States. This is a development the Minister warmly encourages.

"With such improvements, we make EU decisions more powerful than their original proposal intended to. I think that the EU Member States and European Parliament have made good progress in this respect.

Keeping this in mind, by 2030 it is expected that energy from renewable sources should account for 32% of energy use and that 18% of the target should be reached by 2022, 43% by 2025 and 65% by 2027.

Staying on the European theme when it comes to energy efficiency and climate change policy, the Minister goes on to explain why he thinks it is good that the European Commission will monitor both the progress in the EU's common energy and climate targets and the Member States' contribution to reaching a common goal. These issues here are really important, and the

ENVIRONMENT

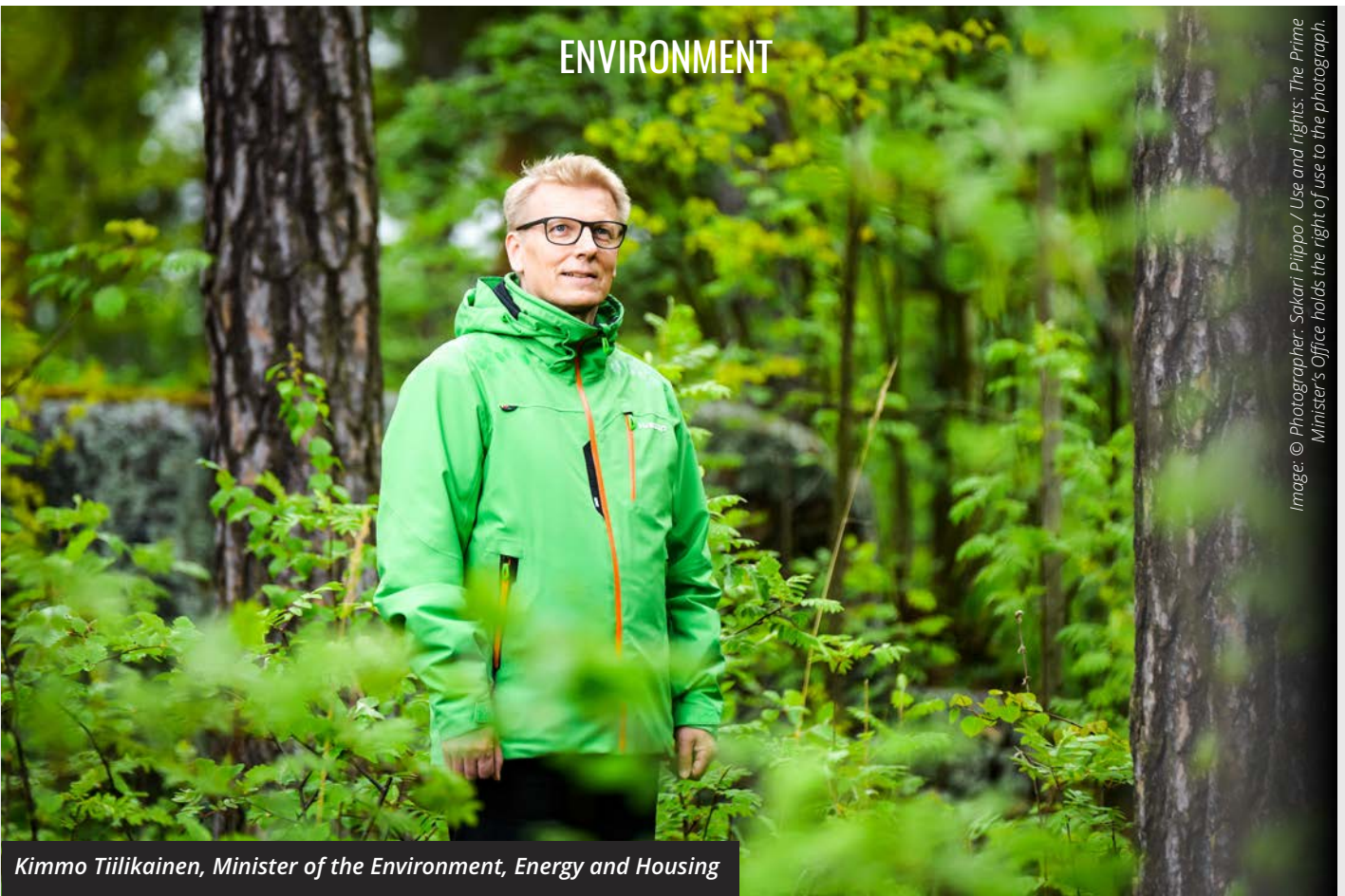


Image: © Photographer: Sakari Piippo / Use and rights: The Prime Minister's Office holds the right of use to the photograph.

Kimmo Tiilikainen, Minister of the Environment, Energy and Housing

targets are tremendously challenging in this respect, the Minister underlines.

“With this improved level of ambition to reach the targets that have been set, it is really important that each Member State plays their part. Monitoring the achievements of each Member State will encourage them to do better and compare the steps to be taken. This follow-up is important because we can really be sure that the EU will fulfil its promises under the Paris Agreement.

“A very important part of this monitoring and following this common effort is the delivery of long-term climate and energy strategies concerning 2030. The EU has long-term energy and climate targets strategy for 2050, but at the same, it is important to ensure that there are in line with Finland’s long-term target to reach carbon neutrality by 2045”.

During Austria’s EU Presidency which began in July 2018, the focus of this work concerns the clean energy package where there will be legislation concerning the internal electricity market, a point that Minister Tiilikainen keenly details as the interview draws to a close. Indeed, we know that Finland firmly supports proposals based on both open market and price formation. Austria, for example, is doing their best to put this forward.

“In the Nordic countries, we have had a couple of decades where there has been a common electricity market and it has been essential in terms of promoting renewables and seeking energy efficiency. I think we can deal with our internal electricity market by ensuring that the role of consumers will increase and that we make the best use of Finland’s Smart Grid in terms of flexibility for the consumer.

“When the amount of renewable energy used increases, it is important that we have a market that will provide electricity on demand. And a flexible and functioning market are both important steps in that.” ■

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Finland: A higher level of ambition in climate policy is needed

Markku Ollikainen, Professor of Environmental and Resource Economics at the University of Helsinki's Department of Economics and Management details why a higher level of ambition in climate policy is greatly needed in Finland

Like all European Union (EU) Member States, Finland is preparing its long-term climate policy plan. For this work, Minister Kimmo Tiilikainen asked for science-based policy advice from the Finnish Climate Change Panel, established by the Finnish Climate Act. The Finnish Climate Change Panel consists of top climate policy researchers and is a truly multidisciplinary body. The Finnish Climate Act requires that for all climate policy plans – mid-term mitigation plan, long-term mitigation plan and adaptation plan – the government calls for the Panel's official statement. This time, the Panel was asked to provide insight into the following question: what level of the 2050 mitigation targets would be globally fair and consistent with the Paris Climate Agreement? The Panel suggests increasing the ambition far beyond the 80% reduction target for GHG emissions adopted by the EU. This recommendation is based on a new illustrative calculation.

The Panel applied estimates of the global carbon budgets that are consistent with the goal of limiting the increase in the global temperature well below 2 degrees and strive for 1.5 degrees. Applying carbon budgets to a country level contains many restrictions, but this approach can nevertheless be very instructive. What a country regards as globally equitable or sufficiently ambitious is a normative question.

Markku Ollikainen



The literature on globally equitable mitigation policy has used alternative, well-formulated equity criteria, focusing on their outcomes. The Finnish Panel based its calculations on those criteria:

- Equality principle: The remaining carbon budget is shared out equally to each person in the world.
- Ability to pay principle: Each country gets a share of the per capita carbon budget based inversely on the country's per capita gross domestic product.
- Historic responsibility principle: Each country receives the same allocation of per capita emissions when accounting for past and future emissions in a selected time period and according to the carbon budget.

Each of the criteria has its pros and cons. However, if all criteria lead to rather similar outcomes, one could conclude that the implications for the ambition of mitigation policy are rather robust.

The key results of the Panel's analysis are condensed in the following table. The chosen carbon budgets are based on IPCC's calculation principles and are consistent with 66% probability of achieving the two goals specified by the Paris Agreement.

The bolded figures provide the maximum national carbon budget available for Finland up to 2050 under each equity criteria. Calculations are made postulating alternative levels of the net (forest) sink in the land use, land-use change and forestry (LULUCF) sector. Thus, GHG emissions

| Carbon Forest budget sink | | Equality Principle Reduction vs. 1990 | Ability to pay Principle Reduction vs. 1990 | Historic Responsibility Reduction vs. 1990 |
|---------------------------|----------------------------|--|--|---|
| 162 Gt 1.5 degrees | -13 Mt -20 Mt -27 Mt | 107 Mt 136% 116% 97% | 40 Mt 141% 122% 102% | -561 Mt 191% 171% 152% |
| 762 Gt below 2 degrees | -13 Mt -20 Mt -27 Mt | 504 Mt 103% 83% 64% | 189 Mt 129% 115% 90% | -164 Mt 158% 139% 119% |

Finland's fair share and mitigation targets under alternative equity principles

reported in the table contain both fossil and process-based emissions and negative emissions by alternative levels of the net sink. In principle, the higher the sink, the less the country has to reduce fossil emissions.

The message from the table is clear. Under the 1.5 degrees target, Finland needs to eliminate practically all GHG emissions and keep the sink at least at the current level, which is -27.1 Mt. Under the 2 degrees target, the equality principle gives a reduction rate below a 100%, while historic responsibility requires more than 100% reduction and the ability to pay does the same for lower sinks.

Assuming a linear reduction of emissions, Finland should be carbon neutral by 2035 under the first two criteria and 2030, under historic responsibility when the target is 1.5 degrees. When the target is 2 degrees, the years are the same, except for the equality principle, it is 2045, which is Finland's official target.

The figures in the table contain some restrictions, however. As the global

carbon budget contains an assumption concerning the aggregate global sink, the whole national sink cannot eligitly be exchanged for emissions. Furthermore, from 2020 onwards, the EU's LULUCF policy imposes forest reference levels for the Member States and this reference level is not exchangeable with fossil emissions. For instance, if the non-exchangeable part of the sink is -15 Mt, then for the current sink all emissions should be eliminated under all equity criteria. Thus, by 2050 Finland should have net-negative emissions under all criteria and be carbon neutral after 2030.

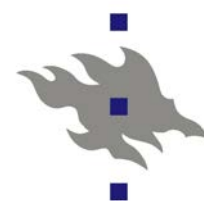
Finland's emissions in 2017 were in total 56.1 Mt out of which 31 Mt came from the emissions trading sector and 25.1 Mt from the effort sharing sector. Thus, the challenge is to eliminate all 56 Mt emissions and keep the sink at least at the current level. Is the complete elimination of emissions possible?

The Finnish energy sector can be made carbon-free by 2050. Provided that the development of electric vehicles is fast enough, and that Finland uses other efficient policy measures,

transport should be carbon free by 2045. Among the polluting processing industry, the metal and cement industries face the biggest challenge. These industries need to find new production technologies globally. Another challenge lies in agriculture, especially in livestock farming.

The complete elimination of national emissions is challenging and costly. Wise and efficient climate policy designs help to achieve the targets cost-efficiently and even to improve the competitiveness of the economy. Any obstacles on this path must be evaluated against the risks that the rapidly increasing global temperature causes to humans and nature. There is no time to hesitate in taking strong mitigation actions.

The Finnish Climate Change Panel has provided an instructive analysis for policymakers to use. It is to be hoped that they take seriously these insights into Finland's fair share. Science provides a clear message for policy.



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Combatting climate change: Microbial diversity and biomass issues in the North

Dr Taina Pennanen and Dr Hannu Fritze from Natural Resources Institute Finland share their thoughts on microbial diversity and biomass issues in the north in terms of combatting climate change in the North of our planet

The Finnish land area is 73% covered by forests with the rest consisting of open peatlands, arctic tundra, agricultural fields and built-up areas. One speciality characterising the Finnish land area is the high proportion of organic peatland soils which make up around 35% of the country's total land area. Half of these peatlands have been drained mainly for forestry reasons, but also for agricultural production. Approximately half of these drained peatlands have not succeeded in establishing a productive forest stand. Organic soils manifest the highest carbon (C) storage reservoir of all landforms, and soil C storages are sensitive to land use.

Microbes are involved in all the three major greenhouse gas (GHG) production processes, namely carbon dioxide, di-nitrous oxide and methane (CO_2 , N_2O , CH_4). All these gaseous products are the outcome of the important ecosystem service provided by soil microbes, namely the decomposition of dead organic matter of plant and animal origin.

All ecosystems produce GHGs and the groundwater level is crucial in influencing the production proportion of CO_2 in relation to N_2O and/or CH_4 . Thus, the draining of organic soils lowers the water table level drastically, enabling aerobic decomposition processes and,

thereafter, much of the stored organic C is lost as CO₂, inducing global warming.

Restoration of unproductive drained organic soils by raising the ecosystem water table level changes the soil microbial flora towards the native state, has a strong impact on diminishing gaseous C loss and the return of these peatland ecosystems as a C reservoir. The natural emissions from an ecosystem of the three GHGs is not a threat to our planet. Furthermore, it can be argued that peatland GHG emissions have made it possible to achieve a liveable temperature in the North of our planet.

“The take-home message is that soil microbes indeed influence global climate and to restore hampered ecosystems with the services provided by the soil microbes, one has to know how the natural ecosystem functions.”

Finnish agricultural fields lose C. Globally, half of the original soil C is lost in the last 50 years of agriculture, accompanied by losses in crop production and a simultaneous reduction in soil microbial biodiversity, leading also to a reduced soil microbial biomass. According to the latest scientific understanding, this is crucial since the C sequestration capacity of the soil is directly linked to the amount and diversity of the soil microbes. This is due to those microbes that convert plant and animal originated C into microbial C, which is the slow decomposable part of the soil C reservoir.

This is easy to understand if one thinks that the first living organisms on this planet were microbes and the organic matter important to our forestry and agriculture-based wellbeing had to be made up from the remains of the organisms that are present. In Finland, a large part of the agricultural areas were previous forest soils, and these could be covered with forestry based side chain products to raise the microbial diversity and to improve fungal presence, to help meet the 4per mille target demanded by France in 2015.

Microbial involvement in ecosystem services is not limited to decomposition processes because microbes are also key players in plant growth and performance. 85% of the plant species on the Earth are dependent on symbiosis with their microbial partners and, especially, the fungal association with boreal trees and other plants of this ecosystem are essential for Finnish forests. This ensures water and nutrient allocation from soil to the forest plants in exchange of photosynthetic C establishing the soil microbial wellbeing, the turnover of the microbial biomass C into stable soil C, and the reproduction of new tree generations. Thus, plant-microbe connections are not confined only to soil C, because they also allow forest trees to stock up atmospheric C into the stable form of timber. Therefore, only the wise use of these resources determines if C is sequestered into the ecosystem due to the microbial performance to mitigate climate change.

The take-home message is that soil microbes indeed influence global climate and to restore hampered ecosystems with the services provided by the soil microbes, one has to know how the natural ecosystem functions. ■

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Ocean and climate change: Time for a new wave of energy

Karmenu Vella, European Commissioner for Environment, Maritime Affairs and Fisheries examines ocean and climate change and argues that now is the time for a new wave of energy

With Summer 2018 beating all weather records across Europe, the topic of global warming is on the minds of many. Extreme temperature spikes, droughts, wildfires and storms. Decades of anthropogenic greenhouse gases emissions are taking their toll. And while the impact on our crops, forests and cities is immediately felt, much of the global warming effects take place below the horizon, literally and figuratively. They are in our ocean.

For about half a century, the ocean has shielded humans from even more rapid climate change, by storing most of the excess heat and CO₂ created by our fossil fuel addicted society. Thirty per cent of carbon dioxide from human activity dissolves in the ocean; 90% of the extra heat is absorbed. But despite its strength and resilience, the ocean is about to give in. Ocean temperatures are rising, in turn, leading to sea level rise, deoxygenation and drastically changing climate patterns – the predicted effects of which are highly disquieting.

The absorption of CO₂ provokes ocean acidification, which can ultimately affect the entire food chain. Our planet is not just warming, it is suffering from a high and persistent fever. We have to act now, starting with our energy supply and consumption.

While a victim of climate change, the ocean may also hold part of the solution. The idea of using tidal energy dates back to as early as the sixth century and is finally getting traction: waves, currents, differences in temperature or salinity. The potential for energy generation is enormous and all these options need to be exhausted in our quest for low-carbon power.

Europe is leading the way. The world's first tidal power station, built in 1966, was located in Brittany, France.



Image: © European Union. Photographer: Thierry Monasse

Karmenu Vella, Commissioner for Environment, Maritime Affairs and Fisheries

The world's first commercial wave power device was installed in Scotland (2000), the first wave farm in Portugal (2008). Today, Europe holds two-thirds of the companies, test centres and installed capacities in ocean energy. The sector accounts for 2,000 high-skilled jobs – 70% of them in cutting-edge research and development.

Over the last 10 years, around €3 billion has been invested in ocean energy in Europe, most of it from private funds. But the sector is scarcely out of the egg and needs the strong support from public authorities to mature. The European Commission, together with the Member States, can make a difference.

European funds are allowing regions to invest in technological developments, test centres, supply chain



Image: S. Portland

A Pelamis installed at the Aguçadoura Wave Park off Portugal – the world's first wave farm

and port infrastructure. Since 2014, we have spent €124 million on 17 R&D projects, generating total research investment of some €270 million. Through the InnovFin Energy Demo Projects, ocean energy developers can benefit from long-term guaranteed loans from the European Investment Bank. And with our innovative BlueInvest matchmaking events, we establish new networks between blue economy entrepreneurs and potential investors. Our May edition has facilitated more than 1,200 business contacts, many of them leading to new and promising opportunities.

But the success of ocean energy does not depend on access to finance alone. We also need to put in place the right regulatory conditions, at European, national and local level. This includes good maritime spatial planning, which can increase public acceptance and helps to avoid possible conflicts at sea – for example, between fishing vessels and ocean energy developers. It also includes effective consenting and licensing procedures at the national level. And it requires more information on how ocean energy plants interact with marine life.

These are uncharted waters, which is why the European Commission is supporting projects on the environmental monitoring of wave and tidal devices. These projects will allow policymakers across the European Union to assess the technologies' environmental

impacts and provide appropriate guidance. For project developers and investors, this will significantly reduce environmental risks.

I am aware that ocean energy is not an obvious or easy choice. Start-up costs are high, technology not always sufficiently advanced. The harsh conditions at sea make everything complex and expensive. But in the long run, energy from the sea is more productive and more predictable than other renewable energy sources. Europe has the technology, the skilled workforce and the environmental conditions to make this work. We can turn this into an opportunity for sustainable growth. Also: we have no other choice. Our transformation towards a low-carbon society requires us to use all renewable energy sources at hand. Ocean energy will be, and already is, part of our green, blue future. ■

Karmenu Vella

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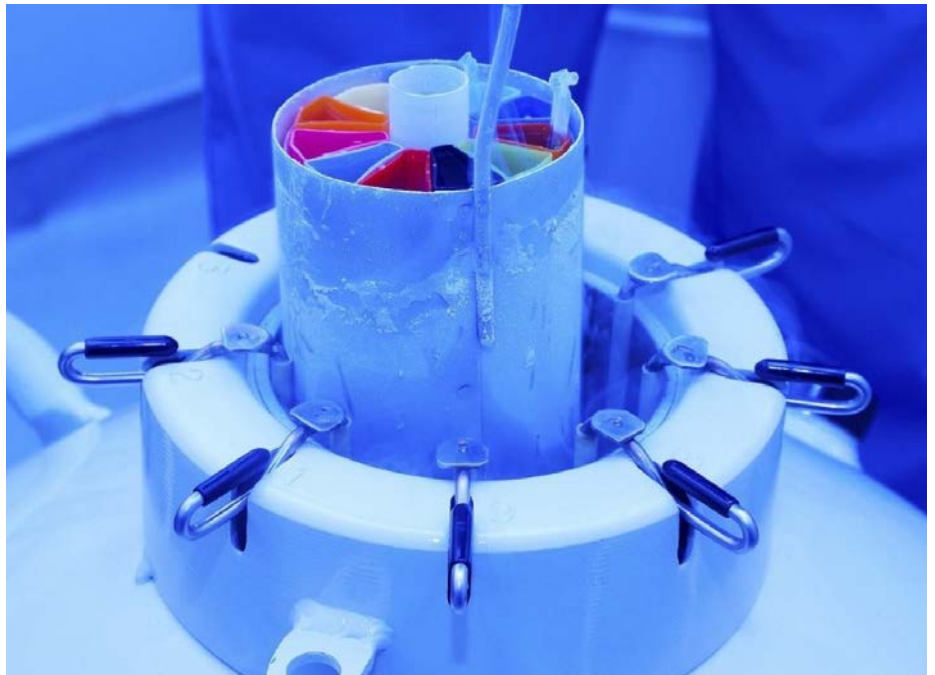
ec.europa.eu/commission/commissioners/2014-2019/vella_en

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Marine biology and ecology research at EMBRC: A “Blue Enlightenment” era is dawning

Marine bioresources are growing in importance with the establishment of the European Marine Biological Resource Centre (EMBRC-ERIC) – a unique research infrastructure for excellence in marine biology and ecology research

On 21 February 2018, the European Marine Biological Research Centre (EMBRC-ERIC) opened its doors to scientists from all over the world, from either the public or private sector, to drive excellence in marine biology and ecological research forward. With a state-of-the-art research infrastructure, distributed in more than 30 research facilities, in nine European Union (EU) countries, EMBRC acts as one organism to address complex problems, whether related to improved understanding of the oceans or in support of RD&I processes, working with key actors in the health, food and environmental remediation sectors.



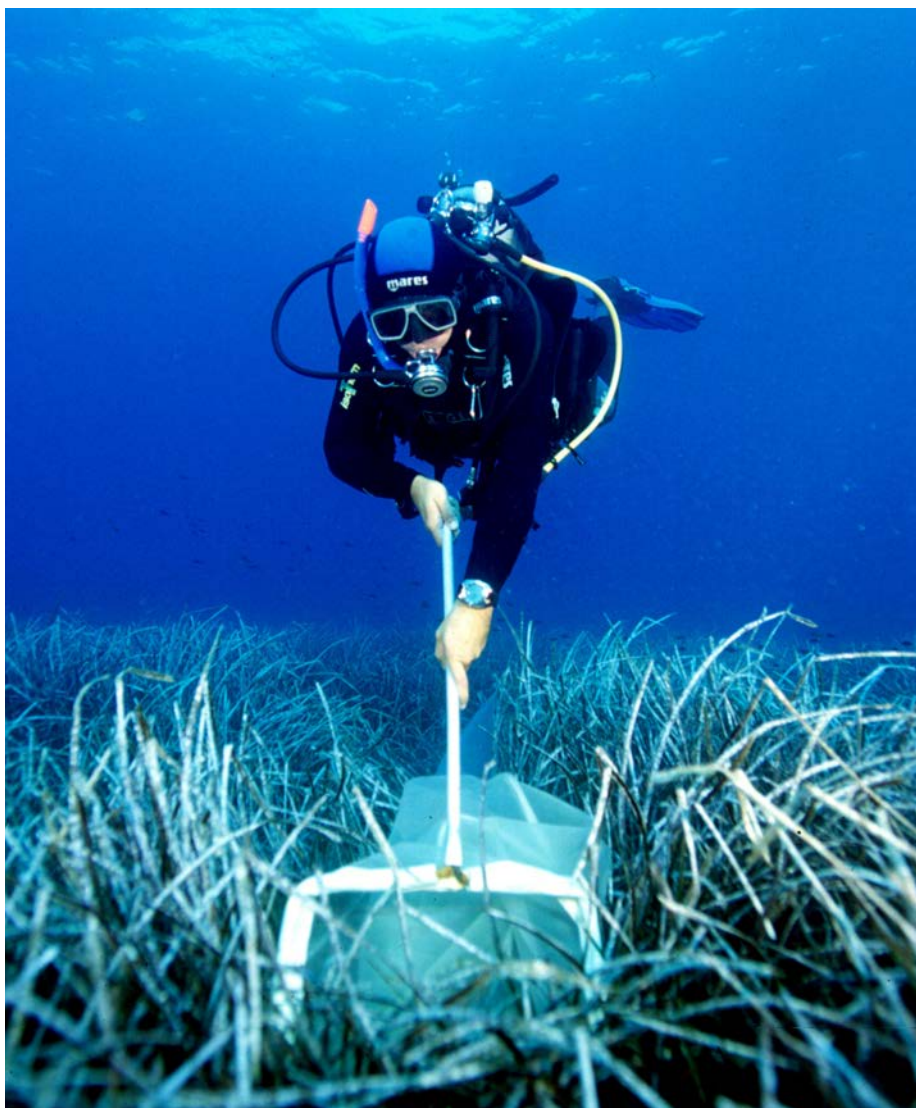
EMBRC is particularly aligned with the policy objectives of the European Blue Growth and Circular Economy strategies, which include the development of new enabling technologies, education measures and the creation and sharing of optimal resources, from advanced technological research platforms to data.

Our seas and oceans provide a rich and largely unexplored reservoir of biodiversity with great potential to contribute to food and energy security, human health and industrial production. Acquiring sufficient understanding of marine ecosystems to allow the sustainable exploitation of marine biological resources requires a step change in scientific

endeavour, which EMBRC is leading. In order to secure Europe’s global competitiveness and address Europe’s grand challenges, EMBRC-ERIC mobilises and links the currently fragmented infrastructure and marine resources in Europe. EMBRC plays a key role in unlocking the potential of the marine realm for new concepts and as drivers for technology development and industry innovation, tackling the societal grand challenges and supporting the related needs for new technologies, materials and models.

Marine ecosystems and its organisms have historically played a key role in human nutrition, while more recently we have discovered their fundamental role in the regulation of the planet’s

support system. Perhaps unknowingly to the broader audiences, marine organisms, such as the giant squid, or the sea urchin, have been instrumental in enabling our understanding of fundamental human physiological processes: from human motoneuronal system to cell fertilisation, some of our major discoveries in the field of medicine started with the study of marine life. In a world with a progressively larger and older population, with a need for proteins projected to rise sorely in the next decades and various diseases becoming resistant to traditional cures, advances in knowledge and technology are necessary. According to a recent study on cancer, about 600,000 novel compounds, potentially leading to novel anti-cancer



drugs are waiting to be discovered. Treatments from marine organisms could be worth between \$563 billion (€ 428.5 billion) and \$5.69 trillion (€4.33 trillion) and with the rise of algae aquaculture, the seaweed industry is expected to reach \$22.13 billion by 2024 (€18.9 billion).

EMBRC provides a unique entry point to an array of services, resources and knowledge for the investigation of marine life, either on demand, through their catalogues, or direct access to ecosystems. These include kelp forests, coral reefs, intertidal rocky shores, lagoons, mudflats, deep-sea environments as well as planktonic and pelagic communities. Special sites and extreme environ-

ments are also provided including (1) volcanic cold seeps, that can be used as proxies for the future high CO₂/low pH oceans, (2) polluted low-oxygen sites that enable environmental impact studies and (3) artificial habitats such as renewable energy test sites for research on bio-fouling etc. Access to subtidal ecosystems is provided through research vessels, remotely operated and autonomous underwater vehicles (ROV/AUV), scientific diving and in-situ monitoring equipment. Specialised services are available for satellite tag and sensor designs for tracking large marine organisms, such as mammals and turtles in their natural habitat. While access to such ecosystems for experiments and training is important,

EMBRC provides more specific resources by organising the sharing of marine organisms for research and technological development purposes both collected from the wild and cultivated. The organisms, or their parts, range from vertebrates, invertebrates and seaweeds to microalgae and protists, bacteria and viruses, including taxonomic reference collections of past and present regional biodiversity.

“EMBRC is particularly aligned with the policy objectives of the European Blue Growth and Circular Economy strategies, which include the development of new enabling technologies, education measures and the creation and sharing of optimal resources, from advanced technological research platforms to data.”

The consortium currently is supported by nine countries, between EU and Associate Countries and is keen to further international collaborations. With great hopes to see the new EU Framework Research Programme (FP9) as the tool to unlock the full potential of the Blue Enlightenment era, EMBRC-ERIC is poised to play a pivotal role at the global level to further our understanding of the relevance of marine bioresources in all the critical issues of our time.



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PerformFISH: A new era of consumer-driven development in Mediterranean aquaculture

PerformFISH is a €7 million European Commission-funded project with the aim of exploring and tackling the underlying causes behind the stagnation of the Mediterranean Marine Fish Farming (MMFF) sector, as this analysis by Katerina Moutou, Associate Professor at University of Thessaly reveals

PerformFISH addresses aquaculture challenges for sea bass and sea bream in the Mediterranean. PerformFISH focuses on developing consumer-driven aquaculture production by integrating innovative approaches that can help ensure European sea bream and sea bass aquaculture businesses are sustainable and competitive.

The farming of sea bass and sea bream is an important sector in the Mediterranean, contributing significantly to wealth and job creation in remote and coastal areas. Sea bream and sea bass are by volume the third (36.4%) and fourth (28.15%) most farmed fish species in the European Union (EU) and their collective value (€1.04 million) surpasses that of salmon (€0.78 million), trout (€0.55 million) or mussel farming (€0.49 million). However, in recent years there has been growing concern over the lack of growth and improvement in Mediterranean marine fish farming.

PerformFISH has received €7 million in funding from the European Commission to improve the competitiveness of Mediterranean aquaculture by overcoming biological, technical and operational issues with innovative, cost-effective, integrated solutions while addressing social and environmental responsibility. PerformFISH aims to support the economic com-

Aquaculture site in the Mediterranean

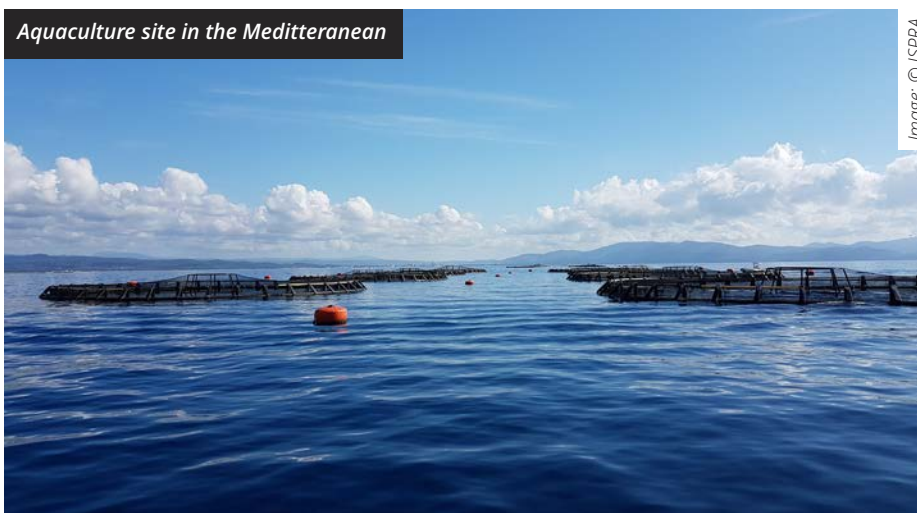


Image: © ISFRA

petitiveness of fish farms in the region by helping them operate sustainably, as well as in a socially and culturally responsible manner.

PerformFISH is coordinated by the University of Thessaly, Greece and its consortium brings together 28 partners from 10 different countries, encompassing a wide range of technical expertise and know-how in the Mediterranean aquaculture area.

Dr Katerina Moutou, PerformFISH Coordinator, of the University of Thessaly (Greece), says: PerformFISH is an important and timely project for the sector as solutions are needed to tackle some of the underlying causes behind the current stagnation of the Mediterranean marine fish farming sector. We have brought together leading researchers and industry across Europe to co-design this innovative

project to directly address the needs of the sector. This research-industry collaboration is truly unique and it is very exciting to see what we can achieve working together.

The technical research of PerformFISH focuses on generating knowledge and demonstrable solutions for key fish-farming components, including selective breeding, juvenile quality, health, welfare, feeds and feeding technology. Aquaculture involves dynamic systems in open environments and as such, the new products and innovative practices developed will be tested in operational settings to more accurately assess the feasibility of applying the research to real farming conditions across the Mediterranean.

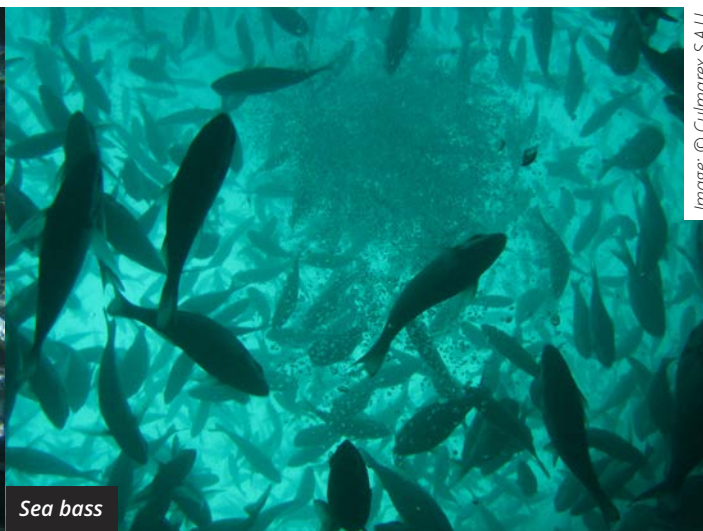
PerformFISH is also set to create a quantified benchmarking system to effectively track and evaluate key

Image: © Culmarex S.A.U.



Sea bream

Image: © Culmarex S.A.U.



Sea bass

drivers of Mediterranean marine fish farming performance. The identification of Key Performance Indicators, which have been widely adopted by the entire Mediterranean aquaculture sector, is pivotal in stepping into a new era of informed solutions supported by the collective intelligence of the sector. Ultimately, PerformFISH will develop a revised code of conduct to implement good practices and effectively communicate them to raise consumer awareness and advocate social and environmental responsibility.

Consumers have a central role in PerformFISH. The project has been designed to bridge the gap between consumer demand and product design, complemented with product certification and marketing strategies to drive consumer “confidence in culture”. In addition, the consumer knowledge gained from their experience and expectations is an indispensable part of the “co-creation” marketing concept; an innovative process based on active collaboration with consumers. In this respect, consumers are a valuable asset in constructing a generic branding framework for a “Made in EU” product label to accommodate the standards of product quality, and environmental and social responsibility for the European sea bass and sea bream industry.

PerformFISH has the direct support and endorsement of the industry, with producers’ associations from Greece, Spain, Italy, France and Croatia directly involved as partners in the project. These associations, through their membership, represent 92.8% of all sea bream and sea bass production in the EU.

The project’s holistic approach will ensure that Mediterranean marine fish farming matures into a modern dynamic sector, highly appreciated by consumers and society for providing safe and healthy food with a low ecological footprint, and employment and trade in rural and peripheral regions.

For further information please visit www.performfish.eu.

Notes

The PerformFISH project will run until April 2022 with an overall budget of €7.045 million. The full title of the project is “PerformFISH – Consumer Driven Production: Integrating Innovative Approaches for Competitive and Sustainable Performance across the Mediterranean Aquaculture Value Chain”. It is funded by the European Commission’s Horizon 2020 funding programme, grant number 727610. This article reflects the views only of

the author(s) and the EU cannot be held responsible for any use which may be made of the information contained therein.

PerformFISH is coordinated by the University of Thessaly (UTH). The main mission of UTH is the promotion of scientific knowledge through research and the contribution to the cultural and economic development of the local community and the wider society. UTH has acted as a partner and coordinated several EU funded projects in the framework of RFSR, FP7, INTERREG, MED, LIFE, LLP, Horizon 2020 in addition to several international projects funded by Institutions outside EU.



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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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State-of-the-art technology for natural radioactivity removal in groundwater

Anna Goi, Senior Research Scientist at the Tallinn University of Technology turns our thoughts towards state-of-the-art technology for natural radioactivity removal in groundwater

The natural radioactivity in groundwater was found in a number of European countries like Estonia, Spain, Germany, Italy, Sweden and Finland as well as in U.S. and in some African countries. Naturally occurring radionuclides, release into the groundwater during the rocks dissolution or from the soil leaching. These are mainly compounds originating from radioactive decay, or the release or transfer of excess energy, of uranium-238 and thorium-232, i.e. radium-226, radium-228, polonium-210, lead-210 and radon.

The obvious benefit of deep groundwater aquifers using is that the water is highly protected against anthropogenic pollution while the doses associated with exposures to groundwater natural background radioactivity are usually low and often delivered over a period of time resulting in stochastic radiation-induced health effects. Therefore, the radiation is usually overlooked as a potential hazard at public waterworks and the private wells.

Radioactivity that is tasteless, invisible and odourless accumulates in the tanks and piping systems resulting in radon generation through the radionuclides decay in bearing materials. Radon is a known human carcinogen (classified by the International Agency for Research on Cancer as Group 1)¹ with genotoxic action². Naturally occurring radon accumu-

lates in poorly ventilated buildings and enters through an opening in the walls of the building, resulting in health effects, the most common of which is lung cancer.³

Besides radiological parameters, the concentration of other natural constituents in the groundwater as ammonium and heavy metals often exceed the parametric values set out in the Council Directive 98/83/EC on the quality of water intended for human consumption. To get water of potable quality, as well as to make it palatable and aesthetically attractive for human consumption, the introduction of the effective, safe, reliable and cost-effective drinking water treatment technologies is required.

Conventional water purification technologies based on the processes, such as ion-exchange, microfiltration, coagulation-flocculation, manganese dioxide oxidation-sand filtration, lime softening, co-precipitation with barium sulphate and electro dialysis have been employed. As the physical-chemical composition of the water is unique in the regions depending on the underlying geology, there is no universal water treatment technology. Thus, the waterworks should apply a targeted selection and adoption of the technology to the water composition that substantially influences the activity concentration of the radionuclides in water. This should be carried out along with assessing microbiological

and chemical risks as a part of developing water systems safety.

According to the Council Directive 98/83/EC, the total indicative dose of radioactivity in water should not exceed the value of 0.10 mSv/year. This value represents a very low level of health risk and is typically at least a factor of 20 lower than doses that members of the public receive from all sources of radiation.² Comprehensive and complex combined technologies for water purification allow easily to achieve this value and as a result to satisfy the demands for safe water.

However, despite the best efforts in the technology development process, the radioactive wastes are ultimately produced. This happens even if the technology aims at only co-occurring contaminants removal, such as iron and manganese since the radionuclides are known to be absorbed on the particulates formed due to the oxidation of these compounds. As a result, the treatment process of the water containing natural radioactivity influences considerably the working environment at the waterworks. Staff can be exposed to radiation through handling the residual streams generated by the treatment process and the spent material replacement and transportation. Thus, the technologies should be assessed not only taking into account their efficiency in the drinking water quality control and the cost of installing and operating, but



also in the safe design of the process and the safe disposal of residuals process.

Moreover, there are several EU regulations implemented that greatly support the environmentally, economically and socially sustainable drinking water treatment technology development. Among these regulations are the Council Directive 2013/51/Euratom which lays down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption, the Council Directive 2013/59/Euratom creating basic safety standards for protection against the dangers arising from exposure to ionising radiation and the Council Directive 2011/70/Euratom establishing a community framework for the responsible and safe management of spent fuel and radioactive waste.

The ALCHEMIA project (LIFE16 ENV/ES/000437) supported by the contribution of the LIFE financial instrument of the European Union (EU) aims to demonstrate the technical and economic feasibility of the use of sustainable systems based on the manganese dioxide oxidation and

filtration for the effective removal of natural radioactivity in water. The consortium of the project consists of three partners from Spain – the CARTIF Technology Centre as coordinator, the Solar Energy Research Centre (CIESOL) and the Diputación de Almería (DIPALME) and three from Estonia – Tallinn University of Technology, University of Tartu and AS Viimsi Vesi.

The implementation of the ALCHEMIA solutions in the particular drinking water treatment plants in Almería (Spain) and Viimsi (Estonia) will serve as the knowledge-sharing platform for other municipalities and countries. A cost-benefit analysis will be carried out within the project to compare technologies based on the processes of manganese dioxide oxidation-filtration and the reverse osmosis in terms of operation, maintenance, waste management costs, safety, local conditions and legislative requirements. A database containing relevant information on drinking water treatment plants along EU treating water with natural radioactivity is developed.

During the project's execution, particular stakeholders from target sectors such as water suppliers, manufacturers, policymakers are engaged to pro-

mote the results transferability and the dissemination of good practice to the other facilities within the EU. Considering the whole life-cycle of radioactivity including the management of the waste generated allows the authorities to increase the safety and efficiency of the water industry by improving and implementing the environmental legislation.

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Acknowledgments

The authors gratefully acknowledge the LIFE+ Programme under the responsibility of the Directorate General for the Environment of the European Commission through the agreement LIFE16 ENV/ES/000437-LIFE ALCHEMIA project.
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Tackling microplastics: Impact on the environment and the food chain

Dr Ruth Barnich, Principal Taxonomist at environmental consultancy Thomson Ecology explores tackling the issue of microplastics, with a focus on how we can better assess their impact on the environment and the food chain

The presence of plastic litter in our oceans is currently the subject of significant media attention. Not a day goes by without public discussions over the enormous amount of plastic entering the oceans or the need to reduce the consumption of single-use plastic items. As a member of the OSPAR Convention, whose aims are to protect the marine environment of the North-East Atlantic, the UK government is investing in different aspects of research around plastic litter pollution. Recently, it announced the funding of an important research project exploring the ways in which microplastics enter the marine environment and also the impact that they have on life in our oceans.

“The problem of microplastics is here to stay. We need to make sure that we understand how it may be affecting the marine environment, as well as the food on our tables.”

As a marine biologist, I have worked in the field as an academic and expert for more than 30 years. I am currently chief scientist at Thomson Unicomarine, the marine laboratory of Thomson Ecology. Our marine team are experts in assessing the diversity and abundance of marine animals in seafloor samples. Over the past couple of years, we have seen an increase in requests for evaluating the number of microplastics alongside the animals in our samples. The key issue that I am now trying to address is the lack of guidance on how to name or record the different types of microplastics that we find. This is because the existing OSPAR litter categories apply to plastic found in trawl nets which collect much larger litter items compared to those that we find in our seafloor sediment grab samples.



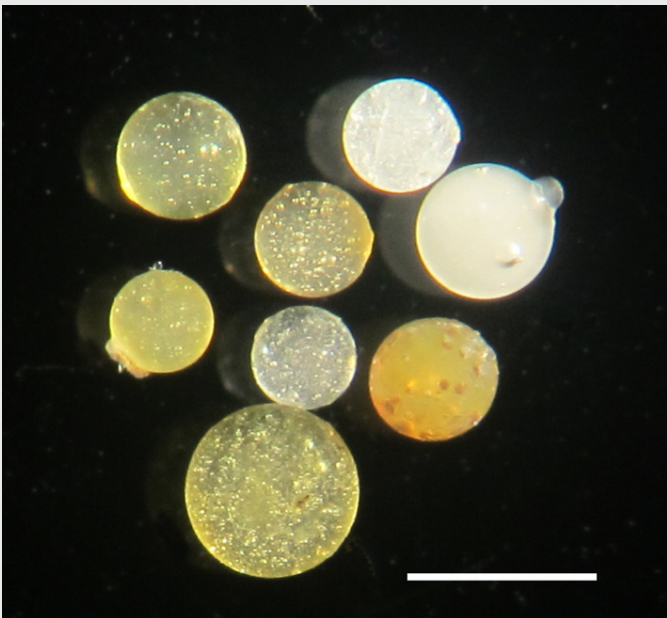
Dr Ruth Barnich

Microplastics can be primary particles (beads, pellets or powders) or secondary when they result from fragmentation of larger items. They range in size from a few microns to up to five millimetres in diameter. The images in this article show some examples of those fragments, beads and granules. The shrimp in the picture is roughly 2.5 mm long and its body surface is covered with tiny plastic granules. This shocking example illustrates how microplastics may enter and move up the food chain and, ultimately end up on our plates.

Because of the lack of a standard classification for microplastics, I have established an internal standardised procedure for naming and recording microplastics



Plastic fragments (scale 3 mm)



Microplastic beads (scale 2 mm)

consistently in our laboratory. This was discussed subsequently at several meetings in the UK and presented to an international audience at the 4th World Conference on Marine Biodiversity in Montreal, Canada. At these meetings, it became clear that other marine laboratories in the UK and abroad face the same issues regarding consistency and comparability of results as we do. In addition, it is also clear that this is an issue that needs to be addressed and agreed internationally as microplastics continue to proliferate.

We process over 1000 grab samples per year. Each cover about 0.1 m² of the seafloor to a depth of 20 cm. Extracting microplastics alongside our targeted ani-



Microplastic granules attached to a shrimp (scale 0.5 mm)

mals is a very cost-effective way of sampling. It would make sense not only to assess their presence but also to forward the extracted microplastics to specialised chemical laboratories for analysis of their nature and source.

The problem of microplastics is here to stay. We need to make sure that we understand how it may be affecting the marine environment, as well as the food on our tables. Now is the time to discuss standards and terminology across the different fields of research here in the UK, so that we can accurately assess the scale of the problem. We urgently need a forum to exchange ideas and ensure that we join our efforts up internationally in order to help tackle plastic pollution in the most efficient way. ■

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Warnings and forecasts of hazardous tropical weather in the United States

In this special interview, Dr Michael Brennan, Branch Chief at the Hurricane Specialist Unit within the National Hurricane Center (NHC) speaks to us about their work in issuing the best watches, warnings, forecasts and analyses of hazardous tropical weather, including hurricanes

Michael Brennan, PhD, is the Branch Chief of the Hurricane Specialist Unit at the National Oceanic and Atmospheric Administration's (NOAA's) National Hurricane Center (NHC) in Miami, United States (U.S.). The Hurricane Specialist Unit issues tropical cyclone forecasts and warnings for the Atlantic and Eastern North Pacific hurricane basins.

Dr Brennan served as a senior hurricane specialist at NHC from 2008 to 2018, a position where operational duties include the issuance of the track, intensity and wind radii forecasts and associated watches and warnings for tropical cyclones. Dr Brennan's current research interests include quantifying the impact of supplemental observations on model forecasts of tropical cyclone track and intensity. He also conducts training on a variety of topics related to tropical cyclones as well as forecast uncertainty and messaging. Dr Brennan also serves as a reviewer for several scientific journals and is currently an associate editor for the AMS journal *Weather and Forecasting*.

In this fascinating interview, he explains to us the work the NHC on the very latest hazardous tropical weather systems, including their science-based environmental predictions delivered to the U.S. and the global community. He also shares something of their mission to save lives, mitigate property loss and improve economic efficiency by issuing the best watches, warnings, forecasts and analyses of hazardous tropical weather that occur within the North Atlantic and eastern North Pacific basins.

We discover that these areas are monitored constantly for signs of cyclone development and once a tropical cyclone forms, NHC issues an advisory package, which

is their standard forecast of the track and intensity of the storm out to five days and the forecast of how big the storm out is to three days. NHC issues that every six hours, so it is constantly updated with the latest data and model information. Dr Brennan then develops this crucial aspect of NHC's work.

"Within this, the human forecaster still has a very significant role in the forecast process, which they do by analysing the storm and its current state and providing that information as input it into numerical models. NHC forecasters try to maintain continuity with our previous forecasts as much as possible so that we provide users with a consistent forecast that evolves over time in a predictable way."

The conversation then moves to explore Dr Brennan's observations on the type of science-based environmental predictions NHC delivers to the U.S. and the global community, a point he keenly explains to us in his own words.

"We start off by forecasting tropical cyclone formation and make probabilistic forecasts four times a day, every six hours and we provide two probabilities. The first is that the system will go and become a tropical cyclone over the next 48 hours and then over the next five days.

"That approach is mainly based on observational data, satellite imagery, what we see in other observations such as ships, weather balloons, radar or aircraft data, for example. Numerical weather prediction model guidance can provide information about whether a particular system will go on and develop or what the environment looks like in terms of large-scale conditions



From his vantage point high above the earth in the International Space Station, Astronaut Ed Lu captured this broad view of Hurricane Isabel

being favourable for a system to go on and form or not.

“Once we identify a tropical cyclone, the prediction we make of the track and intensity of the storm are heavily dependent on numerical modelling. This modelling has made great scientific advancements during the last 20 to 30 years in terms of forecasting the circulation of the atmosphere and the tropical cyclone track. This is largely due to the progress that has been made with numerical modelling to analyse the current state of the atmosphere through smarter ways of using observations, especially with satellites.”

Dr Brennan adds that with all of the interaction between the atmosphere and the ocean, a tropical storm or hurricane will extract heat from the ocean, so there is an interplay here that has to be captured to forecast intensity. In terms of improving intensity forecasts, this is an area where less progress is being made, but during the last decade or so hurricane

research has certainly progressed and intensity forecast errors have decreased. This is an important point that Dr Brennan details further to us.

“The Hurricane Forecast Improvement Project ⁽¹⁾ follows on from the 2004/05 hurricane season, after which Congress made a major investment in numerical modelling and research to try and improve intensity forecasts. We are seeing progress in this area now, even though we are not where we want to be, but one of the biggest challenges we face here is rapid intensification or weakening where the storm strengthens or weakens.

“For example, in the 2017 season in the Atlantic basin, we had 39 instances of rapid intensification within the first 24 hours of the forecast period, and we were able to successfully forecast six of those 39. 10 years ago, that number of successful forecasts would probably have been zero.”

The NHC's mission

In essence, the NHC's mission is to make better forecasts for tropical storms and hurricanes, save lives, mitigate property loss and improve economic efficiency, Dr Brennan is keen to elaborate on these areas. He explains that many populations live in hurricane-prone areas, such as on islands or at coastal location areas and are, therefore, vulnerable to the effects of storm surge, wind and heavy rainfall. He also details NHC's work in outreach on training, in terms of helping communities to be prepared for adverse weather.

"A big part of NHC's job is not just to make forecasts, but to communicate aspects of our work, as well as training the emergency management community to use the information we provide to enable them to make the best decisions they can when it comes to evacuation.

"Another aspect of our work is helping communities to know what their level of risk is when it comes to storm surge, for example, which is the push of water from the ocean by the hurricane winds onto land. It is what drives most evacuation decisions in the U.S. when it comes to a hurricane.

"Our modelling work is helping communities to reassess their risk from a storm surge, so they can develop evacuation zones so they can map out, plan and have evacuation routes and shelters plus determine how much time they need to get people out."

Dr Brennan tells us that warnings are typically issued 36 hours before tropical storm force winds arrive, but for some communities, evacuation decisions are made three or four days in advance of the storm, depending on how many people they have to move, how far they have to go and where they are all going to go.

In closing, Dr Brennan stresses that hurricanes are events which can change communities for generations to come. For example, look at what happened at the Caribbean islands, including Puerto Rico, which were devastated by tropical cyclones in 2017, Dr Brennan

outlines. The importance of all inhabitants of areas that can be affected by tropical storms and hurricanes to be prepared is a crucial point, Dr Brennan argues.

"Within this, the human forecaster still has a very significant role in the forecast process, which they do by analysing the storm and its current state and providing that information as input it into numerical models. NHC forecasters try to maintain continuity with our previous forecasts as much as possible so that we provide users with a consistent forecast that evolves over time in a predictable way."

"While the forecast has gotten better, we still have a very large number of people that are vulnerable to tropical storms and hurricanes in the Atlantic Basin, so our mission is to make the best forecast possible. We also need to help people to be as prepared as much as possible before a storm, to protect them, so they know what their vulnerability and risk are.

"It is important to have a plan in place for what they are going to do when a storm approaches, well in advance. This is important because hurricane apathy sets in quite quickly in areas that have not been affected by hurricanes, but everybody has to be prepared for what could happen every year." ■

¹ www.hfip.org

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Hurricane hazards and climate science research in the U.S.

Ning Lin, Associate Professor at Princeton University's Dept. of Civil & Environmental Engineering details her fascinating research on hurricane and climate science by refining methods in risk analysis in this in-depth interview

The experience of Prof Ning Lin from Princeton University is very impressive in terms of [her published work](#) and [research interests](#). She is currently leading a multi-year multi-institutional National Science Foundation (NSF) project on hurricane hazards and risk analysis. She also has an [NSF CAREER project](#) on hurricane hazard modelling and application to engineering structure design considering climate change.

In this interview, she reveals her thoughts on research into hurricane and climate science by refining methods in risk analysis. We know that Ning Lin's theoretical risk assessment framework combines physical data with statistics to simulate storms' activity, hazards and risk. This approach projects future hurricane risk and investigates the same from a historical perspective. Prof Ning Lin also describes her research on developing multi-hazard vulnerability models to better predict the damage of hurricane wind and storm surge to residential communities.

Hurricane hazards and risk analysis research

As the interview begins, Prof Ning Lin introduces us to her work on hurricane and climate science by refining methods in risk analysis. Her research group aims to establish a physics-based probabilistic TC risk assessment framework that integrates the analysis of storm

activity, hazards, and risk. She explains that they employ a holistic approach to study the impact of climate change on hurricanes, wind, surge and rainfall hazards induced by hurricanes, as well as public policy.

Due to the limitation of historical records and the complexity of the problem, Prof Ning Lin's group apply physics-based statistical methods to their work. This way, large numbers of synthetic but physically possible storms, characterised by their various track, intensity, and size are simulated (with their annual frequencies estimated), under observed or climate-model projected future climate conditions. The hazards induced by the storms are then estimated, to a large extent, with physical models.

Prof Ning Lin observes that this approach has its advantages. One is that while hurricanes often produce multiple hazards such as extreme winds, storm surge and heavy rainfall it is difficult to perform a direct statistical analysis to estimate the joint probability of such events, as the data is very limited, particularly for specific locations. The physics-based approach can generate a large number of physically correlated hazard events for more reliable statistical analysis. The other advantage is that, unlike the direct statistical method, a physics-based approach does not assume that the climate is stationary and so it can

be better applied in the context of a changing climate.

Developing multi-hazard vulnerability models

The conversation then moves to her work on refining vulnerability models that describe the damage to coastal communities under the joint forces of strong wind, storm surge, and rainfall flooding. Prof Ning Lin's research into hazards and vulnerabilities is unique because it specifically models the physical correlation of hurricane hazards (strong wind, storm surge and heavy rainfall) and thus their joint impact. In this vein, it can be applied to policymaking, including urban planning and federal and insurance bodies in coastal risk mitigation, because they need to find systematic strategies to be ready for any potential hazards. Prof Ning Lin explains this further and details her research in this area.

"Recent disasters, such as Hurricanes Sandy, Harvey, and Irma underscore the significant vulnerability of the U.S. to hurricanes. We investigated the structural damage caused by these hurricanes and developed vulnerability models, which describe the relationship between damage severity and hazard intensity. Then we can combine, on one hand, the hazard information and on the other, vulnerability information to quantify the risk. Along with my colleagues, we are seeking solutions to predict and prepare for these events.

“In terms of policymaking, the federal government in the U.S. has a policy in place on flooding but there are various issues there that could be improved. Together with Howard Kunreuther of Wharton risk centre at the University of Pennsylvania, we are trying to work with policymakers in the National Flood Insurance Program to better account for the effect of climate change so that the policy as a tool will better support coastal communities.

“We are also working with policymakers in New York City, through the New York City Panel on Climate Change (NPCC), to ensure that they have up-to-date knowledge on hurricane hazards and climate change, so they can use that information to develop policy, for example, in the area of construction.

Work with the National Science Foundation (NSF)

Turning to her work with the NSF, one example of this is [Hazard SEES: An Integrated Approach to Risk Assessment and Management in Responding to Land Falling Hurricanes in a Changing Climate](#). This project is developing a new framework for managing and assessing hurricane risk and will apply to all hurricane-afflicted coastal communities. Here, research is taking place in the coastal communities of New York, New Jersey, North Carolina and Florida to discover and compare hurricane hazards and to estimate how they might evolve in the future. As such, engineering and policy strategies for coping with these hazards can be developed.

While Prof Ning Lin is developing her own model as part of this project, she collaborates with other scientists of varied skill sets, such as Michael

Oppenheimer, a Professor of Geosciences and International Affairs at Princeton and Guy Nordenson, an Architecture Professor at Princeton. The scientists involved in this project are developing their own types of models and it brings together various disciplines including atmospheric science, civil engineering, architecture, plus economics and public policy in a holistic way. “In this respect, very good progress is being made because people involved in this project have had to move out of their comfort zone”, Prof Ning Lin observes. For example, Guy Nordenson at Princeton leads a ‘Structures of Coastal Resilience’ study that includes hurricane and climate science into engineering design for coastal resilience, she notes.

Closing thoughts

In closing, we learn that climate change models are surrounded by much uncertainty, so Prof Ning Lin is exploring ways to improve the models and reduce their uncertainties. Such an approach will help us to better understand uncertainties in climate projections and, therefore, improve hazard projections.

In addition, a better design strategy can save much investment and at the same time, ensure that communities remain both safe and alive, as focused by her NSF CAREER project. In closing, Prof Ning Lin shares her views on the importance of design when it comes to tolerating severe weather and also her ambitious plans for the future.

“If you elevate your house, you may get a higher wind impact. If your house is built at a lower level, then you may experience a storm surge impact.

Also, storm surge and rainfall flooding can come together as evidenced by Hurricane Harvey, or perhaps not at the same time, but one after the other. A very interesting topic I am addressing is how do we deal with multi-hazards, not only from a scientific modelling perspective but also in terms of a strategy – that is how we could deal with them and consider them together.

“Recent disasters, such as Hurricanes Sandy, Harvey, and Irma underscore the significant vulnerability of the U.S. to hurricanes.”

“Our methodology has been applied to a number of different locations, such as New York City, Shanghai and Dubai. We are currently applying our modelling to the entire East Coast and the Gulf Coast of the U.S. This way, we can investigate variations in the hazards and risk from location to location. This is a promising aspect of our on-going work. I would envision that in the future, our study will go beyond the U.S. and encompass a scale that is global in its scope.”



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Toxicology: Chemicals and their impact on human health

Brian Berridge, Associate Director of the National Toxicology Program (NTP), details how NTP studies the health impacts of chemicals and other factors in this fascinating interview

The National Toxicology Program (NTP) was established in 1978 by the U.S. Department of Health and Human Services (although it was called the Department of Health, Education and Welfare at that time) due to a growing concern about the effects of various substances in the environment which could directly or indirectly contribute to diseases and illness. In short, their goal today is to supply information on harmful substances, prevent disease and disability due to exposure and to improve the health of the general population in the United States (U.S.).

To find out more about NTP's excellent work in the U.S., we were fortunate to speak with Brian Berridge, Associate Director of the National Toxicology Program who provides compelling insights into the organisation's work. He details the first goal of the NTP as identifying potential hazards associated with chemicals and non-chemical agents that the general population might be exposed to. This includes industrial chemicals, consumer goods, food additives, pharmaceuticals, radiofrequency radiation, infectious agents and a full range of possible agents. Brian then draws our attention to NTP's second goal, which is to develop and validate novel methods used to study and characterise these potential hazards.

The conversation then moves to how the NTP's work in the U.S. addresses the human health effects of chemical agents in the environment. Brian underlines that they largely try to understand the biological activity of the agents they study, some of which are nominated by regulatory agencies and policymakers because they are interested in understanding the potential health effects of environmental exposures. Brian explains this point further in his own words.

"Some of those nominations come from regulators, policymakers or the general public and some are generated from within the NTP. Largely, we use a variety of test methods such as in vitro culture systems, in silico computational methods and animal studies to try and get a sense of biological activity in terms of hazards associated with these kinds of agents."

"All of the data NTP generates is captured in a variety of forms and it is all made public on our website and databases. We also produce formal reports, publish peer review manuscripts in scientific journals and give many presentations at scientific meetings."

"The bottom line here is that we take on the things that folks are concerned about and we study them in a variety of ways, with testing and modelling systems, so we can then report that out for consumption by policymakers, regulators, the general public and the scientific community."

"In terms of the methods being developed at NTP, as time has gone by the range of agents has become broader. We don't just look at chemicals any more, but we also look at pharmaceuticals and non-traditional agents such as radio frequency radiation associated with cell phones as well as exposure to lighting conditions for those in shift work."

We now turn our thoughts on why the NTP was set up in the U.S. in 1978 and consider something of its journey from then to the present day. Brian believes the original intent was to create a focus within the U.S. government to take on a responsibility for carrying out some of this testing and also to coordinate amongst other agencies who were doing a similar type of work. Brian adds that

a fundamental interest of the public is cancer risks, an activity that had largely taken place in the National Cancer Institute. After the NTP was established in the late 1970s, it was given some responsibility for taking that on, Brian notes.

“Over the years, our interests and efforts have become broader, so NTP took on and developed methods for evaluating immune system toxicity, as well as developmental and reproductive effects. As time has gone on, scientists have realised that not everybody is equally prone to these effects. Individual susceptibility has, therefore, become a much more important part of our work.

“All of the data NTP generates is captured in a variety of forms and it is all made public on our website and databases. We also produce formal reports, publish peer review manuscripts in scientific journals and give many presentations at scientific meetings.”

“In terms of the methods being developed at NTP, as time has gone by the range of agents has become broader. We don't just look at chemicals any more, but we also look at pharmaceuticals and non-traditional agents such as radio frequency radiation associated with cell phones as well as exposure to lighting conditions for those in shift work. These are agents beyond traditional chemicals that potentially have public health effects.”

Finally, we ask Brian if there any specific research initiatives that he would like to highlight as an example of NTP's work in the U.S. He draws our attention to the traditional testing of chemicals of public health concern for which there has been long-term exposure. He then details NTP's work around more short-term concerns, such as a chemical spill in the Elk River, West Virginia back in 2014 where a more rapid response was required and ultimately delivered.

“This population was exposed to very high concentrations of an industrial chemical which got into the water supply, so you can imagine that caused a fair bit of concern. NTP got its resources and capabilities together

pretty quickly and carried out a number of studies over a short period of time to generate information that would help the folks there to understand what the potential hazards were.

“The other part of our business is about developing and validating novel methods and as such, we are the host for the NTP's Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM). Essentially, their role is to facilitate the adoption of novel methods that do not use animals.

“We also contribute to a programme called Toxicology in the 21st Century (Tox21) which has been running since 2008. The aim of this initiative is to develop high-throughput methods to rapidly test whether substances in our environment adversely affect human health. The number of things that are being put into the environment, such as the products we consume or industrial chemicals has far outpaced our ability to test them in traditional ways. We had to develop high-throughput methods to understand things that we really need to focus on that represent a true risk versus those that are less of a problem.

“One last thought is that NTP, as is the case with a lot of scientific efforts, tries to keep pace with both the needs and the opportunities. Accordingly, we're constantly assessing novel approaches, assessing our portfolio for public health relevance and adjusting to changing expectations.” ■

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Polychlorinated biphenyls (PCBs): A persistent environmental health problem

Carolyn R. Klocke, Postdoctoral Scholar and Pamela J. Lein, Professor at University of California, Davis both argue that polychlorinated biphenyls (PCBs) are a persistent environmental health problem today

Polychlorinated biphenyls (PCBs) are a family of synthetic chemicals that were produced in large quantities for industrial and commercial applications beginning in the late 1920s through the late 1970s. PCB mixtures were synthesised globally and identified under several trade names, including Aroclor® (United States and United Kingdom), Clophen® (Germany), Phenclor® (France) and Kanechlor® (Japan). Chemically, PCBs are biphenyls with variable chlorine atoms substituted for the hydrogen atoms in the benzene rings. There are 209 possible PCB compounds – each of which is referred to as a congener – that are named according to the number and position of chlorine substitutions (i.e., lower-chlorinated congeners have lower number designations and higher-chlorinated congeners that have higher number designations).

While concern regarding adverse health outcomes associated with occupational exposures to PCBs arose as early as the 1930s, by the 1960s and 1970s there was significant alarm about the human health risks of PCBs in the environment. The manufacturing, use and disposal of PCBs had resulted in widespread PCB contamination of air, water and soil, and because PCBs are highly resistant to degradation, they had accumulated in the human food chain and were readily detected in human tissues, including breast milk.



PCB Cleanup site at Sheboygan Falls, Wisconsin, United States, circa 1990

Image: Wisconsin Department of Natural Resources

These observations, coupled with emerging data linking environmental PCB levels to increased cancer risk in humans and animal models, impelled the United States Congress to institute a ban on PCB production in 1979. This was followed by a global ban on the production and use of PCBs by the Stockholm Convention on Persistent Organic Pollutants in 2001.

In the decades following the ban on PCB production, environmental PCB levels decreased significantly. During this time, basic research scientists identified the biological mechanisms by which PCBs cause cancer and regulatory scientists established “safe” exposure levels for PCBs in the environment and human food supplies based on attributable cancer risk. It

was widely believed that the PCB problem was solved and that further research on PCBs was not warranted. However, emerging research on PCBs over the past decade has revealed a number of unexpected findings that suggest the mainstream understanding of PCB exposures and PCB toxicity may be too limited and that PCB regulations focused on cancer outcomes may not be protective of vulnerable populations.

One surprise from current research is that while environmental levels of PCBs are decreasing globally, levels have stabilised or may be increasing in some geographic regions. One explanation is the accelerated release of “legacy” PCBs from ageing products. For example, higher than expected

levels of PCBs in the air over the city of Chicago are thought to be due in part to the release of PCBs from ageing paints and caulking materials used to construct municipal buildings during the era when PCBs were intentionally added to these construction materials. The release of legacy PCBs from paints and caulking materials may also explain why PCB levels in the indoor air of elementary schools in the United States exceed the 2009 public health guidelines set by the United States Environmental Protection Agency. Additionally, novel PCBs that were not part of the original industrial mixtures have been detected in the environment and in human tissues. The toxic potential of most of these contemporary PCBs, many of which are lower chlorinated congeners, is largely unknown.

Historically, consumption of contaminated food was thought to be the primary source of PCB exposure in humans, with fish, meat and dairy products comprising the main dietary sources of PCBs. However, recent studies documenting PCB contaminants in the air of major cities and indoor air of municipal buildings, including schools, suggest that inhalation may be a significant and underappreciated source of human exposure. While sources of airborne PCBs, which include both legacy PCBs as well as the lower chlorinated contemporary PCBs, are not yet completely understood, some studies have demonstrated that PCBs can be unintentionally produced during the synthesis of yellow and green paint pigments. Once dried, volatile PCBs can be released into the air (a phenomenon also referred to as “off-gassing”) to be inhaled by

humans. Whether the toxic effects of PCB are different if they are inhaled from the air vs. ingested with food remains to be determined.

Another evolution in our understanding of the environmental health impacts of PCBs is the realisation that the developing brain is a vulnerable target of PCBs. PCBs interfere with the growth and maturation of neurons in the developing brain, which shifts the developmental trajectory of the brain in a manner that disrupts normal patterns of connections between brain regions. The magnitude of this effect differs depending on the specific PCB congener involved and whether it is a higher- or lower-chlorinated congener. Interestingly, a pathological change that is common to many neurodevelopmental disorders, including autism and attention deficit hyperactivity disorder (ADHD), is altered connectivity in the brain, and recent studies report that elevated maternal PCB levels are associated with increased risk of having a child with autism or ADHD.

The recent discovery of PCB contamination in the indoor and outdoor air has also raised concern regarding the effects of exposure to airborne PCBs on the developing lung. Lung development continues long after birth, so there is the possibility that inhalation of PCBs interferes with lung development and growth. Since PCBs are known to interfere with neuronal development, it is hypothesized that the inhalation of airborne PCBs may interfere with innervation of the lung, resulting in increased airway hyperactivity, a hallmark characteristic of asthma. It has been hypothesized that

airborne PCBs contribute to the unexplained and perplexing increase in childhood asthma since the 1960s.

Collectively, epidemiologic studies and experimental data from animal models suggest that further investigation of PCBs is warranted to understand how the changing patterns of PCB exposure are contributing to non-cancer outcomes, specifically neurodevelopmental disorders and potentially pediatric asthma. Such work is required to ensure that regulatory policies targeting PCBs are protective of the most vulnerable members of society.



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U.S. efforts to promote food security and provide humanitarian assistance

The vital work of the US Agency for International Development (USAID) is examined here by Open Access Government, with a focus on their efforts to promote food security and provide humanitarian assistance in other countries, such as Ethiopia

The US Agency for International Development (USAID) leads efforts in international development and humanitarian terms to reduce poverty, save lives, strengthen democratic governance and help people progress beyond assistance. Their incredible scope of work ranges from preventing the next global epidemic, helping a farmer access tools to grow their business or responding to a devastating earthquake. By way of background, 35th President of the United States (U.S.), John F. Kennedy created the organisation by executive order in 1961 to lead the government's efforts in international development and humanitarian assistance.

The USAID's work covers many areas, such as economic growth and trade, environment and global climate change, gender equality and women's empowerment, working in crises and conflict, as well as water and sanitation. Another area of their work concerns food security, which we will now look at in further detail. We know that given the scarcity of resources and other challenges, there is a need to be more efficient in how this demand is met. They believe that ensuring a sufficient supply of food for people requires aligning short-term assistance with a long-term development strategy to assist countries to feed their own inhabitants.

In essence, food security can be defined as people having both physical and economic access to sufficient food to cater for dietary needs and to enable a productive and healthy life, at all times. We learn that food insecurity can often be traced back to poverty and has far-reaching consequences on the ability of families, communities and countries to develop. Also, we find out that extended undernourishment stunts growth

increases susceptibility to illness and slows cognitive development.

In addition, the growth of the agriculture sector is highly effective in reducing poverty and as such, USAID strongly believes in investing in smallholder farmers who depend on agriculture to feed their families and make a living. There was a spike in world food prices back in 2008 which hurt economies across the world and this led to destabilising riots in no less than 30 countries. To feed a population that is expected to grow to 9 billion people by 2050, USAID points out that the world will somehow have to double its current level of food production, albeit with less water and land.

At the G-8 Summit in L'Aquila, Italy in 2009, the U.S. rallied global leaders to address the root causes of global food insecurity. This meeting set the foundation for the U.S. government's global hunger and food security initiative, [Feed the Future](#), which is making a significant contribution towards a concerted global effort to combat global poverty, hunger and malnutrition. Led by USAID, Feed the Future plays on the strengths of agencies across the U.S. government and leverages resources with multilateral organisations, NGOs, research institutions, the private sector other stakeholders to step up inclusive agricultural growth.

Feed the Future, in collaboration with 10 other U.S. government agencies and departments, aims to do the following:

- [Invest in cutting-edge scientific and technological agricultural research;](#)
- [Develop agricultural markets;](#)



Image: © Sjors737 | Dreamstime.com

Ethiopia, Afar region, a group of semi-nomadic cattle farmers severely effected by drought and massive loss of livestock. This boy will walk for hours to find a water and food source.

- Help farmers access capital.
- Offer extension services;
- Develop sustainable agriculture strategies;
- Provide emergency food assistance.

So, we know that through efforts like Feed the Future, USAID, in summary, are: “Advancing global food security by helping to improve the most basic of human conditions: the need that families and individuals have for a reliable source of quality food and sufficient resources to purchase it. This, in turn, supports global stability and prosperity.”⁽¹⁾

Finally, let’s take a look at a recent example of how the USAID is providing assistance, which in this case is to support the inhabitants of the Federal Democratic Republic of Ethiopia. As many people in Ethiopia have left their homes due to escalating conflict or natural disaster and are facing severe food insecurity as a result, the U.S. announced in July this year an additional \$170 million in humanitarian assistance to support them.

The funding will provide emergency food and nutrition assistance, life-saving medical care, shelter and safe drinking water. It will also fund programmes to

improve sanitation and hygiene to treat and stop the spread of preventable diseases. It is estimated that 8.5 million people in Ethiopia are in need of urgent humanitarian assistance, a situation that has escalated due to the insecurity and large-scale displacement along the border of Oromiya and Southern Nations Nationalities and Peoples region. We learn that the number of people displaced along the Gedeo and West Guji zones has risen to almost one million since April 2018. This newly displaced population is on top of the 1.6 million Ethiopians who have been pushed away from their homes by drought conflict and as such, require immediate and vital humanitarian assistance.⁽²⁾ ■

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Climate Hazards Group: Strengthening defences against food in-security

The Climate Hazards Group contributes to Food Security Outlooks that strengthen food security

The Climate Hazards Group (CHG) brings together a cooperative team of multidisciplinary scientists and food security analysts from the University of California, Santa Barbara, the U.S. Geological Survey (USGS), Africa and Central America to develop data sets, tools and forecasts that help guide effective disaster responses and long-term development plans in food-insecure countries.

Working closely with partners in the USGS, NOAA CPC, NOAA ESRL, NASA, USDA and the Famine Early Warning Systems Network (FEWS NET), the team uses climate and hydrologic models together with satellite-based Earth observations to provide six-to-eight month food security outlooks for the world's most vulnerable populations. The CHG supports critical planning and timely humanitarian assistance that ultimately saves lives and livelihoods.

When climate variability and shifting climatic trends converge to produce severe droughts, fragile food insecure populations may face rapid-onset food crises as resources diminish, prices rise and household incomes decline. In vulnerable areas, these unanticipated climate shocks may devastate herds and harvests and degrade local food stocks. Unfortunately, the number of very hungry people continues to grow at an alarming rate over the past few decades, with more than 76 million

people experiencing life-threatening conditions in 2017 and 2018.

Many of these extremely food insecure people live in Africa, which experienced a recent sequence of severe droughts associated with an extreme El Niño and La Niña. To monitor these droughts, the CHG has developed the Climate Hazard Group InfraRed Precipitation with Station data (CHIRPS) data product.

CHIRPS harnesses the power of satellite technology, which is able to provide regular, detailed observations of entire regions. With each pass of the satellite, observers gain comprehensive information about how precipitation interacts with the geography. When combined with station data, CHIRPS allows for the rapid identification of hydrologic extremes, such as the terrible El Niño-related droughts in Ethiopia and Southern Africa in 2015-16, or the La Niña-related droughts in East Africa in 2016-2017.

Recent research (a, b, c) by the CHG has linked these droughts to very warm sea surface temperatures in the eastern and western Pacific Ocean. Very warm east Pacific waters (associated with the 2015-16 El Niño) contributed to rainfall deficits and very poor growing seasons in Ethiopia and Southern Africa.

In 2016, the global climate transitioned to a La Niña event, presenting cool east Pacific conditions and very warm

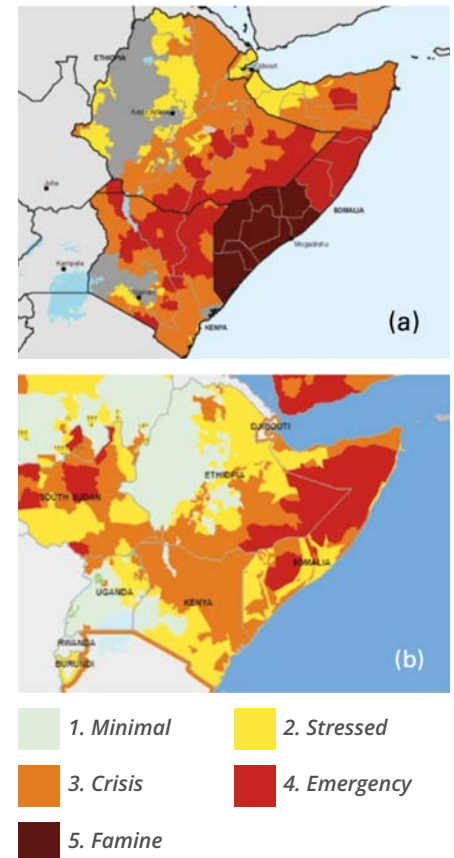


Figure 1. Integrated Food Insecurity Phase Classification (IPC) Maps showing the levels of food insecurity for (a) July-September 2011 and (b) June-September 2017. From this WMO report.

waters in the western Pacific and eastern Indian Ocean - perfect conditions for producing back-to-back droughts in Kenya, Somalia and eastern Ethiopia. Recognition of the dangers posed by these warmer waters helped the CHG and partners effectively predict droughts (d) in 2015, 2016 and 2017.

The CHG team has helped document predictable sequences in these extremes (a). Several times over the

past twenty years, a strong El Niño has occurred, followed by a La Niña. In 1997-2001, 2008-2011, and 2015-2017, successive El Niños and La Niñas produced multi-year increases in drought and food insecurity. These insights have helped FEWS NET, working with its network partners, successfully provide “food-security early-warning advisories with a six-to-eight months month lead-time (d).”

In 2010-11, such a pattern contributed to a very intense drought over Somalia, Ethiopia and Kenya, with more than 12 million people requiring assistance. Sadly, in Somalia, a combination of armed conflict and poor food access and availability led to the deaths of more than 250,000 people.

In October of 2016, the CHG began providing advance warning of another similar drought for East Africa. By June 2017, 27 million East Africans required urgent food assistance. This drought led to a United Nations appeal for \$4.4 billion in funding – twice the amount requested in 2011.

Indeed, “the improved early-warning systems and multi-agency responses employed during this drought, as well as improved humanitarian access thanks to less-adverse patterns of conflict, meant that famine was averted, unlike the case in 2010-2011 in Somalia” (d).

In 2011, Somalia food prices reached catastrophic levels. In 2017, the timely arrival of aid helped stave off meteoric increases, averting famine (Figure 1).

The CHG and FEWS NET partners also helped provide early warning for the 2015-16 drought in Southern Africa. Predictions for a strong El Niño led to pessimistic food-security outlooks beginning in July of 2015. By January



Figure 2. CHG members. Chris Funk, Greg Husak, Joel Michaelson, Alkhalil Adoum, Gideon Galu, Tamuka Magadzire, Seth Peterson, Laura Harrison, Diriba Korecha, Shradhanand Shukla, Chris Shitote, Frank Davenport, Diego Pedreros, Emily Williams, Pete Peterson, Marty Landsfeld, Sari Blakeley, Will Turner, Juliet Way-Henthorne, Mario Rodriguez and Amy McNally

2016, nearly five months before the end-of-season crop harvests, analyses of seasonal rainfall to date and historical El Niño rainfall performance led to a consensus FEWS NET agro-climatological assumption that crop performance in most Southern Africa countries was likely to fall below average. By June of 2016, the early warning community estimated that some 40 million people in the region needed humanitarian assistance.

Communication, collaboration, capacity

These early warning successes have made an important contribution to the implementation of the United Nations’ Sustainable Development Goals, particularly to Goal 2 and the challenge of ending hunger and achieving food security for all.

Close working relationship between climate scientists and food security analysts have enabled scientists to respond to the analytical needs of food security experts. These effective communication systems have facilitated the production of well-targeted briefs, reports and web-based interventions delivered to high-level decision-makers in both donor countries and organisations, and in the affected countries.

A unique and valuable component of the CHG team is its international composition (Figure 2). Almost half of the members of the CHG team live in Africa or Latin America. These scientists work closely with local stakeholders, decision-makers and science institutions to increase disaster preparedness and guide long-term “climate-smart” development. Building on the CHG’s commitment to developing data sets and tools, as well as harnessing the tremendous potential of satellite-based Earth observations, these capacity-building efforts are strengthening defences along the frontlines of climate variation and change.



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The update of the Baltic Sea Action Plan (BSAP) beyond 2021

Susanna Kaasinen, Project Manager at the Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM) explains the update of the Baltic Sea Action Plan (BSAP) beyond 2021

The countries around the Baltic Sea have cooperated for over forty years to protect the sea through the Baltic Marine Protection Environment Commission (HELCOM). In 2007, the HELCOM members – Denmark, Estonia, European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden – adopted the Baltic Sea Action Plan (BSAP) with the aim to restore the good ecological status of the sea by 2021.

The BSAP is an ambitious programme that has four main goals:

- The Baltic Sea unaffected by eutrophication;
- The Baltic Sea with life undisturbed by hazardous substances;
- Maritime activities carried out in an environmentally friendly way and;
- A favourable conservation status of Baltic Sea biodiversity.

For each goal, there are specific objectives and actions agreed to be accomplished either regionally or nationally.

Although progress has been made, there is still a way to go to complete the agreed actions and reach the planned goals. The recently published results of the State of the Baltic Sea Report (HELCOM, 2018a) show that the good ecological status of the Baltic Sea has not yet been reached and a mid-term review of the BSAP highlights that more needs to be done to accomplish all the agreed actions to improve the status of the sea (HELCOM 2018b).

While increasing the efforts to complete the already agreed actions, the HELCOM members are currently launching the update of the BSAP beyond 2021. The updated BSAP will have the same four strategic goals regarding eutrophication, hazardous substances, maritime activities and biodiversity, but will also take into account new global commitments and emerging issues.

The sufficiency of current measures will be analysed, and new measures will be agreed upon as needed.

The update process will involve a wide array of experts and stakeholders around the Baltic Sea and will utilise the most recent scientific findings. The United Nations' ocean- and water-related Sustainable Development Goals and targets will be incorporated into the updated BSAP. New ecological objectives will be developed for, for example, marine litter, underwater noise and seabed damage and disturbance.

The update will also take into account the impacts of climate change which can hamper the efforts to reach the set goals. For instance, the warmer climatic conditions may increase the nutrient runoff to the sea which will make it more difficult to reach the nutrient reduction targets and the goal of Baltic Sea unaffected by eutrophication. There is still work to be done to reach the good ecological status of the Baltic Sea and the updated BSAP will need to ensure that a good status will be reached and maintained under the changing climate in the future. ■

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Environmental approaches to regional security

Juri Martin from EuroAcademy offers his expert thoughts on environmental approaches to regional security

In many regions of the world, the renewable natural resources are being utilised faster than their natural rate of renewal and the regional environment is being abused in many other important ways as well. Moreover, the ecogeographical regions (ecoregions, regional approach, spatial planning) of the world are not generally delimited in synchrony with the political boundaries of the world.

The concept of environmental security

Two major prerequisites must be satisfied to achieve environmental security:

- A *protection requirement*, that is, the quality of the human environment must be safeguarded;
- A *utilisation requirement*, that is, any exploitation (harvesting or use) of renewable natural resources must be carried out on a sustaining basis.

The problems associated with environmental security fall into a number of more or less distinct categories and sub-categories:

1. Problems associated with the **protection and conservation of the environment:**

- Avoidance of vandalism (wartime or other non-remunerative destruction);
- Avoidance of excessive pollution, that is, pollution in excess of the natural renewal or cleansing processes and;

- Avoidance of any permanent anthropogenic intrusion whatsoever in a modest number of special areas.

2. Problems associated with **utilisation of the environment (ecosystem services):**

- Avoidance of utilisation at rates beyond long-term sustainability, that is, in excess of maximum sustained yield or maximum sustained discard and;
- Avoidance of utilisation – in the event of past abuses – at rates that will prevent recovery of the degraded environment (recovery, moreover, that may well require human assistance).

The problems associated with environmental protection, conservation and utilisation will, of course, vary in detail depending upon the nature of the resource. Resources can conveniently be divided into the following categories:

- **Non-extractive resources**, including the land and its soil, water and the atmosphere and;
- **Extractive resources**, including non-renewable resources and renewable resources.

It must be stressed that all utilisation of the renewable natural resources must be carried out on a sustained-yield basis; and that all disposal of waste must be carried out on a sustained-discard basis (circular economy). Without

an inflexible commitment to the sustainable development of resources and the sustainable disposal of waste, there can be no environmental security.

“It must be stressed that all utilisation of the renewable natural resources must be carried out on a sustained-yield basis; and that all disposal of waste must be carried out on a sustained-discard basis (circular economy).”

Protecting the quality of the human environment implies the prevention of soil erosion, of air pollution and of water pollution in excess of levels that would jeopardise the public health. It further implies the maintenance of representative habitats in their natural state and the prevention of species extinctions. In those instances where environmental damage or deterioration of some sort is already prevalent, the protection of the human environment implies actions that would restore the damage, at least in so far as this remains possible.



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New recycling project could ensure that no plastic is left behind

Iain Gulland, Chief Executive of Zero Waste Scotland sheds light on a new recycling project which aims to ensure that no plastic is left behind

When it comes to unintended consequences, few examples are as dramatic as plastic. Fully synthetic plastics are now more than a century old and in that time they have utterly transformed our world. Such is the huge range of products that make use of plastics, it's hard to imagine a world without them.

But their influence extends well beyond our homes and offices. In the waste and recycling sector, "the Blue Planet Effect" has almost certainly become the most-used phrase of 2018. The public has been rightly shocked at the devastation being reaped upon our oceans by plastic pollution. And that crisis is not limited to the sea.

To further complicate the picture, the Chinese government has announced import restrictions on plastic waste. The UK had been shipping up to half a million tonnes of plastic to China each year for recycling – with that avenue now closed, domestic solutions become an even more urgent priority.

The huge volume of public concern around plastic has led to a flurry of action by governments at all levels. The European Commission has launched its plastics strategy, which includes a commitment for all plastic packaging on the market to be 100% recyclable by 2030. The UK government has pledged to eradicate all 'avoidable' plastic waste by 2042 while Scottish ministers have announced plans to introduce legislation to ban the manufacture and sale of plastic stemmed cotton buds as well as establishing an Expert Panel to offer advice on further actions on specific plastic items. These commitments are great to see but it's going to take more than legislation and targets to make this happen – innovation will be key.



Iain Gulland, Chief Executive of Zero Waste Scotland

That's why we're proud to be supporting Project Beacon. The project combines existing and innovative mechanical and chemical recycling through three principal players (PI-Polymer Recycling, Recycling Technologies Ltd and Impact Recycling Ltd) to create a world-first Advanced Plastics Reprocessing facility at Binn Eco Park in Perthshire. Zero Waste Scotland is investing £1.7 million through our Circular Economy Investment fund – a fund made possible thanks to investment from both the Scottish Government and the European Regional Development Fund through the Resource Efficient Circular Economy Accelerator Programme Fund.

Project Beacon responds to a fundamental issue facing those of us trying to increase recycling rates. Many people are still confused about what items they can recycle. Project Beacon will demonstrate a system that enables householders to recycle all household plastics at the kerbside, part of their mission to make sure that 'no plastic is left behind'.

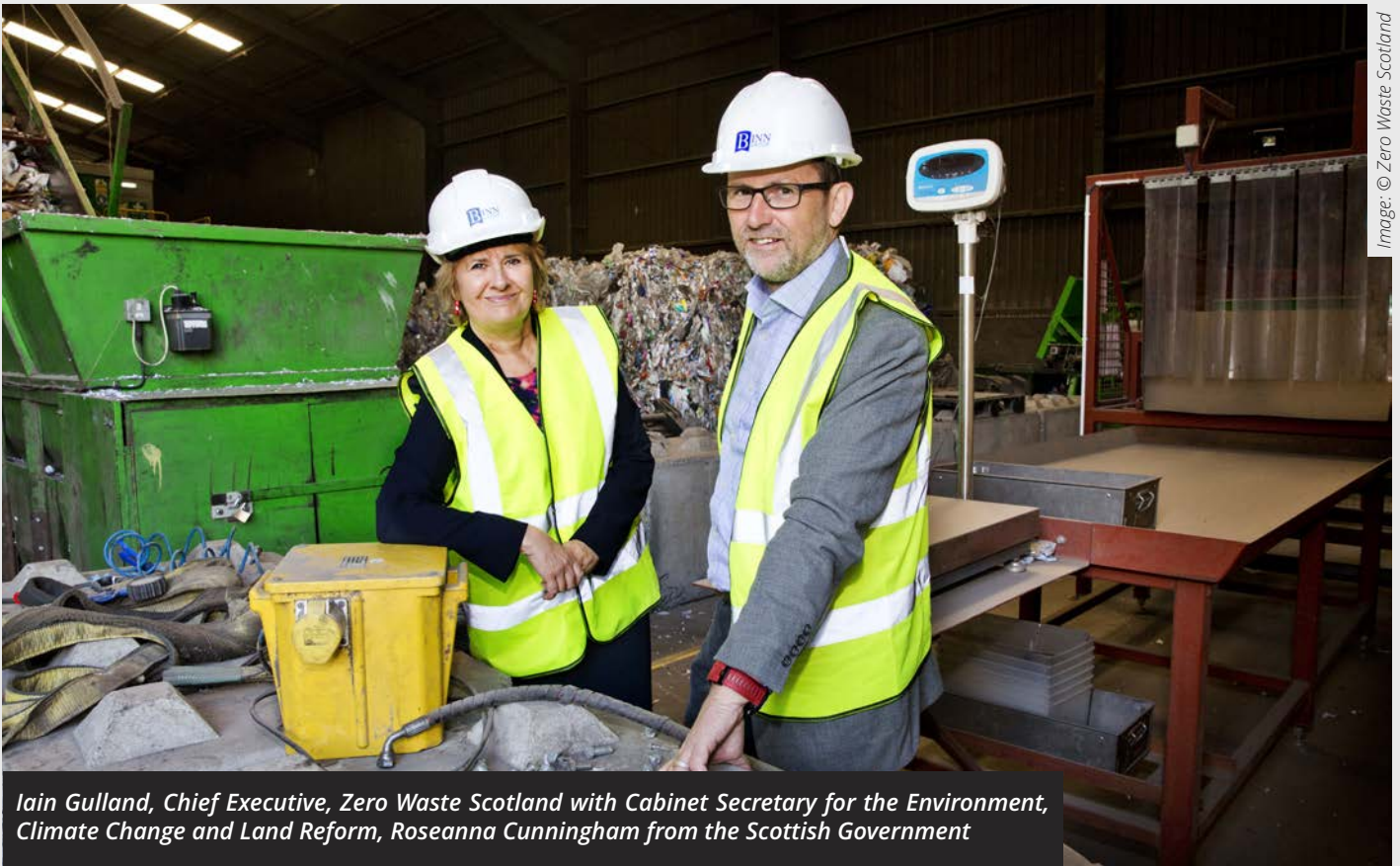


Image: © Zero Waste Scotland

Iain Gulland, Chief Executive, Zero Waste Scotland with Cabinet Secretary for the Environment, Climate Change and Land Reform, Roseanna Cunningham from the Scottish Government

The system uses new state-of-the-art separation systems to support mechanical recycling but fuses this with a game-changing chemical feedstock recycling process. This includes a patented process based on thermal cracking, which recycles end-of-life plastic waste that typically cannot be recycled using mechanical methods – for example, mixed, laminated, black, film and even contaminated plastic waste. This new process produces a range of chemical constituents that can be used to reform new virgin plastics or other chemical products. This has the potential to convert over 90% of all received plastics to new value-added uses.

This would allow local authorities to collect ‘all plastic in one bin’ at the kerbside, removing the uncertainty many people feel over what plastics can and cannot be recycled at home. The Project Beacon facility will demonstrate a circular solution with the potential to scale up globally – if Scotland can recycle 90% of its plastic waste then so can other countries facing similar challenges.

The facility will process between 15,000 and 25,000 tonnes of plastics per annum and create over 70 new jobs. The money we have invested has been more than matched by the private sector. This is a sign that investors are convinced circular economy approaches

to issues like plastic are not just good for the planet, they are potentially lucrative opportunities. I hope it will serve as a positive example to other businesses in Scotland of the exciting opportunities offered by our country’s growing circular economy.

It’s set to be an exciting time for those of us working to curb plastic waste in Scotland. The Scottish Government has also announced plans for a deposit return scheme, which Zero Waste Scotland is helping to design. With Scotland also the host nation for this year’s Circular Economy Hotspot from 30 October to 1 November, this will profile Scottish businesses action on the circular economy to an international audience, so there’s a real momentum behind transforming Scotland’s economy towards a model where things are made to last. ■

Iain Gulland
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Recycling: The ‘return-to-retail’ model for deposit return systems

Truls Haug, Country Manager, UK Collection Solutions at TOMRA details the ‘return-to-retail’ model for deposit return systems

The world is on a plastics spree. The global consumption of plastic drinking bottles hit 480 billion in 2016 and is set to increase by 20% within the next three years. Rising litter and ocean plastic are putting pressure on governments, businesses and consumers to address the environmental impact of beverage container waste.

Deposit return systems (DRS) offer an effective solution for collecting and recycling containers, reducing pollution by incentivising consumers to return their empties. Forty markets worldwide have adopted DRS on single-use containers, with numerous ways to implement them. A key question for legislators is where to place return points: at multiple smaller locations, or should there be fewer, dedicated depots?

One approach is the ‘return-to-retail’ model, where shops selling beverages become legally responsible for accepting used containers for recycling. This achieves up to 99% return rates in the best-performing markets. Offering convenient locations for consumers and faster roll-out for legislators, this model also benefits retailers through increased footfall, financial incentives and an improved corporate image.

TOMRA has first-hand insight into different collection models and the results they achieve. Founded in 1972, TOMRA collects 35 billion containers



for recycling annually through 82,000 reverse vending installations worldwide. TOMRA has vast experience in markets that legislate retailer participation, in terms of those with central depots and hybrid models offering both. Here is how the return-to-retail model works and what it means for government, business and consumers.

What is the return-to-retail model?

Return-to-retail legislation requires stores selling beverage containers to collect them for recycling after use. Shops gain an opportunity to help recycle a retail product that can pollute streets, parks and oceans. Legislation might apply only to larger supermarkets, like Lithuania where urban stores over 300 sqm must participate, while smaller stores can opt-in.

For efficiency purposes, shops often decide to provide reverse vending machines (RVMs). Located indoors or outdoors, RVMs make container returns both fast and convenient. RVMs count and analyse containers, reject ineligible items and pay refunds. Faster than manual handling, RVMs ensure recycling takes minimum personnel time.

Return-to-retail results

“Pure” return-to-retail models exist in nine European, one U.S. and three Canadian DRSs. Ten additional markets have hybrid models featuring some retailer participation.

The world’s eight best-performing DRSs employ return-to-retail, achieving an average return rate of 93%. Germany, which introduced a return-

to-retail DRS in 2003, sees 98% of plastic bottles collected and 99% of cans. Norway, where TOMRA pioneered the first RVMs in 1972, returns 92% of all beverage containers for recycling. Regions without retail involvement average 77% returns, with some markets as low as 48%.

For government

With convenient locations and the strong track record of return-to-retail, legislators are, therefore, more likely to achieve **positive community response and higher return rates**. Lithuania saw returns rise from 34% to 92% within just two years of launching its return-to-retail DRS – something that is certainly an environmental, economic and policy success.

With supermarkets close to residential areas, return-to-retail **removes the need to build or outfit new depots**, so DRS can deploy faster and more cost-effectively. Supermarkets typically have networks across whole markets, including remote communities, ensuring recycling points for everyone. Supermarkets can accommodate truck access, for dedicated pick-up or backhauling to a central warehouse (for organised collection, lower costs and fewer trips).

Finally, return-to-retail collection often avoids extra costs. Non-retail redemption operators tend to incur higher handling fees, require funding for site maintenance and charge commercial rates for services like bin changing and refunds.

For retailers

1. Increased footfall. Retail returns bring more shop visits, especially if recycling refunds serve as in-store credit. 93% of Swedish RVM users shopped when they recycled; 44%

did their full weekly shopping. In four countries, shoppers returning containers spent more money than those not recycling.

2. Financial reimbursement. Many markets pay retailers a handling fee for each container received, to recuperate any investment and operational costs. This revenue continues once the investment is covered.

3. Brand image. Retailers build their corporate image, showing the store's CSR commitments and supporting sustainability initiatives.

4. Richer data. Today's RVMs offer retailers digital products to enhance customer service, including user analytics, marketing channels and consumer engagement opportunities.

5. Operational support. TOMRA offers advice on the most suitable machines (with solutions for the largest hypermarket to the smallest corner store, so RVMs can have a very small footprint), plus service and support after installation.

Several options exist to finance RVMs. In some regions, retailers purchase RVMs, while other markets lease or simply host. In Lithuania, TOMRA provided RVMs to stores for free, as the DRS system operator pays TOMRA a 'throughput' fee.

For consumers

Return rates improve with convenient access: while depots are fewer and further away, people already visit supermarkets regularly. Recycling becomes habit and consumers avoid 'going out of their way' to recycle. Eliminating travel time reduces car

congestion, fuel consumption and air pollution.

With many food shops available, consumers have multiple return points, cutting wait times. In RVM user surveys, over 75% of respondents said avoiding queues was extremely important.

With return points in stores, retailers keep the area clean, redemption opening times are easy for consumers to remember and staff are nearby. Consumers enjoy their recycling experience, benefiting the retailer and the environment.

The future of return-to-retail recycling

As more markets introduce deposit return legislation, the clearer it becomes that model design – including the extent of retailer participation – greatly influences return rates.

By adopting the return-to-retail approach, governments, businesses and consumers can help increase the effectiveness of DRSs and reduce container waste.



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Protein plastics for a future sustainable society

Mikael Hedenqvist, Professor at KTH Royal Institute of Technology provides a fascinating glimpse into research on the development of protein plastics

The polymeric materials division at the Royal Institute of Technology, has been doing research and development of protein plastics since the late 1990's, often together with the group headed by Professor Eva Johansson at the Swedish Agricultural University, Department of Plant Breeding. There is an ever-growing need for plastics from renewable resources rather than oil, to reduce the amount of green-house gases produced, leading to global warming.

“...we have shown that there are many possible applications for protein-based plastics and even though they are moisture sensitive, for more demanding environments (high moist conditions), they can be prepared with antimicrobial agents (in the same way as wood is for certain applications).”

Using a renewable feedstock will minimise the “pollution”. Protein plastics are an interesting alternative, not the least since it is often a side-stream product (co-product or by-product) from an existing industrial process. By making plastic products (added-value products), especially from a by-product improves the effectiveness by which we use the natural resources and leads to a more sustainable society.

The sustainability improves even further if the additives put into the plastic are from a renewable resource. When it comes to renewable resources, proteins for plastics can be obtained from

“food” plants (e.g. from soy, wheat, corn, oat, potato, pea) but also from non-edible sources (e.g. cotton and oil plants like *Crambe Abyssinica* and *Brassica Carinata*). Animal-based proteins are also alternatives for plastic production, refer to e.g. proteins from milk (casein and whey), connective tissues (collagen and casein), feathers and wool (keratin) and silk (fibroin).

Available proteins

Figure 1a shows some of the protein plastics we are or have worked with. Wheat gluten is among the proteins that forms the most cohesive material. Therefore, it has been used to improve the cohesion of other protein materials (Fig. 1a).¹ Wheat gluten plastics can be made into many different types of products, including flexible films, foams and rigid solid 3D items. It can be coloured in all kinds of colours and made opaque or translucent. Protein plastics are stiff and to obtain flexible products, these have to be plasticised with e.g. a natural sugar (keeping the whole product bio based).

The plasticisation will also make the material tougher. Glycerol is a large by-product from biodiesel fuel production and therefore available in large amounts. There are alternatives to glycerol (e.g. sorbitol) but it is hard to beat glycerol in terms of its effectiveness as a plasticiser.² The rapeseed protein (rape seed meal/cake) is also available as a by-product from biodiesel production.³ Mixing it with

wheat gluten and plasticiser leads to material that resembles PVC flooring (flexible but inelastic/dull). *Crambe Abyssinica* is a plant with oil seeds which is, based on its toxicity, inedible for both humans and animals.

We have shown that it is possible to extrude *Crambe* into films when it is combined with wheat gluten and plasticiser.¹ Whey protein (by-product milk protein from the cheese production) is a protein that with plasticiser forms flexible films with good cohesion.⁴ If it is a high protein purity grade (whey protein isolate) the films are fully transparent. To reduce the price films can be made with lower protein purity, but the films will be less transparent. For the lower purity grades, there is also a distinct smell of cheese.

Wheat gluten with its high cohesion is perfect for foaming (refer to bread-making). Hence foams are easily obtained with this protein.⁵ Our freeze-dried foams have both closed and open cells and can be either rigid or flexible (with plasticiser). With different additives, the strength can be increased (e.g. with bacterial cellulose nanofibers), the foams can be conductive (using nano-sized carbon black or carbon nanotubes).⁶ Soft conductive foams can be used e.g. to provide protection for static sensitive devices. The foams can also act as sponges (absorbents) with a large uptake of both polar and non-polar liquids.⁷

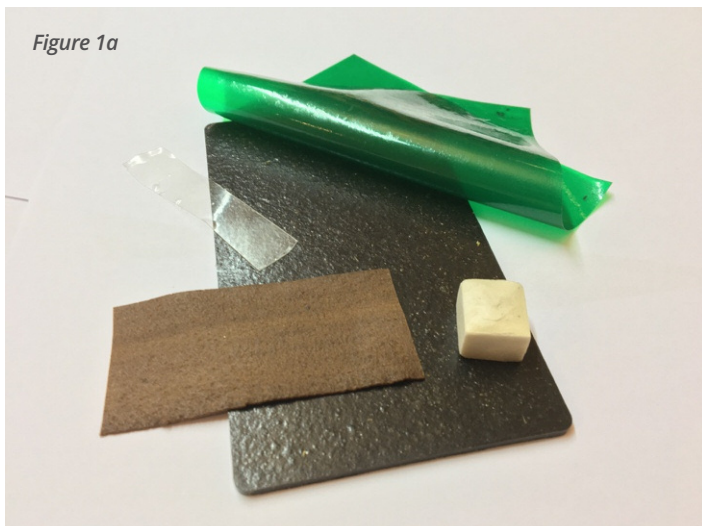


Figure 1a

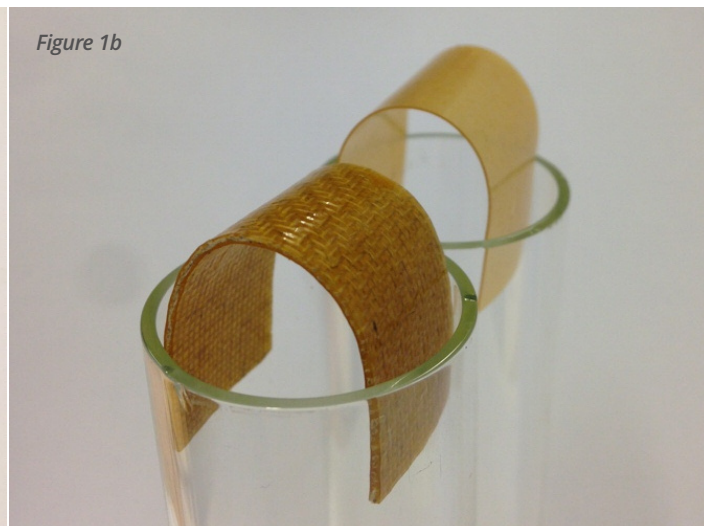


Figure 1b

Figure 1a. The dark-brown plate is made of a mixture of wheat gluten and a rapeseed protein-based material. The green material is a caramel-coloured wheat gluten film and the cube is a wheat-gluten foam, obtained from freeze-drying an aqueous protein dispersion. The transparent film is a whey protein-isolate sample and the light grey film is based on proteins from *Crambe Abyssinica* and wheat gluten. All samples except the foam is plasticised with a sugar (glycerol).

Figure 1b. Two plasticised wheat gluten films with (in the front) and without a flax fibre weave.

The research in the field of bio based composites is extensive. To preserve a fully bio based material both the matrix and the reinforcement should be obtained from a renewable resource. We have shown that it is possible to obtain flexible films with improved strength and fracture resistance by combining a plasticised protein plastic (wheat gluten) with a flax fibre weave (Figure 1b).⁸

To conclude, there are many possible applications for protein-based plastics and even though they are moisture sensitive, for more demanding environments (high moist conditions), they can be prepared with antimicrobial agents (in the same way as wood is for certain applications).

To preserve rigidity in e.g. water, the proteins can be crosslinked. The protein plastics constitute in several ways a material group by itself, it is not a classical thermoplastic since the properties change somewhat after each thermal treatment, with plasticiser it resembles an elastomer or a duller material,

similar to plasticised PVC, at high protein aggregation/polymerisation the protein turns into a thermoset.

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Contagious Cities: Cultural programming in a policy context

Ken Arnold, Creative Director at Wellcome explains what contagious cities are and the extent to which they are considered to be cultural programming in a policy context

Bacteria and viruses inhabit us, just as we inhabit cities. These complicated and sometimes unexpected cohabitations are the focus of 'Contagious Cities', an international cultural initiative produced by Wellcome. They have had profound influences on our health and how we lead our lives, especially in cities, where people, goods and germs are endlessly intersecting. And they are issues with pressing relevance in our ever more connected times, but also ones that animate stories from history.

Timed to coincide with the centenary of the 1918/19 influenza pandemic, 'Contagious Cities' is staged across three globally influential cities – Geneva, Hong Kong and New York. Each has its own fascinating, often tragic, but also sometimes hopeful disease stories to share. With partners in each place, Wellcome will bring together different areas of expertise to co-produce exhibitions, artist residencies, events, curated walks and broadcasts presented to new audiences. Our goal is to foster and support locally grounded conversations around the international challenges of epidemic preparedness.

New York

New York is one of the few truly global cities, existing as much in the world's imagination as in its specific geographical location. In excess of 20,000 New Yorkers died during the flu pandemic. But this was lower than other eastern U.S. cities because New Yorkers had learned from earlier experiences with infections like TB.

For Contagious Cities, artist Mariam Ghani has been in residence at the New York Public Library and City University of New York researching a work that will explore linguistic and visual metaphors used for illness. It will feature in the Museum of the City of New York's exhibition 'Germ City: Microbes and the metrop-

olis' (September 2018 to April 2019). Co-curated with colleagues just next door at the New York Academy of Medicine, the show will contain personal, cultural, political and medical perspectives on New York's fight against contagious diseases. Meanwhile, at the other end of Manhattan, the Tenement Museum will host a series of special tours of its historic buildings, focused on former residents' tales of disease, immigration and reform.

“‘Contagious Cities’ is primarily aimed at generating inclusive public conversations that explore common topics across international cultural differences: innovative forms of programming for a variety of diverse audiences. But we are also keen to grasp the opportunities inherent in culture’s unique convening power. We see it as a compelling chance to focus attention on global health topics of vital significance to Wellcome, but in a different light, from unusual perspectives.”

Hong Kong

Hong Kong is perhaps the world's most connected city, with a vibrant history as a hub of international travel, but also of contagious diseases. The impact of the 1918 flu pandemic was relatively mild, but the so-called third plague pandemic that spread from Hong Kong a quarter century earlier was far more devastating, leading to millions of deaths worldwide. Hong Kong was also at the centre of the 2003 epidemic of the severe acute respiratory syndrome (SARS).

Angela Su is producing a new piece of artwork that will delve into the complicated baggage of the project's title: what does it really mean for a city to be labelled contagious? Her work will be part of an exhibition at Tai Kwun, Hong Kong's brand-new centre for heritage and arts. Curated by independent curator Ying Kwok,

THE BUILT ENVIRONMENT



New York



Hong Kong



Geneva

the show will examine the city's relationship with epidemic diseases and particularly some of their psychological legacies. Other elements of the project will feature an artist-led programme at the art space Oi! and a guided app for the Taipingshan Medical Heritage Trail created by the Hong Kong Museum of Medical Sciences.

Geneva

Half of Geneva's citizens were hit by the 1918 flu. Commissioned by 'Contagious Cities', Blast Theory has produced an artwork in response to their research stay at the World Health Organization's Strategic Health Operations Centre (the so-called SHOC room) in Geneva, where epidemics and pandemics are monitored in order to coordinate international responses. Their piece is likely to reflect on moments of uncertainty in how decisions are made there.

This multi-faceted cultural initiative is strongly linked to a key priority for Wellcome: to understand and strengthen global preparedness for future potential epidemics. During the recent Ebola outbreak in the Democratic Republic of the Congo (DRC), for example, Wellcome contributed to the swift and decisive action that has led to its fragile, but relative containment. Here is tangible evidence of how learning from the (recent) past can inform the global community's attempts to outsmart future epidemics.

'Contagious Cities' is primarily aimed at generating inclusive public conversations that explore common topics across international cultural differences: innovative forms of programming for a variety of diverse audiences. But we are also keen to grasp the opportunities inherent in culture's unique convening power.

We see it as a compelling chance to focus attention on global health topics of vital significance to Wellcome, but in a different light, from unusual perspectives. And we are eager to see how much of a platform this might give us to disseminate key messages through targeted media coverage, as well as to expand our sphere of cultural influence, but crucially without diminishing the integrity of the project's cultural outputs.

How might we, for example, share thematically relevant contemporary culture with thought leaders in public health and important policymakers, but not reduce the art to flimsy instruments of persuasion? Can we find ways to introduce artworks, exhibitions and thematic events as means genuinely to learn from the past, stimulate new ideas and help spread collective responsibility and action? In truth, 'Contagious Cities' represents an experiment in the cross-fertilisation of culture and policy – Wellcome's own version of the ancient art of cultural diplomacy. If successful, it promises, on the one hand, to add vitality to international exhibitions and public events and, on the other, to infuse policy-based conversations with the riches of cultural understanding. ■

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Epidemiological interactions between rural and urban populations and the consequences of urbanisation

Romola Davenport and Richard Smith from the University of Cambridge explore epidemiological interactions between rural and urban populations and the consequences of urbanisation

Today, urban populations almost always have higher life expectancies than their rural counterparts, because cities provide better access to health facilities, clean water and sanitation and because urban dwellers tend to be richer. However, this pattern is a very modern one. Before the early twentieth-century rural populations were almost uniformly healthier than urban ones. Indeed, in the centuries before c.1770, European cities were characterised by death rates so high that their populations would have imploded without a reliable stream of rural migrants. Some scholars have argued that this 'urban graveyard' effect imposed an upper limit on the levels of urbanisation and therefore, economic growth that those pre-modern societies could sustain because cities imposed such a drain on the populations of their rural hinterlands.

For rural migrants to towns, the health costs of immigration were high. Before the twentieth century, towns were characterised by much higher levels of infectious diseases, especially gastrointestinal diseases, as a consequence of inadequate sanitation and so-called 'crowd' diseases that relied on high population densities for transmission.

For those born in towns, these diseases took their greatest toll in childhood, when diarrhoeal diseases were most lethal, and when many diseases were encountered for the first time. For urban-born adults, the disadvantages were not so great, because those who survived to adulthood had already encountered and developed some immunity to many of the most dangerous urban diseases. Migrants, however, were in an immunological sense akin in some ways to young children. Many rural migrants came from areas where diseases, such as measles and smallpox were rare, and they often arrived in cities with no immunity to these diseases.

The consequences of these differences in disease exposure in rural and urban areas are strikingly illustrated in the case of smallpox. Before the introduction of vaccination c.1800, smallpox was the single most lethal disease of eighteenth-century Britain, accounting for up to 10% of all deaths in southern England and up to 20% in the north.

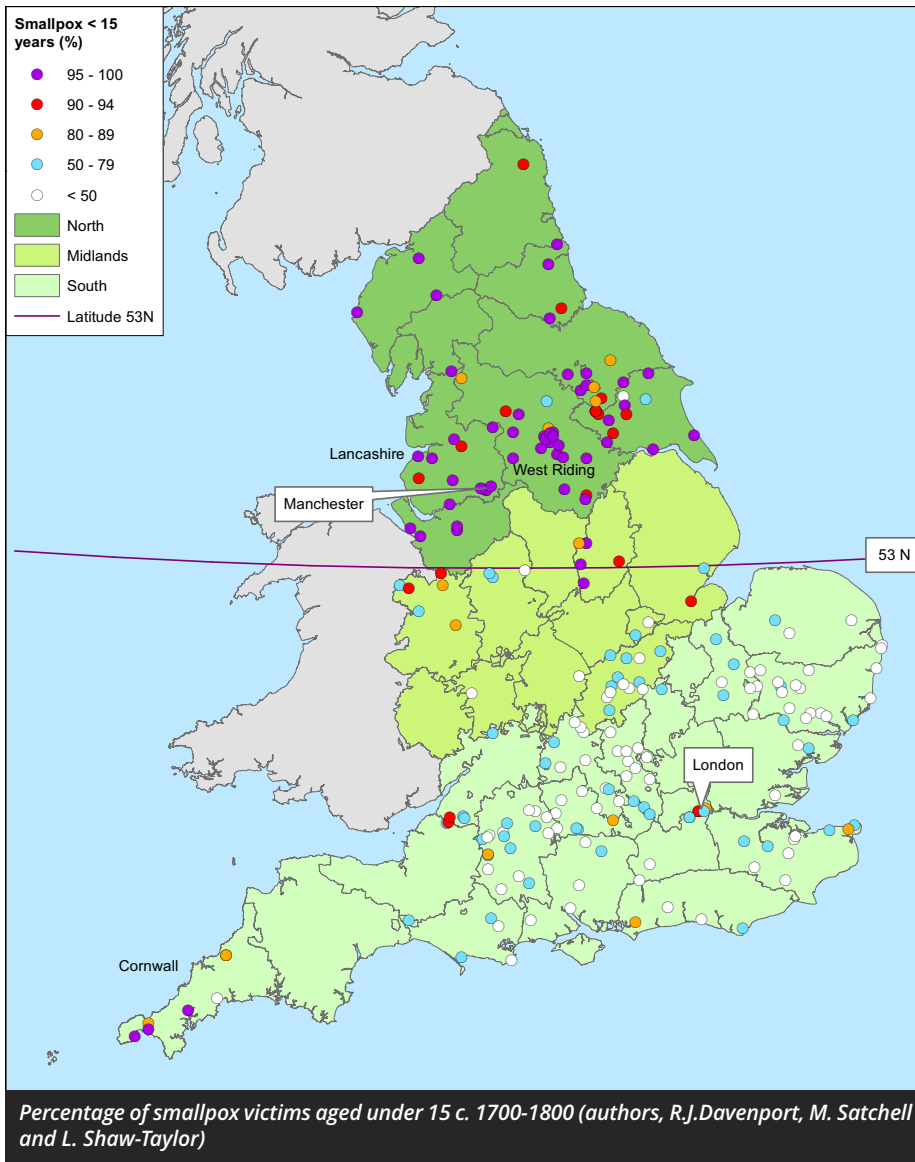
In eighteenth-century London, smallpox was pre-eminently a childhood disease, with deaths concentrated amongst children under seven. However, there was a second bulge of smallpox deaths amongst young adults, primarily when young migrants

arrived for the first time in London. Although probably taller on average than their urban-born peers and healthier than the rural populations they left behind, these young economic migrants contributed to high urban death tolls.

"For rural migrants to towns, the health costs of immigration were high. Before the twentieth century, towns were characterised by much higher levels of infectious diseases, especially gastrointestinal diseases, as a consequence of inadequate sanitation and so-called 'crowd' diseases that relied on high population densities for transmission."

Before vaccination, the dangers of smallpox to rural migrants to towns depended on the extent to which smallpox patterns differed between towns and their migrant hinterlands. In southern England, smallpox was a rare epidemic disease outside the largest cities and many rural dwellers survived to adulthood without infection.

However, in northern Britain smallpox circulated as a childhood disease throughout rural as well as urban areas. As a consequence, very few migrants died of smallpox in northern towns because they were already immune. This north-south difference



accompanied industrialisation. As a consequence of vaccination, changes in urban breastfeeding habits and other as yet unidentified factors, mortality in British cities had fallen by the early nineteenth century to the point where urban populations could reproduce themselves and cities acted to brake, but not to reverse population growth. Further improvements in water supplies, housing, income and sanitation were required to reverse the urban-rural gradient to the point where urban life expectancies exceeded rural (a point reached by the 1930s).

However, the example of smallpox illustrates the complex interplay of pathogen life histories, local policies, migration patterns and immunisation and other disease control strategies that continue to influence epidemiological interactions between rural and urban settlements. These interactions are historically contingent, a point that has given fresh force by recent reversals of urban-rural life expectancies in some affluent nations as a consequence of urban deprivation and changes in the main causes of death.

in patterns of circulation of smallpox in rural populations appears to have arisen from differences in local responses to smallpox.

In the south, smallpox victims were isolated, and markets closed to prevent outbreaks. In addition, once inoculation (a forerunner of vaccination, involving immunisation with a low dose of smallpox) became popular then many southern parishes performed occasional mass immunisations of the entire vulnerable population to prevent outbreaks. Northern communities did not adopt these tactics, possibly because they lacked the means to provide publicly-funded isolation facilities and free

mass inoculations. The circulation of smallpox as a childhood disease throughout northern Britain increased smallpox mortality in rural areas, but also reduced the mortality gradient between town and country, lessening the risks of rural-urban migration in the north compared with southern Britain.

After 1800, the enormous decline in smallpox infection with vaccination made cities substantially safer for young children and for especially southern migrants. Vaccination made a major contribution to reducing urban mortality rates and in reducing the human and demographic costs of the unprecedented urbanisation that



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Autonomous vehicles can accelerate the journey towards smarter cities

Dr Ingo Stuermer, Global Engineering Director Autonomous Driving, Aptiv explores the extent to which autonomous vehicles can accelerate the journey towards smarter cities in the future

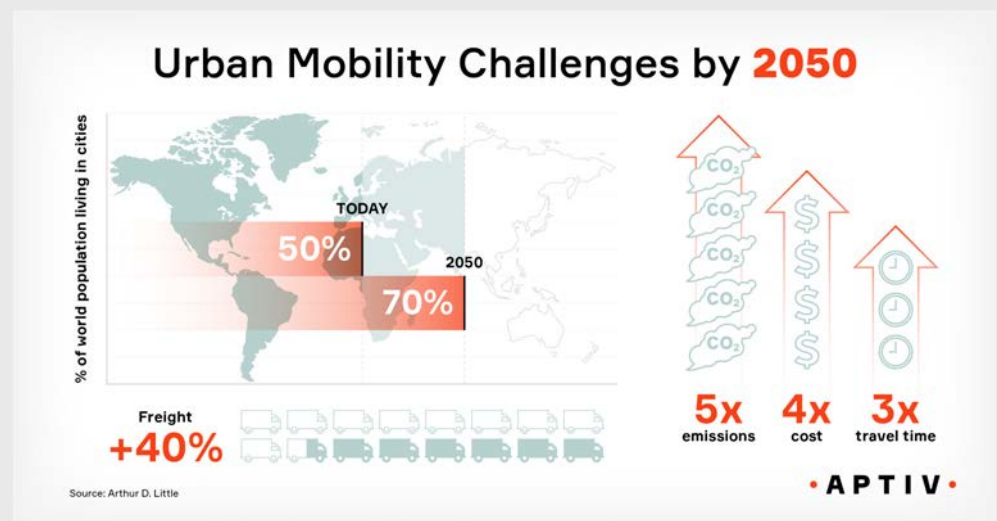
Cities are fast becoming the epicentre for mobility innovation – and for good reason. Mobility is the lifeblood of any city. It enables the movement of people, goods and thus ideas, social interactions and resources. Mobility is what makes a city liveable and an attractive place to live.

Cities today, however, face massive challenges in improving mobility. If you ask any city mayor, planner or transit official, he or she can reel off multiple challenges such as safety, congestion, environmental concerns and equitable access for all. With urban populations projected to increase to 70% of the global population by 2050 (up from about 50% currently), these challenges will only continue to grow.

This increased population growth in cities means that by 2050, congestion and thus commute times could increase threefold, costs of transportation could increase fourfold and emissions could rise to five times the current levels.

To ensure our cities continue to remain liveable, it is clear that a number of steps need to be taken to address these issues. These may involve empowering cities to come up with new solutions, offering financial support at a national level, or embracing new technologies that are helping to evolve the very concept of mobility as we know it.

It is the latter option that I would like to spend some time discussing in this piece – specifically, the pivotal



role that autonomous vehicles can play in paving the way for a smarter, more connected city. Because, believe it or not, autonomous vehicle technology has an incredible potential to address most of these challenges.

Did you know, for example, that studies show autonomous technologies can reduce urban travel time and bring down emissions by 30% and 66% respectively? Or that autonomous technologies have the potential to lower the number of required parking spots by 44%?

While autonomous vehicles may still feel like a distant dream to many (unless you live in Las Vegas where they are already being used on the road today), they are a reality towards which we are rapidly moving. And one day in the not too distant future, they will play a very important role in helping to keep our cities moving.

Autonomous vehicles offer so much more than simply mobility benefits. Perhaps the most striking and

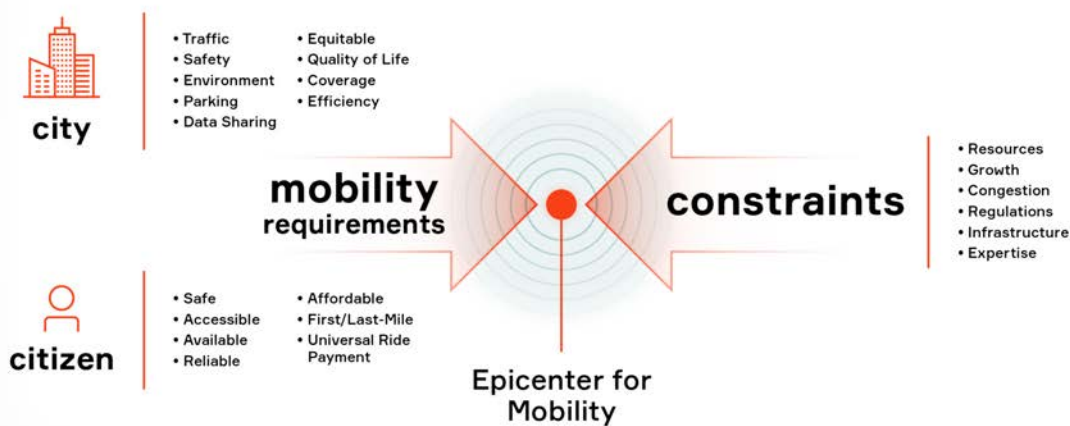
Benefits of **mobility automation** to cities



Source: World Economic Forum and BCG

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Why Smart Cities



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valuable impact they can have on cities of the future concerns the safety of their residents. Autonomous technology has the potential to reduce traffic accidents by nearly 90%. That is a staggering figure that offers significant value to all cities across the globe. It is for this very reason that progressive cities are planning for connected and autonomous vehicles by deploying upgrades including vehicle-to-infrastructure technologies and smart traffic signals, both of which can be helpful in enhancing road safety.

With urbanisation set to move into overdrive in the coming years, new technologies and new solutions will need to be deployed by city planners and councils in order to keep streets moving and the public safe. These are just a few of the reasons why autonomous

stakeholders need to focus on working with cities to understand challenges, use cases and how autonomous technology can integrate and work with city requirements. The cities that handle these mobility challenges best will provide an enhanced quality of life and thus attract more residents, capital, jobs and opportunities. This is why it is critical that cities realign themselves with a mobility focus. ■

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The impact of exogenous factors on high rise housing estates

Dr Gideon Bolt from the Faculty of Geosciences at Utrecht University details the impact of exogenous factors on high rise housing estates

In the previous issues of Open Access Government, I discussed the planning failures that played a role in the deterioration of large housing estates (Bolt, 2018a), as well as the role of housing allocation (Bolt, 2018b). However, it should be acknowledged that exogenous factors, like the construction of new neighbourhoods and economic restructuring, often play a more dominant role in the deterioration than internal factors. In this issue of Open Access Government, I will dwell upon these exogenous factors (see Bolt, 2018c for a more elaborate overview).

New housing production & tightness of the housing market

The competitive position of large housing estates depends on the tightness of the local housing market. Van Gent (2010) compared four housing estates in Birmingham, Amsterdam, Barcelona and Stockholm. Although the four neighbourhoods were similar in their urban design, Birmingham was much more stigmatised as a slum area. Residents there are seen by outsiders as people that only stay there because they have no choice to move to a better place. The other three housing estates could benefit from spillover demand due to the tightness of the regional housing market.

The tightness of a housing market can be alleviated by new housing production. In the segregation literature, it is

often overlooked that this can be a factor that exacerbates the spatial division between the rich and the poor. In Dutch cities, post-war housing estates face a tough competition from greenfield developments built at the edges of the big cities. These developments attract middle and high-income households, many of whom move out the relatively deprived housing estates. This resulted in an increased concentration of low-income people in post-war housing estates. The spatial division between the rich and the poor is increasing in all of the six cities investigated, but the trend was strongest in cities where the greenfield developments were the most extensive (Boschman et al., 2013). In Eastern Europe, the lack of new housing production was one of the reasons that large housing estates in Eastern Europe did not end up in a downward spiral during the first decade after the collapse of communism (Herfert et al., 2013).

Declining employment

The social downgrading of large housing estates is in many cases, the result of economic restructuring. For instance, the decline of the Park Hill housing project in Sheffield, which initially was one of the most appraised public housing schemes of the post-war period can to large extent be explained by the collapse of the steel industry (Monclús & Díez Medina, 2016). In the UK, Glasgow is the city that is hit the hardest by the process

of deindustrialisation. The average level of income deprivation in the city is 25% (twice the Scottish average) and in areas dominated by high rise housing estates, deprivation levels reach over 40% (Kearns et al., 2012).

Some Eastern European housing estates have suffered even more from the deindustrialisation process than their western counterparts. In contrast to the rest of Europe, new cities were constructed at sites where new factories emerged. When factories closed, these cities were abandoned, as they were too dependent on a single employer (Monclús & Díez Medina, 2016). Some of these cities could escape that fate due to their central location. For instance, the Czech city of Kročehlavy was built around a few industrial plants. When industrial employment declined dramatically in the 1990s, Kročehlavy did not end up in a process of social degradation. Due to its proximity to Prague, it is gaining younger residents who commute to Prague for their work (Temelova et al., 2011).

Conclusion

According to Turkington et al. (2004, p. 265), the heydays of high rise housing estates (the 1960s and early 1970s) produced the “most uniform and international European housing type” ever built. All over Europe, housing estates emerged that were very similar in terms of construction methods, location and urban design. At the



same time, housing estates across Europa did not all follow the same trajectory after their completion. That is because the main reasons for the deterioration and social degradations are exogenous factors, not internal factors. Of course, it makes a difference whether the initial quality of a housing estate is good and whether an estate is well managed. But people who are responsible for the management of an estate make no decisions about the performance of the regional economy. They also make no decisions about the size, quality and location of new housing where their estates will have to compete with.

Social housing in many Western European countries is not residualised because housing managers make the wrong allocation decisions, but because home ownership is prioritised over renting. Admitting low-status households often leads to a lower maintenance budget, but it is a rational choice as a higher proportion of vacan-

cies would have a more devastating effect.

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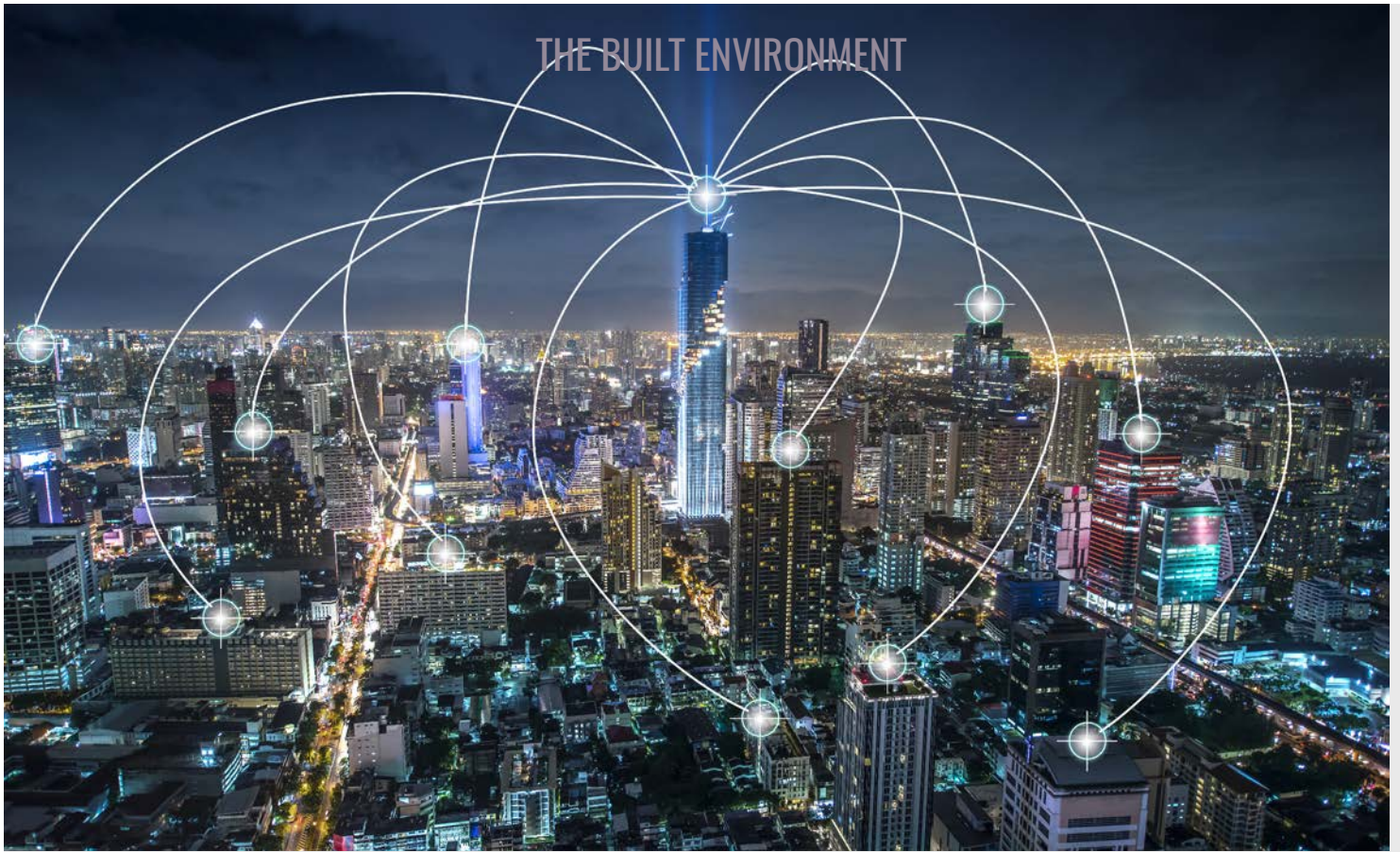
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The infrastructural revolution: Enabling smarter and more liveable cities

Chris Fry, Director, Infrastructure & Regeneration, Ramboll explores how the infrastructural revolution is enabling smarter and more liveable cities

Our towns and cities are constantly changing around us. Containing a variety of buildings, the UK's towns and cities are based on historical foundations and an ageing infrastructure. With restricted budgets, a practical solution is required to keep up-to-date with the ever-changing world, so that the UK can continue to develop, transforming its towns into smart cities.

It is expected that the number of connected devices forming the internet of things (IoT) will rise from 15 billion to 75 billion globally between 2015 and 2025 (Statista), with devices becoming smarter over time. For example, we currently have self-weighing recycling bins that can identify and report when they need emptying, but in the future, we might expect bins to identify products that you have used and automatically reorder them for you.

There is a vast and ever-expanding range of possible applications and benefits of smart technology in our villages, towns and cities. Techniques such as modular and offsite construction are revolutionising productivity in construction, with significant savings in time and materials as well as safety improvements. At the same time, disruptive start-ups and established industry players are competing to innovate new products and services, making use of smart energy, smart buildings and smart mobility.

Smart technologies can also help us achieve cleaner and greener spaces. However, as noted by Matthew Farrow of the Environmental Industries Commission (EIC), "global cities are struggling to manage the pressures of growth, and while over time many of these pressures will be environmental, the most urgent have often been things like transport congestion".

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The goal itself need not be specifically achieving 'smart' solutions but should be improving places of work and living for people and society generally. Visionaries and planners of smart cities would be wise to closely follow their customers' and local communities' needs and wishes.

Social and economic empowerment can be achieved through smarter infrastructure, such as district heating, decentralised community energy generation or battery storage systems. Equally, mobility on demand could negate the need for cars, or even the ability to drive. Nevertheless, providing affordable access will be challenging, given that disparities in opportunities and health between richer and poorer neighbourhoods are still widening in many places. Bristol, one of the UK's leading cities in this arena, has a smart city and innovation strategy with a clear focus on citizen-centric solutions.

Rapid technological advancement is offering considerably more opportunities than were available before. A clear purpose based on an understanding of local needs is fundamental to success for smart city developments. Liveability and sustainability are notions that could provide useful guidance in the search for this clarity of purpose. An aspiration for liveability has become well established in forward planning for the Danish capital, Copenhagen, leading to more integrated solutions including sustainable drainage systems and larger-scale 'blue-green' infrastructure solutions, such as green streets and multi-purpose public spaces.

As it considers the opportunities for creating a smarter city, Copenhagen is following an integrated and liveability-orientated approach. Exploring options for city-wide digital communication networks, enabling smart control of street lighting and traffic controls, soon to be expanded to the consideration of other opportunities, such as water management and keeping vulnerable citizens safe.

The issue of funding proves difficult for those pursuing smart city aspirations, mainly because in this interconnected world, there is no simple answer to the question of who pays and who benefits. The costs and advantages of 'backbone' digital communication networks, the smart solutions that utilise them and the ultimate beneficiaries (such as those with lower asset maintenance costs), may fall upon different operators at different



**Chris Fry, Director,
Infrastructure & Regeneration,
Ramboll**

times. Technology companies and the public sector will also have varying expectations and restrictions on their investments that will affect their business models.

Whilst we have to consider our complex economy and ageing infrastructure, it helps to also keep practicality in mind. Ambitions for the medium to long term future are worthwhile, but a top-down smart city approach is unlikely to deliver any short-term results. Working to upgrade existing assets and opportunities with smarter functionality, and integrating these alongside newer, fully smart interventions, is likely to be more successful.

By utilising artificial intelligence (AI) and analysing our existing operational data and digitalised design, we can help cities take immediate steps towards updating infrastructurally and becoming smart. Adopting smart technologies, including future generations of IoT devices, with existing communications will allow for the expansion of city-wide wireless networks, which in turn will see our cities not just develop, but evolve. ■

Ramboll is an active contributor to the EIC's collaborative Sustainable Smart Cities programme. For more information see www.sustainablesmartcities.org

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Swindon & Wiltshire’s emerging Local Industrial Strategy

Paddy Bradley Director of Swindon and Wiltshire LEP lifts the lid on the organisation’s emerging Local Industrial Strategy

Since the UK government published the UK’s Industrial Strategy in November 2017, we have been working in partnership with businesses and the government towards developing a Local Industrial Strategy for the region of Swindon & Wiltshire.

Our economic priorities identified through our Strategic Economic Plan are closely aligned with the foundations of productivity in the UK’s Industrial Strategy. Before the White Paper was published, we identified six themes which identify our place: innovation in emerging low carbon energy

technologies; advanced engineering, the aerospace defence sector and robotics; cybersecurity; using science to keep people safe; research and development and higher skills development; and strategic infrastructure investment.

“Our Local Industrial Strategy will focus on future-oriented, productive business sectors which are embracing technology and are offering the prospect of growth in high-value jobs.”

The first four are relative strengths, the last two are challenges to overcome to

accelerate our economic growth. Our Local Industrial Strategy will be “fit for the future”, cross democratic boundaries and will enable established and productive sectors to thrive and become globally significant.

Over the last year, we have been laying the foundations for our Local Industrial Strategy by undertaking research and developing our higher education, digital capabilities and energy strategies. We have also started work on our rail strategy and refreshed our Local Economic Assessment. Together, these will form a strong and robust evidence base for the refresh of our Strategic

Swindon & Wiltshire’s Emerging Local Industrial Strategy



Where should we focus our attention?



1 Ageing population



3 AI and big data



2 Clean growth



4 Future of mobility

We asked businesses which of the Industrial Strategy ‘big ideas’ will have the greatest impact on local productivity growth for Swindon and Wiltshire:

- 1** Business-led, multi-campus university:
 - Meet employer demand for higher level skills.
 - A strong university presence will attract students from outside the area and provide wider economic benefits.
 - There will be enough skilled workers to fill job vacancies, making the area attractive to investors, retaining local talent and improving both productivity and social mobility.
- 2** Electric vehicles and battery storage
 - Use of hydrogen rather than batteries because electric vehicles have a poor range.
- 3** Hydrogen as an alternative source of clean energy
 - Hydrogen as an alternative clean energy source.
 - Renewable resource fuelled employment sites which are carbon negative and micro networks of energy to be developed.
 - Army rebasing to meet technical skills demands.
 - Business rates used to support low energy initiatives.
 - Change in legislation/planning regulations.
- 4** Cyber resilience and trust in the use of big data
 - Cross cutting with ageing and future of mobility grand challenges.
 - Lot of change expected across sectors including financial services and agri-tech as well as demand for cyber security and resilience.
 - Focus on tech and innovation hubs and developing business networks.
 - Supply chain development opportunities from proximity to major centres where research and ‘ideas’ emanate.
- 5** Immunology development and med-tech
 - Academic life sciences project is driving innovation and life sciences.
 - Innovative use of data.
 - Data connectivity and access to rural area for medical support.
 - Value older people in the workforce including reskilling and upskilling the workforce to meet skill shortages.
- 6** Defence and aerospace supply chain development
- 7** Autonomous vehicles (land and air)
 - Invest in technology for autonomous vehicles along the A350 to the ports.

Economic Plan and for our Local Industrial Strategy.

Everything we do it business led, so alongside this evidence collection we have started talking to businesses at the heart of our thriving economy. We held some business engagement events in June 2018 to explore local opportunities against the UK’s four Industrial Strategy Grand Challenges that will enable Swindon & Wiltshire to put the UK are the forefront of the industries of the future and be a

global leader over the next 15 years. So, what did businesses tell us?

Our Local Industrial Strategy will focus on future-oriented, productive business sectors which are embracing technology and are offering the prospect of growth in high-value jobs. These businesses could be present in both our centres of urban population and our rural economy. The challenge here is in identifying potential “winners” in the competitive world of economic growth.



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Redefining the green belt to tackle the UK's housing crisis

astudio architects argues that redefining the green belt will help tackle the UK's current housing crisis

Mention the words 'green belt' and most people will conjure up romantic images of rolling fields, fresh air and luscious countryside. It is what we dream of as we rush down overcrowded concrete streets, but the reality of England's green and pleasant land is far different and the green belt is in urgent need of redefining. By lifting self-imposed planning restrictions and building on the least attractive and lowest amenity parts, we could remove the shackles on the UK's severe housing crisis.

Britain is in the midst of a dangerous housing shortage. Homelessness is on the rise, with over 77,000 households living in temporary accommodation last year and the limited housing we do have is unaffordable due to rising rent prices, falling wages and a stagnant construction industry. This is exacerbated by stringent planning constraints, which drive house prices up by restricting the land available for development – one recent study found that an oppressive planning system increases house prices by 35%.

Experts suggest that we need up to 300,000 additional homes to be built every year. The question, then, is how we can generate the homes we so urgently need when there is not enough available land on which to build them.

Should such strict planning barriers remain in place, a growing population will continue to be confined to smaller and smaller homes, and the government will be forced to carry on spending upwards of £2 million a day on temporary accommodation for the homeless – simply because no housing is available.

So does building on the green belt offer a solution? Certainly, it is a politically and socially sensitive subject. However, the green belt itself is actually a somewhat

arbitrary designation – and a significant portion of the land within it is not actually green.

In fact, a sizeable element of the 'green' belt is actually brownfield land with little or no environmental value. That means that disused petrol stations, warehouses, railway sidings and scrubland are all designated green belt land despite, firstly, not being green, and secondly, having little to no purpose for communities. The hedgerows, fields and woodlands that we associate with the green belt are typically protected areas of outstanding natural beauty or ancient woodlands, meaning that they, rightly so, remain untouched.

There are claims that maintaining the green belt is necessary to prevent urban sprawl and protect the environment. But while the environmental benefits of undeveloped land are plentiful, there are a number of problems associated with maintaining the green belt in its current form.

Over a third of it is devoted to intensive farming and by forcing developments to be in areas further away from cities and towns, car use and travel is boosted and commutes lengthened. The system also encourages further urban densification, taking green space away from the city dwellers who value it most and putting pressure on local parks due to harsh urban containment policies.

The nation has a preoccupation and nostalgic attachment to green spaces and a misunderstanding of how much green land there really is. One in ten English adults thinks that 75% or more of the country is already effectively built on. In reality, according to the Office for National Statistics (ONS), England has one of the lowest levels of built environment per capita in the whole of the European Union (EU), behind only the

Netherlands and Cyprus, with only 2% of the UK being concreted over, and 98% being classed as natural land.

This has finally led to suggestions that the green belt is redefined and opened up to development by lifting some of the planning restrictions currently in force. Strategically located developments on green belt land could be critical in enabling an increased supply of houses, evening out land use and affordability so that homes are built in the right places, closer to major cities with the supporting jobs and infrastructure.

Such jobs and infrastructure could take the form of new schools, shops, community centres, GP surgeries or hospitals, all of which would help take pressure off green belt communities and the cities around which they exist.

“Experts suggest that we need up to 300,000 additional homes to be built every year. The question, then, is how we can generate the homes we so urgently need when there is not enough available land on which to build them.”

In July, the government published the revised National Planning Policy Framework (NPPF), which referenced that councils may lose some of their powers to control development if house building falls below 75% of government targets.

While concerns have been expressed that developers might try to “game” the government’s new NPPF, by sitting on land to slow down the rate of development, triggering a relaxation of planning rules – how justified they are is debatable.

Developers have little interest in slowing down development of housing projects, as has been suggested, in order to force councils into allowing them to build on green belt plots. Delays would most likely affect the profits of larger developers, most of whom are responsible for the vast majority of house building in the UK and lead to objections from shareholders.

The stated intention of the new NPPF is actually to require higher environmental standards of house builders while protecting green belt land and ensuring that houses are being built on time.

To truly combat the failing housing market, we need to make sure we are building the right homes, in the right places. And while no-one wants to see property developments in the wrong places it is equally true that not all green belt land needs to be kept free from any development at all.

Analysis by estate agency Hamptons found that building on green belt land around 80 railway stations could provide 509,000 homes across Britain, and a recent study by the Adam Smith Institute stated that one million people could be housed by developing on 3.7% of London’s green belt areas close to existing commuter stations, with potential for a further three million new homes by building on less than 5% of green belt land in the ten least affordable UK cities.

It is crucial, however, that people can actually afford to buy these houses. Currently, promoting affordability does not seem to be the direction developers are moving towards: according to a CBRE report, 2017-18 alone saw 460,000 houses planned for the green belt – of which close to 80% were unaffordable. Developing yet more luxury projects, which often remain unoccupied, will do little to ease the housing crisis as people remain priced out of owning a permanent home.

Clearly, a fine balance needs to be struck, between preserving the best of the green belt, while also thinking creatively about how to solve the UK’s housing crisis. Currently, it shows no signs of abating and the country is in serious need of affordable homes. The weight of evidence suggests it is on England’s brown, unpleasant lands that we could find them. ■

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Cowpea: A food and animal feed crop grown in West Africa

In this interview with Michael Abberton, Head of the IITA Genetic Resources Centre (or Genebank), he shares his expertise on cowpea, a food and animal feed crop that is grown in the semi-arid tropics particularly Africa, but also Asia, the United States and Central and South America

When it comes to plant and animal genetic resources as the foundation for sustainable agriculture and global food security, it is worth thinking about the benefits that a gene bank can bring to humanity. A concern with the preservation of natural resources, conservation and diversity are important in Michael Abberton's role as Head of the IITA Genebank.

Genetic diversity enables plants to adapt to new pests and diseases, as well as to threats from climate change, drought and soil erosion, for example. Diversity, Michael believes, concerns all species including most important food crops and why they should be available to all. Diversity in and between crops is important, Michael explains and is key to being able to develop resources so that they can adapt to different environments.

The interview moves on to explore Michael's thoughts on how IITA scientists have developed high yielding cowpea varieties that have resistance to some major diseases and pests, released in 68 countries. Michael explains that there are a staggering 17,000 accessions of cowpea conserved in the IITA Genebank today, from 88 countries, representing 70% of African landraces and nearly half of the global diversity. These have primarily been collected from West Africa to which the cowpea that is now cultivated is indigenous, we discover. Michael then tells us his views on why cowpea is such an important crop in West Africa today.

"Cowpea is a food and animal feed crop grown in the semi-arid tropics particularly the savannahs of West Africa but also other parts of Africa, Asia and the Americas. It originated in Southern Africa and the cultivated form was domesticated in West Africa.

"While it is a very important crop in West Africa and is used for food and livestock, it grows, well particularly in the "hungry season" (June to October) in the region, when other crops are not producing.

"What we do at the IITA Genebank is to characterise all the different types using both traditional and modern molecular techniques and make them available to breeders who develop high yielding varieties that are early or medium maturing and have consumer-preferred traits such as large seeds, seed coat texture and colour. A number of the varieties have resistance to some of the major diseases, pests, nematodes and parasitic weeds."

On the global importance of cowpea, Michael draws our attention to legumes in general, of which cowpea is one along with soybean, peas and beans. Legumes are a very good source of protein and convert nitrogen into the atmosphere into the form that can be used by plants. Michael explains more on this and adds his thoughts on the major pests attacking cowpea plants today and more about how the crop is used for both humans and livestock.

"This reduces the need for natural fertilizer and at the same time, it puts nitrogen back into the soil. While it is very well adapted to grow in West Africa, it also has importance in other parts of the world, such as Asia, America and East Africa.

"For humans, we know that the cowpea seeds are processed into a number of popular types of food in West Africa. It is a very important source of protein for human consumption and it grows at a time of year when there is not much else available for people to eat.



“Much cowpea is grown in the north of Nigeria, for example, and much of it is brought down to the southwest of the country and is consumed in places such as Lagos, in the large centres of population. Sometimes, a part of the plant can be put back into part of the soil and in many instances, kept for livestock feed in places such as Mali where a lot of cowpea is grown.”

The conversation then moves to Michael’s thoughts on the major pests attacking cowpea plants today and finally, the broader challenges that lie ahead in Africa’s crop sector today.

“Cowpea can be damaged by quite a number of pests, the most important of which are aphids who extract juice from its leaves and stems while the crop is still a seedling and also spread the cowpea mosaic virus. As this is such a damaging pest, the farmers will use insecticides when they can afford to do so, so it is important to produce varieties of cowpea that are more tolerant to pests.

“In addition, the plants are also attacked by diseases caused by fungi, bacteria and viruses. Striga is the most important parasitic plant on cowpea and it can choke the growth of the plant at all stages and nematodes prevent the roots from absorbing nutrients and water from the soil. Cowpea is a type of crop that is very

susceptible to a range of pests and diseases.

“Finally, I think that one of the priorities from the perspective of the IITA Genebank is to make all the 17,000 accessions we have more usable and to use new methods to characterise them. We need to know the genetic makeup of the traits they have so that they can be much more effectively deployed. Within the breeding programmes, we still have major challenges, such as the need to increase yields so that climate change can be adapted to and that pests and diseases can be resisted. On cowpea, we need to use diversity to understand the crop much better and to use it more effectively.” ■

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Transformative research on Cowpea: Innovative trap crop development and deployment

Louis E. N Jackai and Beatrice N. Dingha from the Department of Natural Resources and Environmental Design at North Carolina A&T State University discuss their transformative research on Cowpea for increased and sustained production and use in the USA, with this first article focussing on innovative trap crop development and deployment

Cowpea, *Vigna unguiculata* Walp., is an important source of protein and vitamins. It is widely grown in the Southern USA and in most tropical and subtropical countries worldwide. Cowpea was historically used as a forage crop for horses and cattle (speculated source of the name cowpea), and is utilised primarily as a fresh market and frozen or canned vegetable in Southern USA but is consumed mostly as a dry pea (for example “blackeye pea”) on a global basis.

In the Southwestern USA, especially in California and Texas, about 45,000 t of dry cowpea (“blackeye” and other types) is produced annually, on about 20,000 ha. Roughly a third of the production is exported to Europe, Middle East and elsewhere; North Carolina grows only about 2,000 acres, much below its actual potential.

Cowpea has other uses, including as cover crop (especially in organic systems) for soil health enhancement and as an animal feed supplement. Cowpea consumption by humans and livestock is known to have significant health attributes, some yet to be fully understood or exploited; for example, the potential for cowpea extract to reduce proliferation of triple negative

breast cancer, a very aggressive form of cancer, as well as increasing immune system defense in ruminants against gastrointestinal parasites among other effects (Adjei-Fremah, 2017).

Cowpea is also attractive to pollinators, such as honey bees and other pollinating arthropods foraging for nectar as they carry out important ecological services that are critical for a productive and sustainable agroecosystem. Many varieties of cowpea have high-yield potential (>3,500 kg/ha), superior seed quality and various levels of resistance to insect pests and diseases.

Both small and commercial production can be profitable; fresh market production is primarily by small growers, while dry seed production is mainly a large commercial enterprise. However, the various benefits and uses of cowpea cannot be realised without adequate control of field and storage pests that can destroy an entire crop.

Production constraints

Pests on cowpea are indeed a bane worldwide. Realising the potential of cowpea as a crop, soil health enhancer, livestock feed or any other use will be difficult to achieve without our ability to minimise the damage and preva-

lence of insect pests and diseases. Entomologists, Drs Louis Jackai and Beatrice Dingha and their colleagues at North Carolina A&T State University in the USA have been working on the pest problems of small organic and conventional growers who produce 95% of the cowpeas in North Carolina.

The university is the only institution in the state that has a cowpea research programme focused exclusively on pest management. There is a good reason for this focus. Results from recent studies (funded by USDA-NIFA and USDA-ARS) to determine the factors that limit the expansion and use of cowpea indicate that insect pests, especially pentatomid pests, such as the brown marmorated stink bug (BMSB) and a weevil, the cowpea curculio (Cpc), may be among the most limiting challenges.

Cowpea as a trap crop for an emerging invasive pest

Research conducted at two locations, Greensboro, NC (in the Piedmont) and Goldsboro, NC (in the Coastal Plain) revealed that BMSB, a severe pest on fruit, ornamentals and vegetables and the Cpc present inverse population trends, with the former limiting production in the Piedmont zone and the latter in the Coastal Plain. This was most evident in 2014, when our research

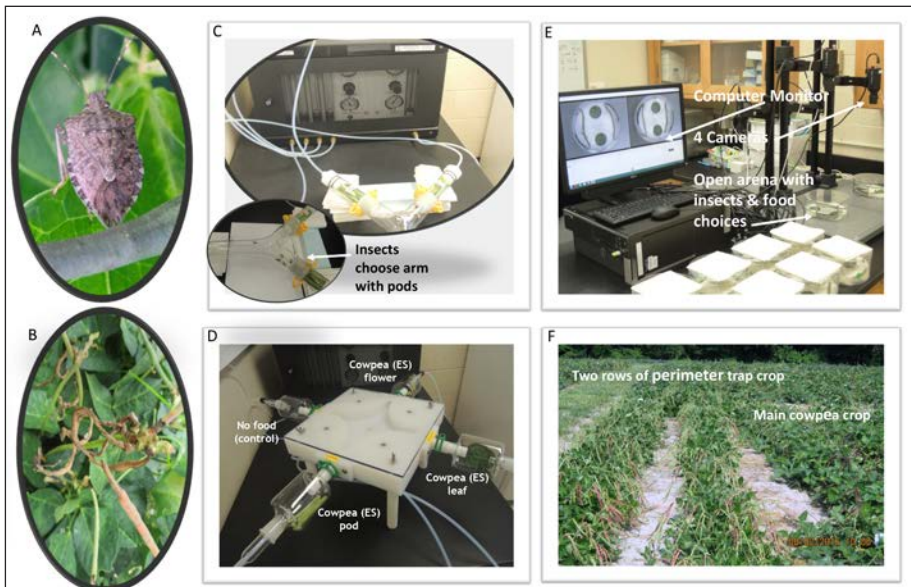


Figure 1: The brown marmorated stink bug (A) causes severe damage to cowpea (B). Several field and laboratory techniques are used in the discovery of a suitable trap crop for this insect including response to plant odors (Y-tube (C) and 4-arm (D) olfactometers and other behaviors related to attraction to a host plant source (using the Noldus Observer XT video system, E). One of the best cowpea trap crop varieties (ES) is shown in F as a 2-row peripheral trap.

showed a near crop failure from BMSB damage in the Piedmont and from the Cpc in the Coastal Plain region.

A broad range of laboratory and field experiments (Fig. 1) have since shown that a few cowpea varieties are particularly attractive to BMSBs and as such, can be used as decoys to attract and divert the pest away from a desired main cowpea crop, thus serving as a sink. This is the textbook definition of the trap crop concept (Hokkanen, 1991; Shelton and Badenes-Perez 2006; Parker et al., 2013), in this case an intra-specific trap crop that uses the same crop species both as trap and main crop.

This finding has many small vegetable growers excited about the long-term possibilities of minimising the use of high-risk pesticides leading to increased food safety and farm profits. In a spin-off from the initial grant, we started to examine the potential of using cowpea as a trap crop in other cropping systems to divert populations of BMSB from high-value crops (such as soybean, corn, sunflower and possibly peppers, tomato and fruit trees – the latter have not yet been tested) to a cowpea trap crop on

which the pest can then be killed, with an appropriate insecticide or other method that would result in less environmental and human health risks, while obtaining reasonable crop yield.

The future of trap cropping and other pest management approaches for BMSB suppression

Crop protection using tactics such as trap cropping can take a long time to figure out *where* (field location; conventional wisdom of periphery trap placement may not always be optimal), *when* (time of trap crop introduction) and *how much/and for how long* (trap density/retention).

In some situations, multiple trap crops have produced better yields (Parker et al., 2016); using both perimeter and strip trap crops, our work and that of others, has produced great success in using a single trap crop variety. Traps work because of the olfactory responses that are triggered by semiochemicals (plant odours) that guide the insects to the trap crop.

The same compounds (single or mixtures) may also be present in the main

crop, as in crucifer trap cropping, but their concentrations and gene expression may make all the difference. Ongoing work in our laboratories will try to understand these dynamics to make trap cropping more efficient and predictable. This approach is the nexus to sustainable pest management in organic systems and overall ecosystem sustainability; indeed, continued research funding from USDA and other sources as well as innovative ideas hold the key to future success of this and similar pest management tactics.

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The development of low-input minor cereal production systems in southern Europe

Nikolaos Volakakis of Geokomi plc and Leonidas Rempelos of Newcastle University present results from the experiments concerning low-input minor cereal production systems funded under the HealthyMinorCereals project and conducted in southern Crete, Greece – a typical semi-arid region of the Mediterranean

With cereal products being the most important source of nutrients and energy in the human diet and wheat being the most consumed crop globally, also the consumption of hulled wheat such as spelt (*Triticum spelta*); emmer (*Triticum dicoccum*); and einkorn (*Triticum monococcum*) has recently substantially increased. Re-introduced to the European market as ‘superfoods’, consumers associate spelt, emmer and einkorn with superior nutritional composition and a lower risk of wheat/gluten incompatibility symptoms compared to common wheat (*Triticum aestivum*). As a result, hulled kinds of wheat gained widespread popularity, making their way as common wheat substitutes in artisan bread and other bakery products, pasta and breakfast cereal. Among organic farmers, they are valued for their ability to grow well under low inputs.

Spelt wheat known as “Dinkel” in German or “Olyra” in Greek cultivated since approximately 5000 BC, has been an important crop for human nutrition in many regions of Europe, from the Bronze age up to the medieval times. After the introduction of potato into Europe, it remained as a staple food and minor cereal crop in Central Europe and northern Spain. Spelt is a hexaploid wheat that can easily be crossed with common wheat in which case its botanical name used



is *Triticum aestivum* subsp. *spelta*. As a result, many “modern” high-yielding “spelt” varieties grown in Central and Northern Europe are crosses between common and spelt wheat genotypes. It is believed that varieties from these *T. spelta* x *T. aestivum* crosses have grain with a lower nutritional value compared with the traditional, “pure” spelt varieties.

Although hulled kinds of wheat, such as spelt were previously grown in semi-arid regions, traditional varieties have been lost since their cultivation was replaced by common wheat in most Mediterranean regions (including Greece). Hence there is no agronomic knowledge (for example, regarding optimum sowing and harvest dates, tillage/mechanical weed control, fertilisation and crop protection) needed to optimise the performance of those cereal crops in the semi-arid regions of the Mediterranean.

The research objectives of our study were, therefore, to:

- Assess the effect of fertilisers with contrasting water-soluble N and P concentrations on crop health, grain yield and its nutritional quality;
- Assess the effect of using supplementary irrigation in rain-fed winter cereal crops on crop health and grain yield/yield stability and nutritional quality parameters of grain;
- Compare crop health, yield and quality parameters in (a) traditional “pure” spelt genotypes and (b) “modern” varieties based on *T. aestivum* x *T. spelta* crosses;
- Identify interactions between contrasting spelt varieties and agronomic parameters (irrigation and fertilisation regimes) with respect to crop health, yield, yield stability and grain quality parameters and;

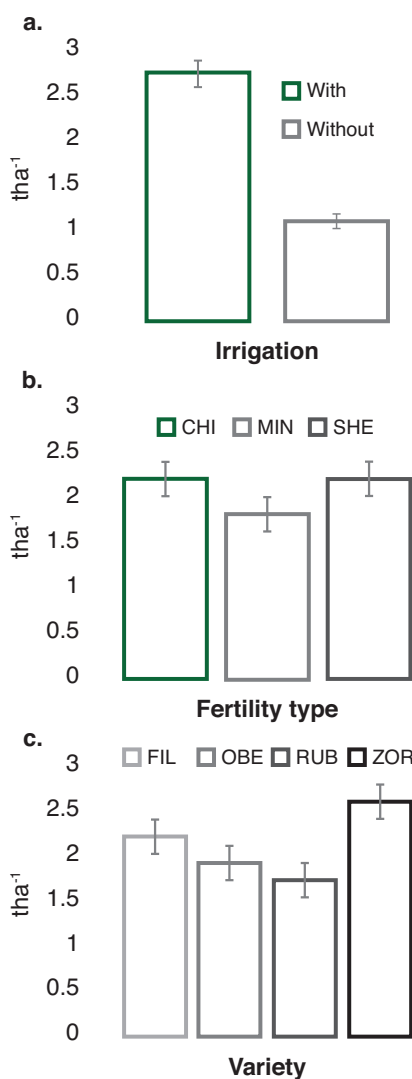


Figure 1: The effect (means±SE) of a. supplementary irrigation; b. fertility type and c. variety choice on spelt grain yield (de-hulled)

- Assess the effect of contrasting climatic conditions on spelt wheat performance.

Our results:

Irrigation: The use of supplementary irrigation was found to significantly increase grain yield (Fig.1a) only in the seasons with low winter rainfall, (2015-2016/2016-2017), while it had no effect on grain yields in the season 2014-2015 with relatively high winter rainfall (data not presented). In Figure 2 average monthly rainfall and temperatures are presented for all three seasons. Since supplementary irrigation substantially increased lodging levels (which is known to negatively affect grain quality) in the season with high rainfall, it is recommended that supplementary irrigation is only used

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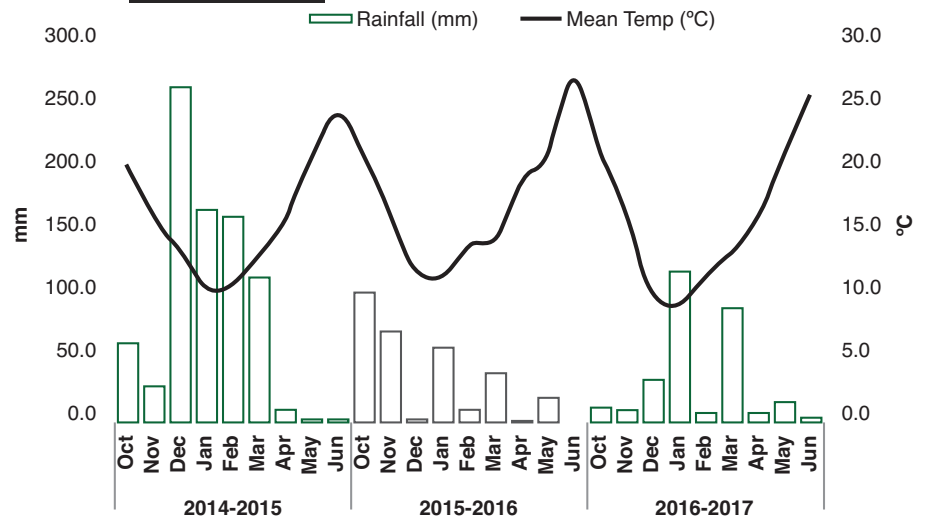


Figure 2: Monthly average temperature and total rainfall during the three years of the study

when long-term forecasts and rainfall and/or soil moisture monitoring indicate that crops do or are likely to suffer from an insufficient water supply.

Fertilisation: Chicken and sheep manure resulted in similar grain yields (Fig.1b) and lower lodging levels than mineral NPK fertiliser. This was surprising but may suggest that under semi-arid growing conditions organic fertilisers may deliver additional benefits (for example, related to water availability and/or prevention of nutrient losses) compensating for the greater availability of N, P and K from mineral fertiliser inputs. It was found that mineral fertilisation significantly increased the protein content in grain but had no substantial impact on the mineral and antioxidant concentrations in spelt grains.

Variety choice: Modern spelt varieties (Filderstolz and ZOR) had lower lodging levels, produced higher yields (Fig 1c) but had lower grain protein concentrations than the older varieties (Oberkulmer and Rubiota). The variety choice had a substantial effect on the nutritional composition of spelt grain, especially with respect to antioxidant concentrations and activity. The modern varieties had significantly higher total phenolic acid and flavonoid

concentrations, as well as antioxidant activity. Relatively small differences in mineral composition between the varieties were detected.

Acknowledgement and disclaimer

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 613609. The views expressed in this publication represent only the views of the authors. The European Union is not liable for any use that may be made of the information contained therein.



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Storing silage: A guide on how to safely store it on a farm

When it comes to how to safely store silage on a farm, this article by Charles Renwick from Lycetts explains who is responsible for which elements and what to expect when it comes to getting in touch with the Environment Agency

In order to keep livestock fed throughout the winter, silage is created and stored earlier in the year. But this commodity needs to be stored correctly, due to the potential impact it can have on the environment. If silage is allowed to leak or seep into the ground, it can quickly contaminate water sources, which further impacts marine life and wildlife. Effluent from silage can be potentially 200 times more toxic than sewage!

Charles Foster, from agriculture insurance brokers [Lycetts](#), notes: "Silage effluent is extraordinarily toxic – so the damage it can cause to watercourse ecosystems is profound. Once the effluent is in the ground and reaches a watercourse, it is very difficult to contain, and it can find its way into springs, wells and boreholes and public water supplies, which will require immediate action by an Environment Agency-approved contractor.

"Farmers must therefore make every effort to ensure their clamps are well maintained, and that includes all pipes and tanks as well." This article serves as a guide for how to store silage safely, who is responsible for which elements and what to expect when it comes to the Environment Agency.

Tips on making and storing silage

There are rules in place for making and storing silage on a farm but be aware that these rules do not apply if you are storing silage temporarily in order to transport it. If you are looking to house silage at a farm on a permanent basis though, it is vital that you do not either make or store any of it within ten metres of any coastal or inland water source. Baled silage also should not be unwrapped within this perimeter, with this type of silage it should be sealed in an impermeable membrane or bagged.

Will you be dealing with field silage? In this instance, it is a requirement that you refrain from storing it within 50 metres of a protected water supply source – i.e. a location where water is taken with the purpose of human food preparation, human consumption and/or use within farm dairies. When silage is stored as field silage, there mustn't be any construction works either and it is important that topsoil is not disturbed at any point in the process.

Silos that are used for making or storing silage need to be suitably resistant to damage or attack. Therefore, each one should have an impermeable base which extends beyond any of its walls. This base is also required to comply with British Standard 8007:1987 and British Standard 8110-1:1997 regulations if made from concrete, or British Standard 594/EN 13108-4:2006 if a hot-rolled asphalt design.

Silos also require collection channels to drain any spillage to an effluent tank. This ties into another important point, in that each silo must have an effluent collection system, though it is fine to store both silage effluent and slurry together should a tank have enough capacity and have been constructed in a manner to withstand both types of effluent. Just take note that gases, which are lethal to both humans and livestock, can result from mixing slurry, so silage effluent should never be placed into an under-floor slurry store.

The Environment Agency's involvement

There will be a few instances where you are in touch with the Environment Agency. In fact, the organisation must be notified at least 14 days ahead of you building a new storage facility for silage, slurry or agricultural fuel oil. The same timeframe must be followed should

AGRICULTURE



you make substantial changes to an existing store of silage, too.

Details for your local Environment Agency are on the [GOV.UK](https://www.gov.uk) website, but be sure to have the following information ready when you get in touch:

- Your name, current address, phone number and email address.
- The type of storage facility that you are intending to create or alter.
- The specific location of the intended storage facility – provided via an eight-figure grid reference.

The Environment Agency will also be in touch if you need to improve or move silage from an unsuitable storage. This will occur when the organisation is concerned that the storage facility is posing a significant risk of pollution, though the farmer receiving the notice will have at least 28-days to carry out the necessary work – more time may sometimes be granted too, such as if planning permission needs to be sought out or the weather is unsuitable for work to be carried out at the time a notice is delivered.

In the event that you disagree with the demand, you can appeal in the 28 day window after the notice was served. This appeal must contain a copy of the notice you have been sent, all related correspondence and a plan of the farm concerned in the notice – complete with the installation as well as all watercourses and drains. It must also be made in writing to the Secretary of State, with a copy sent to the Environment Agency office detailed on the notice as well.

There are three possible outcomes from an appeal:

- The notice will be altered or withdrawn.
- The notice will be upheld, though extra time will be provided for you to comply.
- The notice will be upheld, though you will be provided with no extra time to comply. Instead, the compliance period will often end on the day the decision is made.

It is critical for farmers to have silage stored correctly; a farmer was fined thousands of pounds after his silage seeped into a protected watercourse in 2017. As Mr Foster points out: “Farmers have many HSE and Environment Agency standards to comply with and must keep ahead of the game to avoid these fines which remain uninsured. It will not only allow them to rest easy in the knowledge they are fully compliant with working practices and not polluting the environment, but they won’t suffer an unexpected financial hit if things go wrong.” ■

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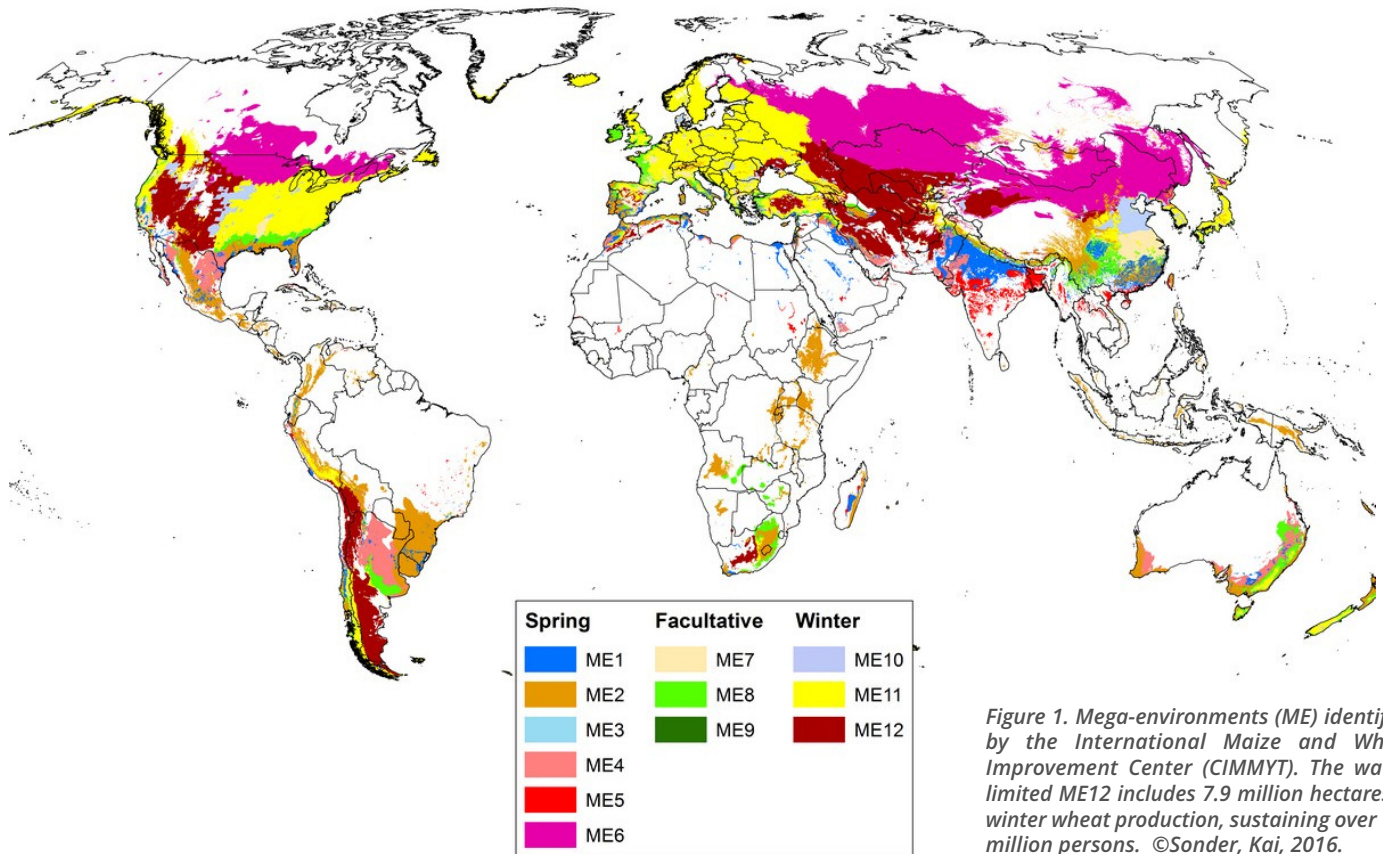


Figure 1. Mega-environments (ME) identified by the International Maize and Wheat Improvement Center (CIMMYT). The water-limited ME12 includes 7.9 million hectares of winter wheat production, sustaining over 140 million persons. ©Sonder, Kai, 2016.

Crop science: What’s to be done about climate change?

Professor Robert Aiken, Research Crop Scientist at Northwest Research – Extension Center asks what is to be done about the creeping trends of climate change in terms of semi-arid cropping systems

Like the proverbial frog in the heating pot of water, we may not notice the creeping trends of climate change. The farmers I serve in the semi-arid U.S. Central High Plains encounter dramatic year-to-year fluctuations in weather patterns, which tend to overwhelm the long-term trends. We’re just learning how to recognise and interpret long-term climate signals, such as the El Niño-Southern Oscillation¹. What’s to be done to ensure global food security in the face of climate change?

Semi-arid cropping systems, the focus of this series, include 7.9 million

hectares of winter wheat production in western U.S., Argentina, western and central Asia (Figure 1); here the evaporative demand for water can exceed annual precipitation by factors of three to five. Is there an opportunity to increase crop productivity, given limited and untimely water supply? My thinking falls along two lines: improving crop water productivity and increased stress tolerance of critical processes such as ovule fertilisation by pollen.

The fundamentals of carbon-water exchange, which underlie crop water productivity, are ‘managed’ by leaf

stomata – gateways permitting carbon dioxide (CO₂) entry to leaf biochemistry, as well as the exit route for water vapour diffusing into the atmosphere. This linked diffusion of CO₂ and water vapour supports the theory that the carbon-water exchange rate is closely regulated, affected by biochemistry and atmospheric humidity.

Greenhouse and field studies (Xin et al., 2009; Narayanan et al., 2013) indicate that sorghum cultivars do differ in carbon-water exchange rates (Figure 2) with parallel differences in radiation use efficiency (Figure 3). This evidence supports accelerated investigations

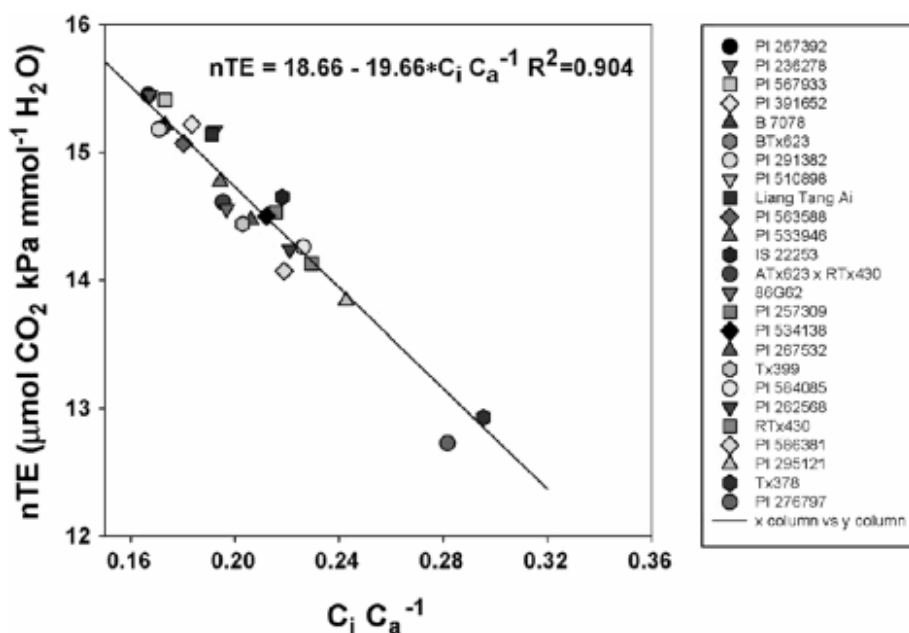


Figure 2. Evidence that sorghum cultivars can differ in the carbon-water exchange rate. Here, instantaneous transpiration efficiency (nTE), normalised by vapour pressure deficit (VPD)—a measure of atmospheric aridity, is shown in relation to the ratio of leaf internal CO₂ concentration to air (C_i/C_a-1). ©Xin et al., 2009.

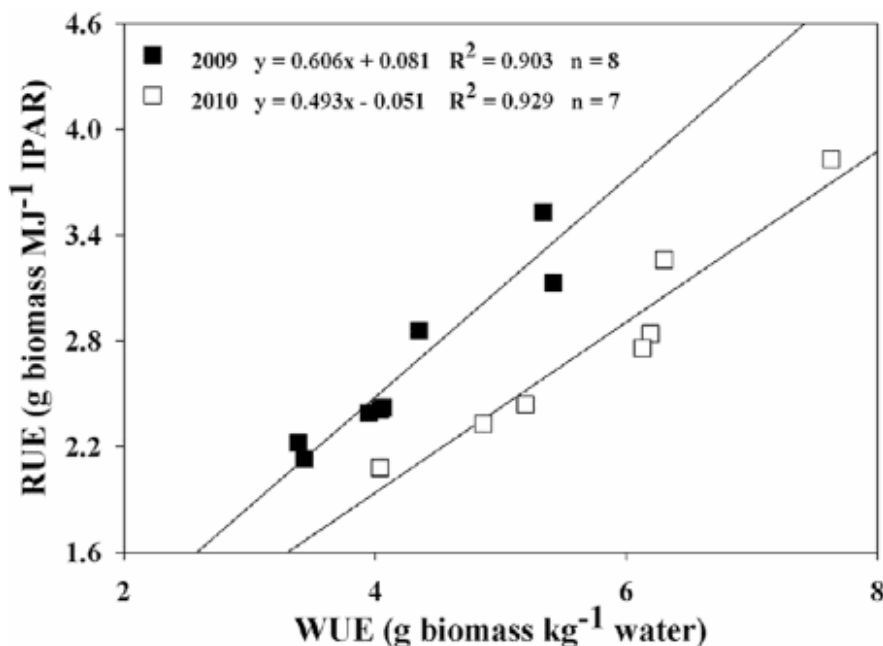


Figure 3. Field evidence that sorghum cultivars differ in biomass productivity in relation to use of water and radiation. Relationships are shown between water use efficiency (WUE) and radiation use efficiency (RUE) among sorghum genotypes; WUE was derived as the slope of the regression of above-ground biomass on cumulative water use, while RUE was derived as the slope of the regression of above-ground biomass on cumulative intercepted photosynthetically active radiation (IPAR). ©Narayanan et al., 2013.

into the mechanisms driving differences in plant carbon-water exchange rates as well as the development of high-throughput screening tools to identify desirable germplasm.

Heat stress and water deficits impair pollen development and fertilisation of ovules, resulting in the ‘seed-set’ required for grain production, according to careful studies conducted in the

laboratories of Dr Vara Prasad². Species of *Aegilops*, a relative of wheat, provide sources of genetic traits conveying heat and drought tolerance to pollen development and ovule fertilisation. Scientists in the Wheat Genetics Resource Center³ are systematically integrating these traits with elite breeding lines, developing wheat varieties with increased stress tolerance.

Sustaining the increased crop productivity to provide global food security will require continued innovation, collaboration and vision.

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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 km³ 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

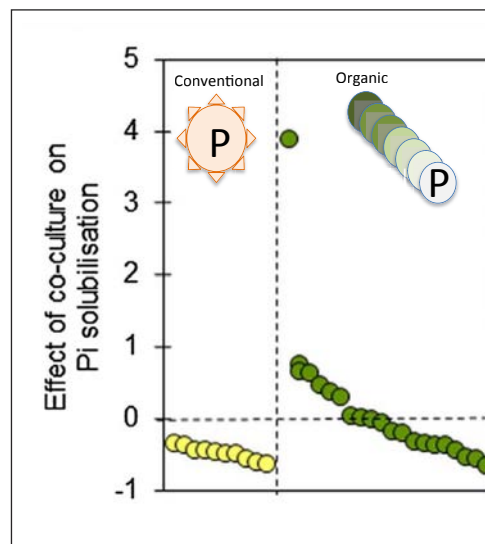


Fig. 1. The legacy of the farming system on the effect of coculture on Pi solubilisation when PSB was grown in pairs of isolates. PSB pairs resulted in significant effects of coculture on Pi solubilisation being positive (i.e. cooperation) or negative (i.e. antagonism). Symbols: yellow for combinations 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.

mechanistic view of the agro-ecosystem by capitalising on ecological processes in agro-ecosystems.

“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 con-

ventional 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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Advancing food and agricultural research in the U.S.

The USDA's Agricultural Research Services and National Institute of Food & Agriculture both play key roles in advancing food and agricultural research, effective resource management and economic opportunities for rural communities, as Open Access Government learns

The United States Department of Agriculture (USDA) was established in 1862 by President Abraham Lincoln at a time when around half of all Americans lived on farms.

Today, 156 years later, just 2% of Americans live on farms. Nevertheless, the modern USDA aims to stay true to President Lincoln's vision in its work on food, agriculture, rural development and conserving natural resources.

The Agricultural Research Services (ARS) is the USDA's chief in-house scientific research agency. It is charged with finding solutions to problems affecting Americans from the field to table, including food safety; assessing the nutritional needs of Americans; sustaining a competitive agricultural economy; and delivering economic opportunities for rural communities, as well as wider society.

“This year, the NIFA has provided \$2.4 million in funding to address shortages of veterinarians and ensure rural communities have sufficient access to livestock veterinary services.”

The ARS runs 690 research projects within 15 National Programmes, employs 2,000 scientists and post-doctorate staff, as well as 6,000 other employees and runs more than 90 research locations both in the U.S. and overseas. The agency's annual budget tops \$1.1 billion.

Recent ARS studies have looked at everything from developing a new way of estimating calories, which showed that not all calories in nuts such as pistachios and walnuts are used by the human body, to create a technology that streamlines the process of inserting multiple genes into crop plants. This could make it

easier to breed varieties of potatoes, rice, citrus and other crops that are more tolerant to drought, resistant to diseases and produce higher yields.

Elsewhere, an ARS-led team has recently retooled tunicamycin, a compound secreted by a common soil bacterium that kills off encroaching bacteria by forming holes in their cell walls, so it poses little or no danger to human or animal cells but can still kill germs.

This could potentially be hugely beneficial in bolstering the effectiveness of penicillin, which ARS scientists originally helped to mass produce to treat troops during World War II.

Decades of widespread use has seen some germs develop resistance to penicillin. In lab trials, however, mixing the modified tunicamycin with oxacillin and other penicillin-based drugs made them 32 to 64 times more potent.

In addition, the compounds did not harm cultures of human and hamster cells when it was added to them in toxicity tests, the team reported in the *Journal of Antibiotics*.

The tunicamycin-producing *Streptomyces* bacteria were taken from the same repository where the first mass-produced strain of the penicillin mould is still kept – the ARS Microbial Culture Collection at the National Centre for Agricultural Utilisation Research in Peoria, Illinois, which in 2001 was designated as an International Historic Chemical Landmark.

The research was carried out by the ARS in cooperation with the University of Illinois College of Medicine and the Chinese Academy of Sciences.

Another key agency within the USDA is the National Institute of Food & Agriculture (NIFA), which administers federal investment in agricultural research and education to address national challenges and ensure ground-breaking scientific discoveries make it beyond the laboratory.

Its priority areas for investment include:

- **Food security:** Supporting science that boosts domestic agricultural production to meet global food demand and fight hunger.
- **Water:** Funding programmes that improve water quality and the efficient use of resources for sustainable agriculture, forest production and ecosystem services.
- **Human nutrition:** Supporting research, education and extension programmes that lead to a healthy population.
- **Agroclimate science:** NIFA-funded projects support adaptation to changing weather patterns, reducing greenhouse gas emissions and sequestering carbon.
- **Sustainable bioenergy:** Contributing to energy independence through investment in bioenergy production and bio-based commercial or industrial products.
- **Food safety:** Reducing food-borne illnesses by addressing the causes of microbial contamination and antimicrobial resistance, improving education for consumers and food safety professionals and developing enhanced food processing techniques.

This year, the NIFA has provided \$2.4 million in funding to address shortages of veterinarians and ensure rural communities have sufficient access to livestock veterinary services.

It has also allocated \$2.9 million for the 2018 fiscal year to the Rural Health & Safety Education Competitive Grant Programme, which provides funding for individual and family health education in rural communities. Initiatives focus on areas such as the value of good health at any age, providing information to increase

people's motivation to take more responsibility for their own health and promoting access to health and educational activities.

Elsewhere, the NIFA has announced grants worth \$2 million to support research looking at the implications of gene editing technologies in agriculture.

The University of Florida, Iowa State University of Science & Technology, Santa Fe Institute and Texas A&M University will lead projects that look at issues such as defining consumers' preferences for regulation and consumption of food derived from gene-edited crops; identifying inducements and impediments to the public trust of gene-edited foods; and evaluating the environment for public and stakeholder engagement around the potential research, development and use of gene drive technology in controlling pests.

At the larger end of the scale, the NIFA has committed \$21 million to Supplemental Nutrition Assistance Programme (SNAP), which aims to encourage eligible low-income families to buy more fruits and vegetables by providing a range of incentives at the point of purchase.

Among the schemes receiving funding is an initiative to introduce an e-incentive benefits redemption system in Georgia – the first of its kind for nutrition incentives. The system will replace the use of wooden tokens that act as currency for SNAP-eligible foods. The scheme aims to eliminate the stigma attached to using tokens, while reducing the costs associated with the “analogue” system and encouraging repeat visits by being more user-friendly. Data on purchasing habits will also be used to shape marketing efforts.

Increasing low-income communities' ability to purchase fresh fruit and vegetables not only helps to improve the health of families but also expands economic opportunities for farmers. ■

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Agricultural Research: Plant cold hardiness in a changing climate

Michael Wisniewski and David Livingston III from the U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) share their expert thoughts on the topic of plant cold hardiness in today’s changing climate

Since the late 1800’s, scientists have sought to understand how plants adapt to freezing temperatures and can survive the formation of ice within their tissues. Unlike animals, plants cannot remove themselves from an unfavourable environment and so have evolved mechanisms that allow them to adapt to temperature stress. Plant responses to freezing temperatures have been divided into tolerance and avoidance mechanisms. As the names suggest, one set of responses allows plants to escape exposure to ice (avoidance) while the other represents changes in the biochemistry and physiology of plants that allow them to tolerate the presence of ice within their tissues (tolerance).

“During the past ten years, unseasonably mild winters and erratic spring weather conditions resulting from ongoing climate change have resulted in spring freezing events that have caused catastrophic economic losses to farmers and are inducing shifts in the community structure of the natural environment.”

An annual life cycle (i.e. going from seed to seed) and the ability to super-cool (i.e. the ability to prevent ice from forming at temperatures well below 0 °C) are examples of avoidance mechanisms, while the accumulation of sugars, cryoprotective proteins, reduction in cellular water and changes in membrane structure, are

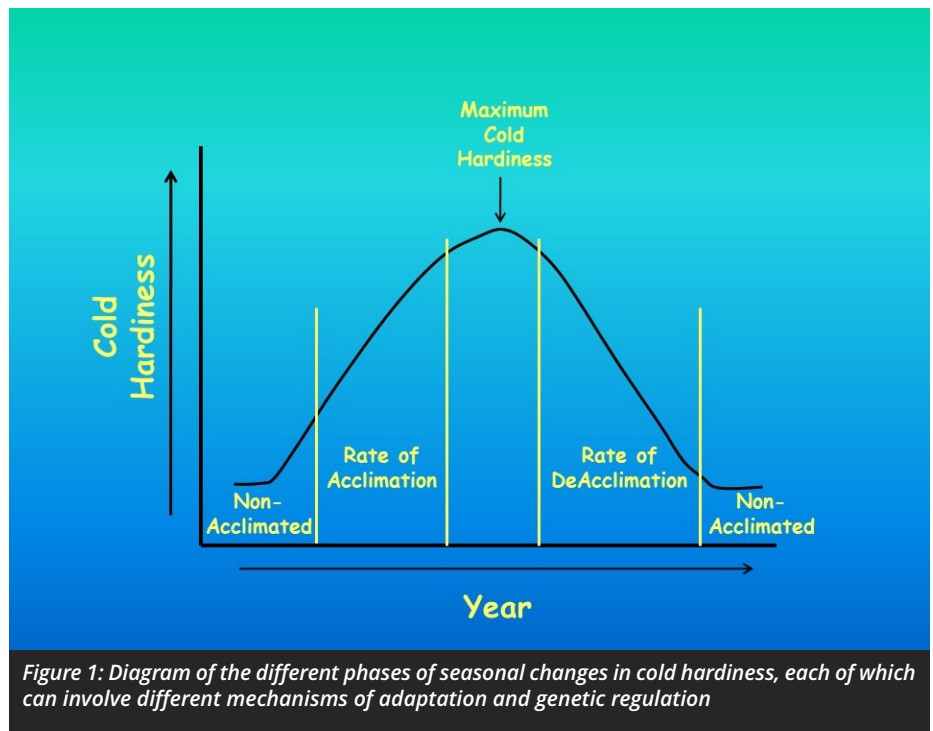


Figure 1: Diagram of the different phases of seasonal changes in cold hardiness, each of which can involve different mechanisms of adaptation and genetic regulation

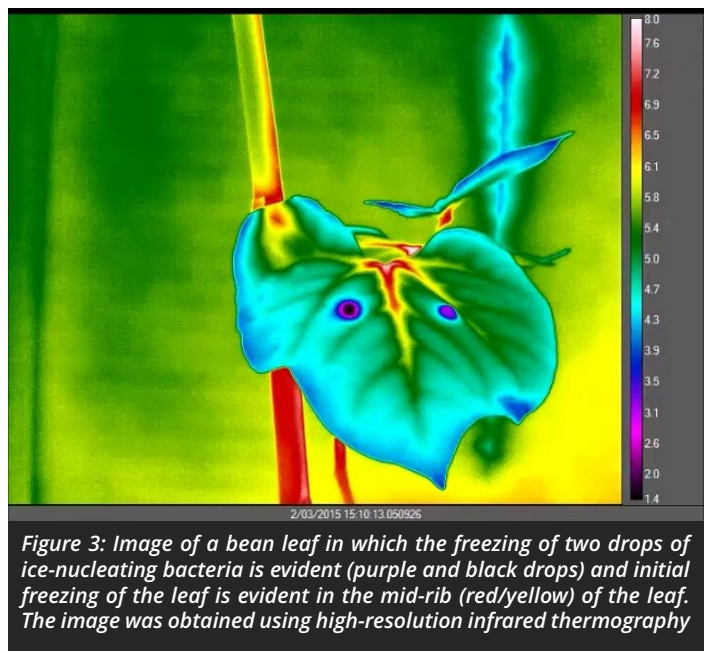
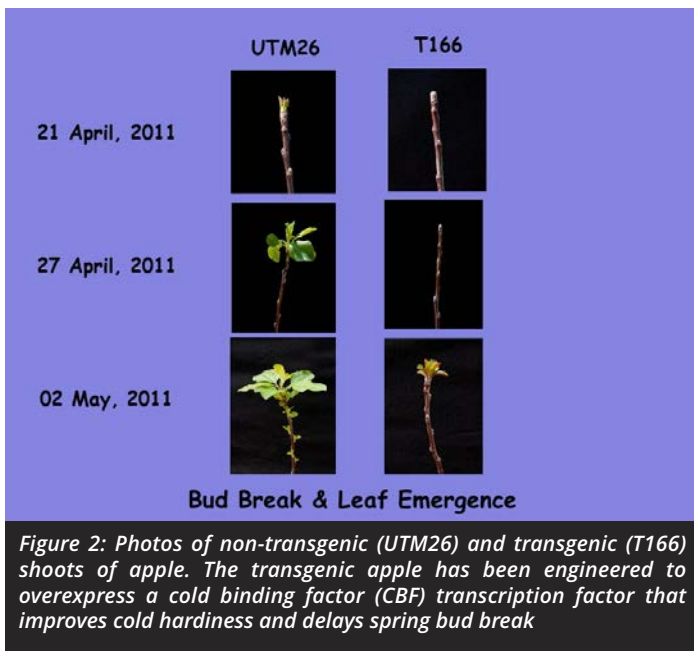
examples of biochemical changes associated with freezing tolerance.

Tremendous gains have been made over the past 30 years in understanding the molecular biology of cold acclimation, the process that plants undergo in response to exposure to shorter daylength and cool temperatures in the fall that results in increased freezing tolerance.

Key genes, called transcription factors, have been discovered that are induced by low temperature and that regulate the expression of entire sets of cold-responsive (COR) genes. The development of rapid, low-cost DNA

sequencing technologies has also allowed researchers to compare the genomes of plant species and genotypes within a plant species that differ in freezing tolerance.

Despite these advances, our ability to improve and regulate plant cold hardiness in a reliable manner has been challenging. Our understanding of the molecular biology of cold hardiness has revealed an ever-increasing level of complexity and genome-wide association studies (GWAS) have made evident a large number of genetic loci that contribute to the polygenic trait of cold hardiness. The challenge in the coming years will be to understand



how to utilise the explosion of information we have gained about plant cold hardiness to address the critical problems facing agriculture, forestry and the natural environment due to rapid climate change, the loss of high-quality arable land and a growing world population.

Seasonal changes in cold hardiness can be divided into several phases (Fig. 1), each of which can be under separate genetic control and involve different mechanisms of adaptation. Other seasonal aspects of plant development, such as dormancy, growth and flowering are also genetically linked to cold acclimation and need to be taken into account. Finally, tolerance to an acute freezing stress (single freezing episode) vs. a chronic freezing stress (sustained exposure to freezing temperatures for a week or more) must be considered. Only by recognising this complexity, can significant advances in improving plant cold hardiness be made.

During the past ten years, unseasonably mild winters and erratic spring weather conditions resulting from

ongoing climate change have resulted in spring freezing events that have caused catastrophic economic losses to farmers and are inducing shifts in the community structure of the natural environment. These events have raised the importance of finding ways of preventing plants from deacclimating (losing cold hardiness), prematurely losing dormancy and avoiding freezing. In fact, genetic transformation has shown that it is possible to produce plants with delayed dormancy (Fig. 2) and high-resolution infrared thermography has been used to elucidate how plants freeze and how ice propagates throughout the plant (Fig. 3). The latter technique has been especially useful in evaluating frost-protection products and evaluating the freezing response of newly developed genotypes.

The increasing occurrence of extreme weather events due to climate change is inducing severe episodes of freezing injury on our modern cultivars of crop plants, exposing them to temperature events for which they have not been bred to cope with, or for which native plants have not had time to adapt to through selection pressures. Only by

recognising the complexity of cold hardiness as a polygenic trait, defined by both biophysical and biochemical adaptations that impact survival, can progress be made in improving cold hardiness in a changing climate. This will necessitate a strong commitment to conduct cold hardiness research.



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Meeting the challenges of climate change for dryland cereal production

The effects of climate change threaten food security worldwide. What needs to be done to improve the resilience of vital dryland cereals to more extreme weather?

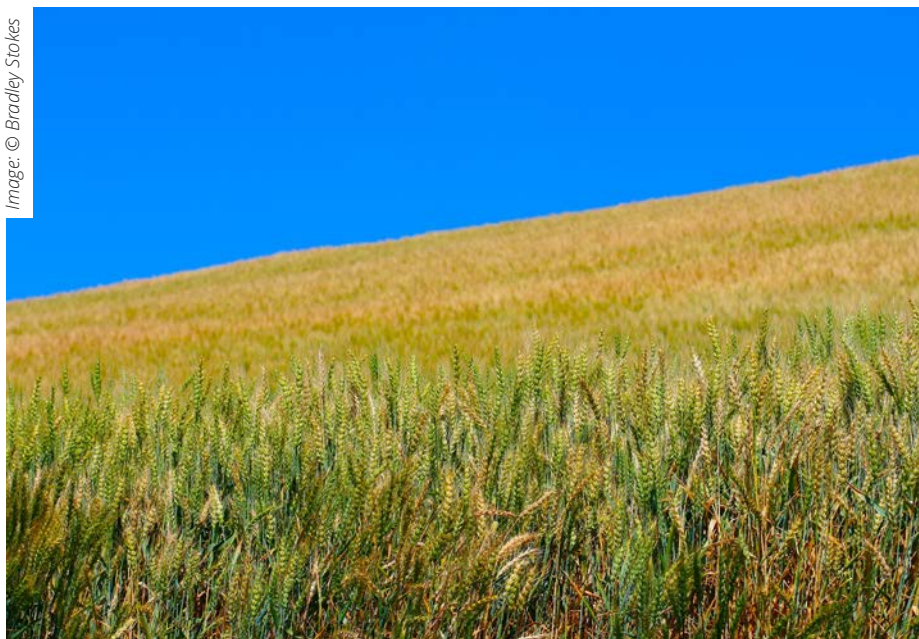
Climate change, including warming, changes in precipitation patterns, and increases in extreme events, is continuing and accelerating, validating the model-based projections of climate scientists and the Intergovernmental Panel on Climate Change.

These changes threaten global food security through expected adverse effects on agriculture. Rain-fed cereals in semi-arid regions of the world are particularly vulnerable because often they are already functioning at the limits of sustainability set by annual precipitation and temperature regimes. Historical rates of increase in the yields of these commodities have already slowed in lower latitudes, with immediate implications for human well-being. Effects in higher latitudes may be delayed due to baseline conditions and the fertilising effect of elevated atmospheric CO₂ concentration, but eventually, these systems also will be at risk.

Building resilience of dryland cereals to the challenge of climate change must address entire cropping systems and their interdependent components. These components include crop varieties, methods of cultivation, nutrient management, rotational practices, pest, weed and disease management, crop harvesting, storage and transport.

Genetic improvement of the crops for yield, heat tolerance and water use

Image: © Bradley Stokes



efficiency must be accompanied by and compatible with improvements in all components of the cropping system. These improvements, include diversifying crops grown to reduce vulnerability associated with continuous cropping, preserving soil carbon, conserving soil moisture, protecting soil health and coping with climate-driven changes in pest, diseases and weeds.

For example, although water scarcity can be addressed by prudently implementing fallow periods, tillage and residue management, novel crop rotations and drought-resilient crop varieties, these will necessitate concomitant optimisation of nutrient, pest, weed and pathogen management. There is, therefore, an urgent need for coordinated efforts by scien-

tists in many disciplines to address whole systems rather than isolated elements.

Further, although the technical advances needed seem achievable, they must be implemented in different social, economic and regulatory contexts. Success will require working closely with farmers and other stakeholders for innovation that can complement the science to ensure new approaches are adopted and supported effectively.

One of the most challenging effects of climate change on cereal systems will be those influencing pests, weeds and diseases. Crop protection is already difficult in most cereal systems and climate change is certain to complicate it. This is because climate change

can cause some pests, weeds and diseases to increase in severity while others may decrease.

Although models project that insect pest pressure in wheat, rice and soybean will uniformly increase with global warming, these have been developed with a focus on insect physiology and population dynamics.

Also important are shifts in pest geographic ranges, climate-driven changes in crop phenology or grower practices, and the effects of climate on natural enemies that provide biological control of pests. Indeed, likely due to these complexities, among the 12 species of wheat pests that have been studied for documented or anticipated responses to climate change, responses are mixed.

Variability in response to climate change is also likely for pathogens and weeds. Thus, against a general theoretical expectation of potential increases in pest, disease and weed pressure with climate change, specific studies are needed to delineate actual effects for individual species and systems and the prudent responses.

As another illustration of the complexity of agricultural system responses to climate change, crop production itself contributes to climate change. Agriculture is responsible for approximately 11% of total greenhouse gas emissions worldwide, with 65% of this due to nitrous oxide emissions from agricultural soils, which could be reduced through improved agricultural practices.

To address these complexities, coordinated efforts are needed that can support scientists and stakeholders in transdisciplinary efforts that consider entire production systems.

One such effort was the recently completed project, Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH). The seven-year project, launched in 2011, involved a team of more than 100 faculty members, scientists, graduate students and others from the University of Idaho, Washington State University, Oregon State University and the USDA's Agricultural Research Service.

Participants represented the core agricultural disciplines, climate science, geography, sociology, economics, education and information sciences. The effort integrated research, education and extension. The outputs and impacts of REACCH can be viewed through the [project website](#). Highlights include more than 100 scientific articles on aspects of these systems, a Special Research Topic in *Frontiers*, [Building Resilience to Climate Change in Cereal Production Systems: Agroecosystem Components and Integrative Approaches](#), projections concerning wheat yields in the region under climate change and online tools for stakeholders to access these, surveys of producer attitudes and practices relating to sustainable wheat production, and a [640-page handbook for producers summarising information to help them succeed](#).

To share their findings with specialists working on cereal systems globally, the REACCH team also organised a conference, entitled [Transitioning Cereal Systems to Adapt to Climate Change](#) (TCSACC).

Experts from 17 countries attended the conference, with backgrounds as diverse as those within REACCH, shared insights and priorities for efforts going forward. One indirect outcome of this was the establishment of an Expert Working Group in Wheat

Agronomy within the international [Wheat Initiative](#), with an emphasis on the interdisciplinary integration highlighted through the TCSACC.

As summarised in a [published synopsis](#) of TCSACC, which also reflects the effort of REACCH, researchers around the world must:

1. Establish coordinated, large-scale, transdisciplinary efforts that are based on integration among knowledge communities.
2. Strengthen the comprehensiveness of cropping systems models.
3. Consider the global context of production systems by nurturing networks connecting these large-scale efforts. Achieving this will require continued support from national and international funding agencies.

The challenges expected from climate change across many sectors are numerous and some are already evident. Compounding these with decreased food security must be avoided.



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Establishing a European Energy Union

Maroš Šefčovič, Vice-President, Energy Union at European Commission speaks to Open Access Government about establishing a European Energy Union and the importance of all Europeans having access to secure, affordable and climate-friendly energy

Establishing a European Energy Union happens by connecting infrastructures, enforcing legislation and increasing competition to help drive down costs for citizens and businesses and boost growth, Maroš Šefčovič, Vice-President of Energy Union underlines. In this interview with Open Access Government, he reveals that this is one of the top priorities of the European Commission today and he believes that this important mission has been accomplished.

As the interview begins, Maroš explains that all the legislative proposals to be included in the Energy Union were put on the table. Important aims here concerns energy security, which means hardware in terms of connection and how we can help each other to prevent any interruptions in the supply of energy. He also tells us that software is required in this respect, to deal with European energy markets and modernise the way in which energy is both produced and consumed. For that, well-interconnected networks are needed, and these can be combined with the European Commission's ambitious climate agenda, he adds.

Maroš then stresses that the European Commission has found a unique way to include climate risk into the modernisation of industry, which consists of 9 million European workers, so while the legislation is now approved, the finishing touches have yet to be applied. In terms of clean mobility, the legislation includes new emission standards for cars and trucks which will increase a country's Gross Domestic Product (GDP) over the next year. Concerning this important energy legislation Maroš underlines that the European Commission has had very strong support from the public for it.

The conversation then turns to Maroš's thoughts on all Europeans having access to secure, affordable and

climate-friendly energy. Firstly, it is vital that Europeans have clean and affordable energy to benefit their daily lives in terms of their wellbeing, Maroš tell us before offering his own thoughts on this.

"It is also important from the point of view of health because every year we are receiving more information about the impact of air pollution of our citizens. With higher levels of pollution in our cities, we now have more evidence that air pollution has negative consequences, such as on the mental state of our people.

"We also want to achieve a level of energy efficiency in terms of saving 32.5%, so I am sure that these two targets set for the EU Member States will be translated into the reduction of greenhouse gas emissions. I think we will overshoot our emissions reductions target of 40%. This is very important because we wanted to show that for example, in terms of climate change we are the global leader and the first major economy which has transformed our commitment to law."

"Also, the price of energy is very important for the competitiveness of our industry, so energy needs to be both affordable and clean.

"I am also encouraged by the proactive approach of our citizens, in terms of them turning into active consumers of energy so they are becoming readier to generate energy on their own. If you talk to those in the construction industry today, they will tell you that they have hardly built any houses or high rise buildings without a smart system in the building."

Looking at the EU's 2030 energy and climate targets, a part of this is a proposed reduction of 40% of green-



Image: © European Union 2018

Maroš Šefčovič

house gas emissions, a minimum of 32% renewables in the EU energy mix and a 32.5% goal of energy efficiency savings. Maroš reveals that this was presented as the European Commission's commitment to the people of Europe but also to the global community in terms of the Paris Agreement in 2015 where it was agreed that by 2030 greenhouse gas emissions must be reduced by at least 40%. It was also agreed there that at least 27% of renewables would be generated by that time and that the level of energy efficiency would be 27%.

"What happened, was that the industry, the politicians, the mayors and the consumers agreed that we can become more ambitious when it comes to such targets. In the discussion between the EU Member States and the European Parliament, we ended up with a higher target, so by 2030, we want to have at least 32% of renewables in the energy mix.

"We also want to achieve a level of energy efficiency in terms of saving 32.5%, so I am sure that these two targets set for the EU Member States will be translated into the reduction of greenhouse gas emissions. I think we will overshoot our emissions reductions target of 40%. This is very important because we wanted to show that for example, in terms of climate change we are the global leader and the first major economy which has transformed our commitment to law.

"This is also very important for industry and I am glad to say that this has had strong support from the public, including the mayors of our European cities who have become the closest allies we have. They are the first ones who deal with air pollution, traffic jams and access to clean water and are helping us a lot in achieving this target."

In closing, we move to a challenge around energy policy and ask Vice-President Šefčovič about the trilateral ministerial talks with Russia and Ukraine, that concern the long-term transit of gas to Europe. He says that this is the most complicated issue he has on his desk, one reason for which is that Europeans have a fresh memory of gas interruptions in 2009. Here, most Central European Eastern countries were put into a situation where the whole of the industry was put on hold and the last remaining energy was channelled to hospitals and households.

"Of course, another factor is the complex question in Ukraine and Russia where a delicate discussion is needed. This is coming at a time when we all had to assess how much gas is needed in Europe. However, the good news is that in a recent discussion we had with Russian and Ukrainian ministers and company leaders, was that we will negotiate a way to ensure transit to Ukraine is secured on a basis of a commercially viable volume. That will help with their heating infrastructure, but also connect them with highly reputable energy operators externally to help them in managing the transmission of gas. I believe that this will make it easier for the European Commission, The World Bank and the European Bank for Reconstruction and Development (EBRD) who gave out a lot of money for the refurbishment of this gas pipeline and we aim to push these talks forward in the future." ■

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https://ec.europa.eu/commission/commissioners/2014-2019/sefcovic_en

The Flexible Heat and Power (FHP) project: Distribution grid connected power to heat resources

Chris Caerts, Product Manager at VITO, details the FHP (Flexible Heat and Power) dynamic coalitions of distribution grid connected power to heat resources project and how this could provide local and system level services throughout Europe

The power system is undergoing a fundamental transformation, driven by the ever-increasing share of renewable energy sources (RES), like wind and solar. These renewable energy sources, that are replacing traditional fuel-based and nuclear generation, are integrated both at the central system level (e.g. large off-shore wind farms) and at local distribution grid level (e.g. building level PV). As the amount of such intermittent renewable generation increases, so does the risk and amount of RES curtailment.

The FHP project has developed a standard-based multi-agent software framework that allows the mitigation of RES curtailment by shifting – in a coordinated manner – the electric consumption of distribution grid-connected power-to-heat conversions, taking the local grid conditions into account.

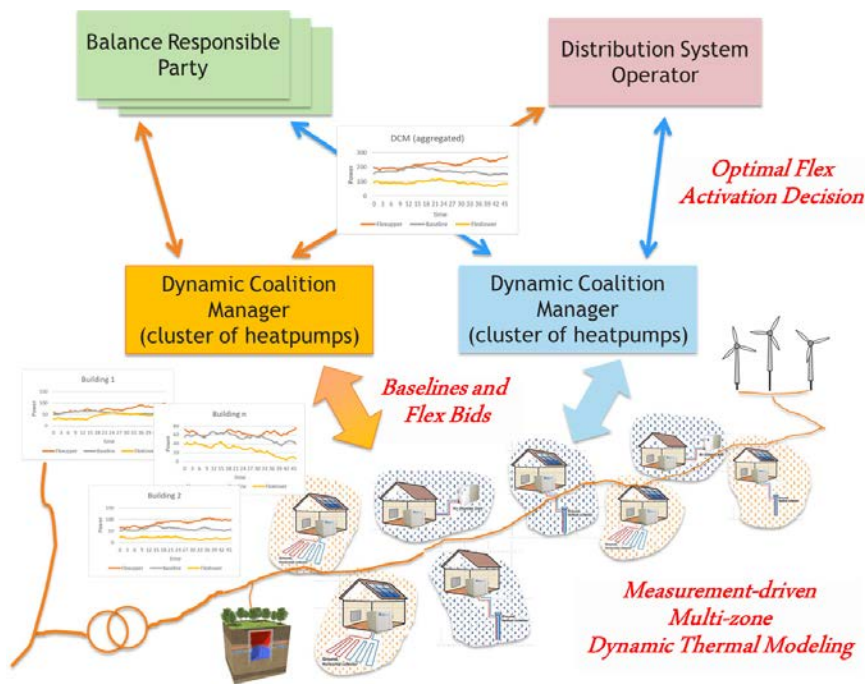
Two types of RES curtailment can be distinguished. Technical RES curtailment is typically caused by distribution grid connected PV generation: as more local PV is added, this may lead to reverse power flows for which the grid was not designed, causing congestions and voltage problems. Economic RES curtailment results from market conditions when there is (forecasted) excess generation, which is not in

balance with the (forecasted) consumption. There is a clear need for the cost-effective mitigation of RES curtailment: which avoids wasting emission-free energy, increases the amount of (OPEX) free energy in the energy mix – which potentially reduces energy prices – and has a positive effect on RES investment business cases.

In the FHP project, the distribution grid connected thermal storage and flexibility (provided by thermal inertia) is used to shift heat pump power-to-heat conversions in buildings and large (seasonal) heat storage vessels in a RES curtailment mitigating manner. A dynamic coalition manager was developed that coordinates the operation and control of a local cluster of heat pumps, to ensure that flexibility activations do not cause any local grid problems. For this, a USEF (1) inspired transaction scheme was developed and implemented as a multi-stakeholder multi-agent platform that facilitates optimal flex trading between flexibility sources (e.g. clusters of buildings represented by a dynamic coalition manager), market operators (e.g. BRPs) and the local grid operator (DSO). RES curtailment mitigation business use cases have been implemented that operate at the day-ahead timescale, the intra-day timescale, as well as real-time (acting on intra-ISP imbalance forecasts).

To characterise the thermal flexibility of buildings, dynamic thermal grey-box models are created in a replicable human expert-free manner, solely based on measurements. Machine-learning techniques are deployed for multi-zone characterisation without any architectural information (a zone is associated with each temperature sensor). Current experiments indicate that with 10 days of auto-validation followed by 10 days of auto-correlation, sufficient accuracy for single-family residential buildings can be obtained. This will be further validated through a pilot validation in Sweden (winter 2018). These building dynamic thermal models are complemented with measurement-driven black-box heat pump models.

Using these two models, a building level power consumption and control profile is calculated for each of the participating buildings. This calculation can be a (thermostatic) on/off control or PI control, but it may as well be the result of optimisation that minimises energy consumption (e.g. minimising losses by smarter pre-heating) or energy cost for a specific business case (e.g. dynamic tariffs, peak pricing, solar self-consumption etc.). This (optimal) consumption plan of the flexible controllable consumption is added to the forecasted non-controllable consumption, to



create a baseline consumption plan for each building.

Next to this, the remaining/updated flexibility with respect to the calculated (optimal) baseline is characterised as a Flex Graph that describes the upper and lower power consumption profiles – that do not violate comfort settings – in the function of time. Both the baseline consumption plan and Flex Graphs are communicated to the dynamic coalition manager who aggregates this information for all participating buildings and sends it to the DSO. The DSO uses the aggregated baseline information to check whether it would cause grid violations and if it does, determines an optimal flex activation plan within the provided Flex Graph.

In the FHP project, the currently used prime objective is the minimisation of local RES curtailment. This will be extended in the future to minimise

cost, taking into account curtailment (compensation) costs, flex activation costs and optionally grid losses. This optimal flex activation plan is sent back to the dynamic coalition manager who disaggregates it into flex activation requests for each of the contributing buildings. This disaggregation uses an iterative incentive based negotiation that results in an aggregated response of the participating buildings – that is as close as possible to the requested flex activation plan.

The DCM also acts as a local energy community manager, that uses the available aggregated flexibility to offer RES curtailment mitigation services to balance responsible parties (or system level RES owners). If such parties are confronted with market conditions that would lead to a RES curtailment decision, they can instead bilaterally engage with the DCM to ask for a consumption shift/increase as an alterna-

tive. Such a flex activation request coming from the BRP will be accommodated to the maximum possible extent, within the DCM's aggregated flexibility and results in a proposed aggregated baseline update for the cluster of buildings. This proposed updated baseline, along with the updated Flex Graph, is sent to the DSO for clearing.

The DSO will check whether the proposed baseline would cause grid constraint violations and if so, calculate an allowed baseline within the Flex Graph that is feasible and deviates as little as possible from the proposed baseline. Based on this, the DCM formulates a flex offer to the BRP (that maybe only partially fulfils its request) and if accepted, disaggregates the resulting flex activation plan over the buildings in a similar manner as for the local RES curtailment case.

USEF: Universal Smart Energy Framework (<https://www.usef.energy/>)

FHP project is funded by European Union under the grant agreement no.731231.



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New food production systems need sustainable energy worldwide

Swedish Surplus Energy Collaboration explain the reasons as to why sustainable energy worldwide is a requirement if we are to continue producing food in the future for an ever-growing population

To produce food in the future, we must use large quantities of energy, also at an ever-increasing scale. The three main reasons for this are:

1. The world population is set to increase to 9.8 billion people by 2050

The world's population will increase from today's 7.6 billion to 9.8 billion by 2050, according to a UN report. In just seven years, India will have passed China as the world's most populated country, the UN predicts. And by 2050, Nigeria will have taken over third place from the United States. With around 83 million people being added to the world's population each year, the upward trend in population size is expected to continue.

2. An increasing number of people are moving to our cities

Today, more than 50% of the world's population lives in cities. The world's production systems for food is changing at a furious pace and more and more energy-consuming means of production, such as fertilisers and pesticides are used. And because we still use the same agricultural land resources to produce our food, as we have for hundreds of years, it now requires many and costly methods to transport to the city, and all over the world.



Photo by Håkan Sandin att King Naresuan Court outside Nakhon Ratchasima, Thailand: A pastoral dream landscape in Thailand today replaced by a highly efficient industrial agriculture that, with the help of chemicals and fertilizers, destroys a millennial agricultural ecosystem

3. The food needs more transports

The world is flooded with food. The variation of food available to the consumer has dramatically increased. Food of all kinds, from every corner of the world, is nowadays available in almost every shop. Our consumption patterns are also changing. In the urbanised world we prefer to buy our food in food bags distributed to our homes, resulting in a dramatic increase in transport in and around our cities. We also consume more processed and packed food and at the same time, we also eat out at restaurants more than ever before.

Can we save energy when producing food?

The answer is as simple as it is obvi-

ous. We must always be frugal with the world's resources and we must lose our dependence on fossil fuels, especially in transport.

However, we must continue to support the growing population of the world with food, so therefore we must also increase our use of energy.

The latest reports from the UN Climate Panel PPCC, which was held in May this year show that we can supply the world with renewable energy, with a good margin. "The technological potential of renewable energy exceeds the world's energy needs during this century, notes the UN Climate Panel".

The following statements can not reasonably be denied.

| | Electricity | Diesel | Oil | Biofuel | |
|----------------------------|-------------|-------------|------------|------------|----------|
| Cultivation and harvesting | 0 | 1449 | 0 | 0 | GWh/year |
| Manure management | | 121 | | | GWh/year |
| Dairy Cows | 341 | 118 | 0 | 0 | GWh/year |
| Beef cattle production | 76 | 466 | 0 | 0 | GWh/year |
| Piglet production | 134 | 5 | 79 | 32 | GWh/year |
| Pig production | 66 | 0 | 0 | 0 | GWh/year |
| Broiler production | 20 | 0.6 | 46 | 116 | GWh/year |
| Egg production | 19 | 0.2 | 19 | | GWh/year |
| Total Energy | 656 | 2160 | 144 | 148 | GWh/year |

Source: Mapping of Agricultural Energy Use JTI - Institute of Agricultural and Environmental Technology, author Andras Baky, Martin Sundberg, Nils Brown

1. We have built our modern societies with the help of large amounts of energy.
2. We will continue to need much more energy.
3. We can reduce the energy needed per unit, when producing our food, being more effective.
4. We need to use renewable sources of energy to save our environment.
5. There is no shortage of renewable energy in the world

Swedish agriculture uses around 10 TWh of energy, of which 3.11 TWh in the form of diesel, electricity and biofuels, as displayed in the table above. This direct energy use will generate approximately 3.64 TWh of indirect energy needed to produce fertilizer and other means of production, of which fertilizer use is about 2.31 TWh. Production in greenhouses and drying costs for cereals consume somewhere between 3-4 TWh, altogether a grand total of about 10 TWh/year.

We are now working to increase the production of fish and vegetables in Sweden, with the aim of making use

of surplus energy that would otherwise be wasted. Doing so we will need to increase our demand of electricity and heat with approximately one hundred percent in the short term.

Food production in-house where people live

Producing our food in-house, where people live, is undoubtedly part of our effort to save energy. Simply because it is so efficient when calculated per produced kg of fish and vegetables.

- Prioritizing the production of fish and vegetables in-house is undoubtedly one of the most effective ways to increase food production in the world. By definition, it is an exponential innovation, that has the potential to quickly reach one billion people in a person's lifetime.
- By producing food in-house, we can place it exactly where we wish and where we have full control over all flows, giving us possibilities to develop circular and mutualistic production systems.
- By placing them in urban areas where people live, we reduce the need for transportation and can also benefit from surplus heat, electricity,

organic materials and other unused resources created in the city.

- Then we can also more easily employ people who have no work.

By producing in-house, we are open to endless innovation possibilities by using high technology and ingenious solutions that the world has not yet seen.



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Creating a greener, cleaner and more sustainable economy across Europe

European Commissioner for Climate Action and Energy, Miguel Arias Cañete is at the centre of efforts to develop a long-term plan to create a greener, cleaner and more sustainable economy across the European Union (EU), as this probing analysis from Open Access Government discovers

The current European Commissioner for Climate Action and Energy, Miguel Arias Cañete is at the heart of endeavours to develop a long-term plan to create a greener, cleaner and more sustainable economy across the European Union (EU).

Climate action and energy, and particularly energy security, are two policy areas with obvious cross-border implications, both for members of the EU and the wider international community.

Tackling climate change, for example, cannot be achieved in isolation; it has long been recognised that coordinated, global efforts are needed to not only deal with emissions but also to foster innovation in greener technology and support adaptation to changing weather patterns.

Energy policy, of course, has a huge role to play in the transition to a low-carbon economy, with renewables and energy efficiency seen as two key pillars in the European Union's efforts to reduce greenhouse gas emissions.

Miguel Arias Cañete has been the European Commissioner for Climate Action & Energy since 2014. His responsibilities include diversifying sources of Europe's energy imports, further developing Europe's renewable energy policy to make it a world leader in the sector and strengthening and promoting the Emissions Trading System (ETS), one of the cornerstones of the EU's climate policy.

Set up in 2005, the ETS is the world's first carbon trading system. It currently operates in 31 countries (the 28 EU members plus Iceland, Liechtenstein and

Norway) and covers around 45% of the EU's greenhouse gas emissions.

Under the system, companies and installations in sectors like power and heat generation, commercial aviation and other energy-intensive industries, such as oil refinement, steelmaking and cement production, can buy and receive emission allowances which they can trade with other ETS participants. They can also buy a limited number of international credits from emission-saving projects around the world.

At the end of each year, companies must surrender enough allowances to cover all their emissions or risk heavy fines. Over time, the total ETS cap will be lowered to reduce overall emissions.

Commissioner Miguel Arias Cañete also takes the lead in selecting energy infrastructure projects to help establish a European Energy Union and proposing new EU laws and rules to implement the 2030 climate and energy framework. The framework has three targets: to reduce greenhouse gas emissions by at least 40% compared with 1990 levels; to have at least a 27% share for renewable energy; and an improvement of at least 27% in energy efficiency.

The EU's efforts to tackle global warming moved into a new phase in the summer as it embarked on the development of a long-term strategy to create a more modern, cleaner and competitive economy.

In July this year, Commissioner Miguel Arias Cañete addressed a High Level Stakeholder Conference at the Universite Libre de Bruxelles to discuss the development of the strategy.

“If we are to meet our Paris objectives on global warming by the middle of the century, we cannot wait till 2030 or 2040 to define our direction of travel,” he comments.

“The strategy will not be a mere exercise of trajectory setting to reduce emissions. It has to reflect a vision of a prosperous, competitive, greenhouse gas-neutral European economy, working for all Europeans. It has to make the most of the opportunities out there. In terms of facilitating investment. In terms of growth and jobs. In terms of improving the quality of life of our citizens.”

“Tackling climate change, for example, cannot be achieved in isolation; it has long been recognised that coordinated, global efforts are needed to not only deal with emissions but also to foster innovation in greener technology and support adaptation to changing weather patterns.”

Commissioner Miguel Arias Cañete also announces progress already made, including recent political agreement on the greenhouse gas reduction elements of the Clean Energy for All Europeans package, namely reinforcing energy efficiency, renewable energy and the governance of climate and energy policies. The measures agreed will include an EU-level binding renewable energy target of 32% and a 32.5% indicative energy efficiency target for 2030. ⁽¹⁾

The new rules, described as the “most advanced regulatory framework to enable the EU to remain a frontrunner in the clean energy transition”, also include a provision for all Member States to report to the commission on national long-term emissions strategies with a perspective of at least 30 years.

“The combination of these two targets – and the requirement for EU countries to establish the first-ever integrated national energy and climate plans defining their contribution to these targets – means that we are in a good position to do even better than 40% greenhouse gas reductions by 2030,” Commissioner Miguel Arias Cañete explains.

“Our initial calculations suggest that the European Union could consider raising the level of ambition and

increase its target from the current 40% to slightly over 45% by 2030. But this is something that will become clearer in the autumn.”

In his closing address, Commissioner Miguel Arias Cañete says three key themes emerge from the conference:

1. The need that our efforts are comprehensive and encompass all sectors of the economy.
2. The need to ensure that efforts are inclusive so that citizens feel the benefits and become “change agents” of the transition.
3. The need to have a clear vision of the way ahead, help create the right conditions for change, and consolidate the EU’s leadership at a global level.

The European Commission is now consulting on the long-term strategy and will set out its proposals for further discussion in November.

“The international community remains committed to the Paris Agreement, and the EU is keen to shoulder our responsibility, to step up to the plate and to show leadership,” Commissioner Miguel Arias Cañete stresses.

“Coming forward in November with the Commission proposal will also allow us to have a broad and thorough discussion next year so that we can submit a long-term strategy to the UNFCCC at the latest in early 2020, as required under the Paris Agreement.” ⁽²⁾ ■

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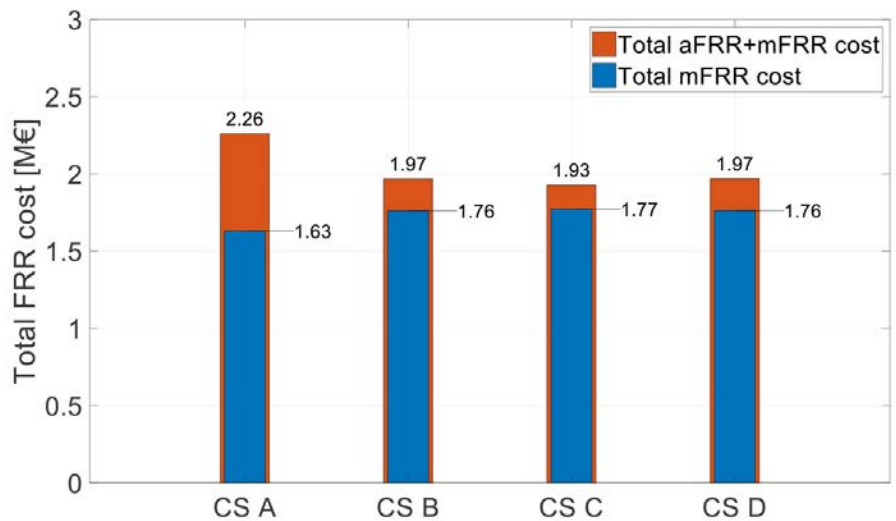
Energy in Europe: A SmartNet to boost the green revolution

The EU-funded SmartNet energy project provides a vision on future ancillary services from distribution grids in Europe, as Gianluigi Migliavacca, Project Manager at Ricerca sul Sistema Energetico explains

The August 2017 issue of Open Access Government has already featured an article on the [SmartNet research project](#), under technical and administrative management by RSE¹, which compares different TSO-DSO interaction schemes and different real-time market architectures allowing ancillary services (AS) provision from distributed energy sources (DER) located in distribution grids. The goal is to assess which interaction strategy delivers the best costs-benefits compromise for the system.

SmartNet considers five possible coordination schemes characterised by different roles and market architectures:

- Centralised AS market model (CS A): TSO contracts services directly from DER. No congestion management is carried out for distribution grids;
- Local AS market model (CS B): DSO manages a local congestion market. Unused resources are transferred to the AS market managed by TSO (procuring balancing and congestion management);
- Shared balancing responsibility model (CS C): TSO transfers to DSO balancing responsibility for distribution grid. DSO manages a local congestion and balancing market using local DER;



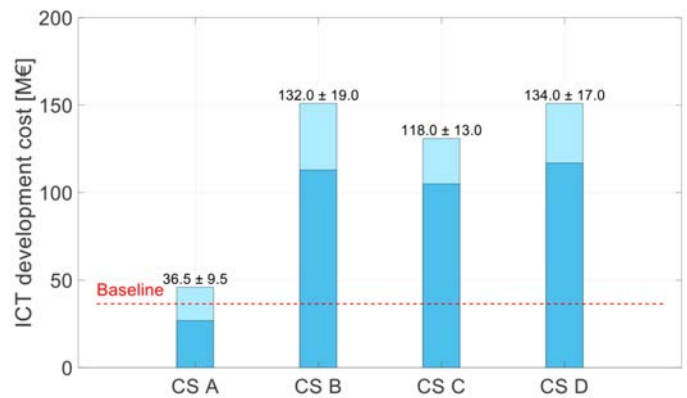
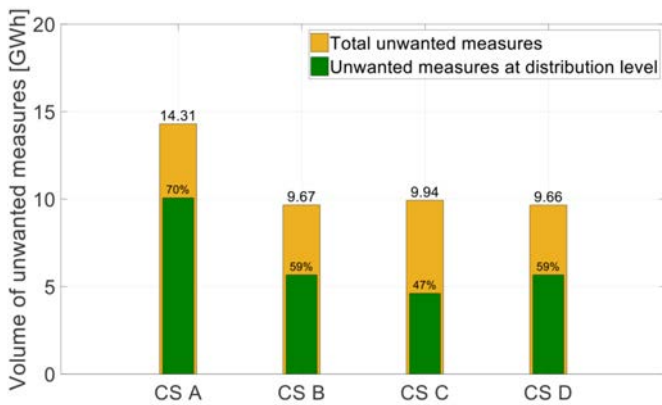
- Common TSO-DSO AS Market Model (CS D): TSO and DSO manage together a common market (balancing and congestion management) for the whole system;
- Integrated flexibility market model (CS E): TSOs, DSOs and commercial market parties contract DER in a common flexibility market (raising regulatory problems: not implemented in simulation).

In order to compare CS performance, SmartNet has developed a challenging simulation platform, modelling in detail T&D networks and ancillary services markets and implementing a very detailed dataset of generators and loads. Simulations are carried out on midterm scenarios (time horizon 2030) for Spain, Denmark and Italy to identify the best TSO-DSO coordination

scheme for each country. The same platform is also implemented in a laboratory in order to test real network equipment on the developed simulation scenarios (hardware-in-the-loop).

TSO-DSO coordination schemes are compared using a cost benefit analysis with the following indicators:

- Cost of mFRR (manual frequency restoration reserve) purchased in AS market for balancing and congestion management;
- Cost of aFRR (automatic frequency restoration reserve) to cope with residual system imbalance not solved by mFRR because of simplified system representation, forecasting errors, network losses and;
- ICT deployment costs.



Two additional non-monetised factors are monitored:

- The amount of CO₂ emissions;
- Unwanted measures (e.g. load shedding) activated in case of congestion still unsolved or unpredicted after AS market clearing. This creates a further imbalance which is solved by aFRR.

A cash flow analysis is also carried out to assess revenue opportunities for the different market subjects. The following diagrams synthesise the simulation results obtained from the Italian scenario.

These diagrams allow to draw the following conclusions:

1. CS A performs worse than all other coordination schemes: disregarding congestion in distribution network brings to buy less mFRR, but a higher amount of more expensive aFRR. Unwanted measures are also much higher for CS A.
2. CS B and CS D perform equivalently: due to radial topology, congestion in distribution networks must be managed within the portion downstream the bottleneck. This generates an imbalance, which can only be solved by the remaining part of the system. This results in splitting the overall market into two sections, where prices are formed independently.

3. CS C, even if much trickier to implement, performs well because the fragmentation of the AS market in several sections prevents to spread over the whole system high bid prices of some resources in distribution.

4. ICT costs are lower for CS A. As they are single-payment costs, their influence on the system expenses can be assumed negligible with respect to FRR costs (shown in the above diagrams aggregated over 16 simulation hours).

The SmartNet project also includes three physical pilots aimed at testing specific technological solutions.

Italian pilot

Implemented in an alpine region where several hydro generators connected to the distribution grid are exploited to provide:

- Real-time information for distribution grid monitoring;
- Participation in voltage regulation on set-point provided by TSO and;
- Participation in aFRR regulation on set-point provided by TSO.

Danish pilot

Demonstrating the provision of balancing and congestion management services by controlling set-points of indoor swimming pools thermostats in rental summer houses. A unidirectional communication channel broad-

casts price signals from aggregators to flexibility providers after identifying their reaction to price.

Spanish pilot

Located in the area of Barcelona, demonstrates the potential contribution of mobile phone radio base stations to reduce congestion in distribution grids. DSO organises a local market, putting radio base stations in competition with other aggregated resources while contributing to system balance by maintaining a fixed exchange schedule at the TSO-DSO connection point.

¹ Ricerca sul Sistema Energetico: <http://www.rse-web.it>



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From net zero energy buildings to autonomous city districts: A necessary step towards the green built environment

Professor Marc Frère of the University of Mons Research Institute for Energy looks at the arguments for creating low energy demand buildings

In Europe, the building sector is a major contributor to energy consumption and, hence, is responsible for 36% of the continent's greenhouse gas emissions¹. In a country like Belgium, space heating needs are mainly covered by fossil fuels (90 TWh/year: 21.7% of the total fossil fuel consumption)².

Construction techniques and energy conversion technologies that are currently available could considerably reduce the environmental impact of the built environment. The concept of very low energy or passive building makes possible the reduction of the annual heat demand (from 130 kWh/(year m²)) – average space heating demand for existing buildings in Belgium to 15 kWh/(year m²)).

Furthermore, low heating/cooling power may be delivered at quite low/high temperatures, which increases the energy conversion efficiency and/or the renewable contribution of heating and cooling technologies.

There is thus a kind of positive chain reaction when promoting the development of low energy demand buildings. As an example, when virtually transforming all the Belgian building stock into passive buildings heated by high performance air-to-water heat pumps (seasonal performance factor=3.1), the fossil fuel consumption

for space heating could be reduced to 7.8 TWh/year (considering a heat distribution efficiency equal to 0.97 and a non-renewable primary energy to electricity conversion efficiency equal to 0.4) instead of 90 TWh/year. The huge gain between the two situations is a combination of reduction of the heat demand and an increase in the global conversion efficiency from non-renewable primary energy to heat.

The European Union promotes the transition towards low energy buildings allowing the use of technologies with a renewable contribution (Energy Performance of Buildings Directive – EPBD – and its recast³).

The idea behind Net Zero Energy Buildings (NZEBs) is that the total annual energy need of the building must be counterbalanced by a renewable production (local production). The electricity needs for ventilation, lighting and domestic appliances may be covered by PV panels. In the case of using a heat pump for space heating and DHW production, the additional electricity consumption may be covered by an extra PV surface area, which is possible for very low heat demands (e.g. passive houses). The generalisation of such a concept could considerably reduce the fossil fuel consumption.

This concept is pushed up by Euro-

pean regulations. However, some major issues still need addressing before these policies can have a real impact on the fossil fuel consumption of buildings:

- EPBD regulation mainly applies to new constructions and heavy refurbishment projects. In a country like Belgium, the building stock is growing with a rate of 0.6% per year due to demography and growing share of services in the economy. The demolition rate is only 0.2% per year, leading to a weak/low impact of new regulations on the building sector energy consumption.
- NZEB concept increases the investment costs.
- NZEB concept, as well as specific policies for promoting the production of green electricity, will lead to the electrification of space heating (through heat pumping). When considering annual energy balance, the above-explained example shows a striking positive impact in terms of fossil fuel consumption. However, it requires a dramatic increase of the electricity production capacity (several GW for Belgium). The mismatch between green electricity production and consumption (namely for space heating) may also require either storage capacities or additional conventional power plants.

To correctly address the last issue and its impact on power generation, it is urgent to promote the concept of nearly energy autonomous buildings or city districts.

In such a concept, a building or a city district would be equipped with green energy production capacities, conventional energy production capacities, as well as energy storage capacities, in such a way that the energy needs are mainly covered by renewable energy sources, with a reduced impact on the global energy network.

It means that, in the case of low green energy production, the needs may be mainly covered by the energy that was stored during periods for which green production was exceeding the needs. This concept may be supported by the following arguments:

- The built environment is probably the unique sector for which technical solutions exist for drastically reducing the energy demand and introducing renewable energy resources. This fact probably justifies a specific energy policy for the building sector with no or limited impact on the other sectors.
- The energy demand of buildings has some specificities. A part of the energy needs (heating and cooling) has a seasonal occurrence. Energy needs cover electricity needs, heating and cooling needs; energy conversion technologies associated with energy storage capacities allow flexibility. For example, exceeding green electricity may be either stored in batteries or converted into heat using a heat pump – a heat storage may be used if there is no heat demand; CHP provides at the same time heat and electricity; cooling needs may be covered by sorption

machines which are thermally driven; thermal energy may be produced by solar collectors; heat or cold storage will add flexibility to the system.

- These examples show the complexity of the energy demand profile of buildings may be a source of big perturbations on the energy grid if buildings are considered as pure energy consumers – but could be at the origin of the development of efficient energy systems when such systems are specifically designed for maximising the local use of renewable resources.
 - The concept of a nearly autonomous building gives the responsibility to the building sector and building users in terms of contribution to the energy transition. It allows an integrated approach of energy production/storage/distribution systems and buildings taking into account local specificities in terms of climate conditions and local renewable resources.
 - When considered at the district level, this concept makes possible large-scale investments (district heating, geothermal wells).
 - Promoting the local use of locally produced green energy may contribute to create social links and to re-centre energy policies at the local level.
- Such a concept has already been experienced^{4,5}. It appeared from existing case studies that:
- Extra investment costs must be covered by public bodies, highlighting the need for a new economic model.
 - There is a wide variety of technical solutions for combining technologies

in order to reach high levels of onsite consumption of locally produced energy.

- Electricity and heat storage, as well as their collaborative working, is a key R&D topic to focus on.
- Education programmes that eliminate the barriers between disciplines related to energy should be encouraged (both at the scientific and technical levels).

This paper was written in the framework of the RESIZED project (ERA CHAIR project funded by EU) devoted to the efficient use of energy in city districts.

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Advanced power electronics promotes the green transition in the Baltic Sea Region

The Interreg 5B project Power Electronics for Green Energy Efficiency (“Green PE”) helps companies in the BSR to transition towards more efficient products using next-generation power electronics

Modern society strongly depends on advanced power electronics (APE) since it opens up for huge energy savings, minimises electronics volume and makes devices ready for smart digitalisation. Improved efficiency in the production, distribution and consumption of electricity is a key factor on the road to a sustainable energy future.

With next generation power electronics and devices that are based on wide band gap (WBG) materials, power losses can be reduced by more than 50%. This is especially relevant to the fields of electromobility, renewable energy generation or energy efficient buildings.

In the Baltic Sea Region (BSR) more than 15,000 companies are working with PE.

Within the last three years, reaching out to hundreds of those companies, Green PE has spread the news about advantages of APE throughout the BSR. Strong collaborations and ties have been created between research and industry (e.g., the new Centre for Industrial Electronics has been initiated in Sønderborg, Denmark). The project has also revealed that the development in implementing renewable energy sources (RES), as well as decarbonised transport (electromobility), varies strongly in the BSR countries.



Denmark has been at the forefront to a green transition and the transformation of the national energy system.

Danish windmill producer Vestas is a good example of how determination and persistence in governmental subsidy and legislation fosters a highly competitive RES industry. In 2017, 44% of Denmark’s energy production came from wind, while the overall energy production from RES exceeded 65%.

The next phase of the transition will be to change consumables and use electromobility as transport means. A substantial amount of charging stations are already distributed throughout the country and there is an obvious market pull from consumers towards electrification of the transport sector. Investments in APE will help to achieve the green goals with increasing range, lowering weight and size of energy efficient components.

In Sweden, the development of efficient PE based on WBG materials and devices is promoted by the WBG Power Centre hosted by the organisation RISE and financially supported by the Swedish Energy Agency and Vinnova. The WBG Power Centre currently has 11 companies and six research groups as members.

A couple of companies in Sweden have already released products with WBG-based devices, carried out the advanced prototype and product tests (for example, Bombardier for commuter trains and GE for HV power supplies) and performed laboratory-based technology development (ABB).

The background to this development is a broad research programme on Silicon Carbide (SiC) initiated by ABB in 1993, encompassing bulk material growth (Oukmetic and Linköping University (LiU), Norstel), epigrowth (LiU and

RISE), as well as technology and device development (RISE, KTH and Ascatron).

The decarbonisation of the energy supply and transportation sectors is a major driver for implementing APE in Germany.

Energy efficient conversion technologies are needed to reduce internal power losses. For future electromobility, there is a clear route towards integrated power modules, combining drive, control and cooling management in single packages in small dimensions. The increased power density requires novel engineering solutions to take the full advantage of this development, as well as advanced WBG materials for the integrated semiconductor devices. These improvements enable a high-temperature operation, a reduction in system size and weight and an increased power efficiency.

In 2017, Lithuania's Ministry of Energy submitted a strategy on how to become an independent energy producer to reduce the import of energy and increase the local production through competitive RES.

By 2030, 70% of the country's energy should be produced locally, of which 45% should come from RES. Likewise, 50% of the conventional transport in urban areas should rely on RES. This requires substantial further investment and technological developments, such as APE. However, the legislation still needs to facilitate this process with subsidy, compensation or tax cuts. Investments in RES or electromobility need to be fastened by reducing bureaucracy and installing financial supporting mechanisms.

Estonia's attachment to oil shale mining for energy generation means that it has been the most carbon-inten-

sive economy in the OECD. To increase the decarbonisation, Estonia is working on improving energy efficiency and stepping up investment in RES.

There is already about 500MW installed RES capacity in Estonia, 63% wind energy and 4% photovoltaics. In 2017, 16,8% of the electricity came from RES.

Estonian transportation is moving towards electromobility. At present, more than 1,400 electrical cars are registered and the net of charging stations (ELMO – 168 stations) covers the whole country.

One-third of Latvia's energy already comes from RES, with the majority of the energy being produced by the local public company Latvenergo.

Like other EU countries, Latvia has published decarbonisation plans. To increase the renewable energy part, a support programme to facilitate the transition has been started, which, however, lacks continuity.

The electrification of the transport sector is supported by waiving the taxes on electric cars and free charging. For this to have an effect, the cars themselves, as well as the charging stations and infrastructure, have to be made smarter using APE. At present, fewer than 300 electrical cars are registered in Latvia.

The electrification of the transport sector has been going on in Poland for the past 30 years, and it is now one of the most dynamically and developed industries using APE.

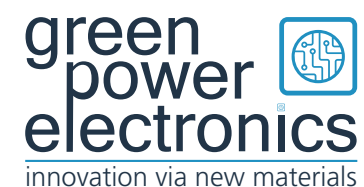
Due to governmental support programmes, the most developed APE products in Poland are electrical buses, which have become an international commercial success (e.g. Solaris).

As for RES, there is about 300MW photovoltaics capacity installed in Poland, which should increase to about 1GW by 2020. The increase in installed capacity is primarily a consequence of the public bid auction system. The prosumer segment has only moderate growth potential up to now.



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How climate change impacts the energy sector in Europe

Climate Service Center Germany (GERICS) explores the degree to which climate change impacts the energy sector in Europe

The challenge to guarantee energy supply long-term is central for today's energy sector in Europe. With climate change, this challenge is taking on a new dimension. To reduce greenhouse gas emissions, major efforts are underway to shift to renewable and clean energy sources. Many of these new energy sources, such as wind power or solar power are highly dependent on the weather. To be able to assess and secure long-term energy production and distribution, changes in the climate and the related impacts have to be considered when evaluating the potential for energy generation in different regions. This includes, for example, regional assessments of wind speed trends and the expected change in the intensity of solar radiation, a comparison of the future energy demands, along with the projections for wind and solar energy generation, or examining the impact of extreme weather, such as freezing rain, on transmission lines and other aspects of energy infrastructure.

Energy suppliers and transmission system operators are becoming more and more experienced with handling short-term weather data, especially to estimate the upcoming, immediate demand and to determine the best energy mix to meet this demand. For medium- to long-term planning purposes, a look beyond the weather forecast of a few days, at seasonal forecasts and climate projections, can help avoid unpleasant surprises. How-

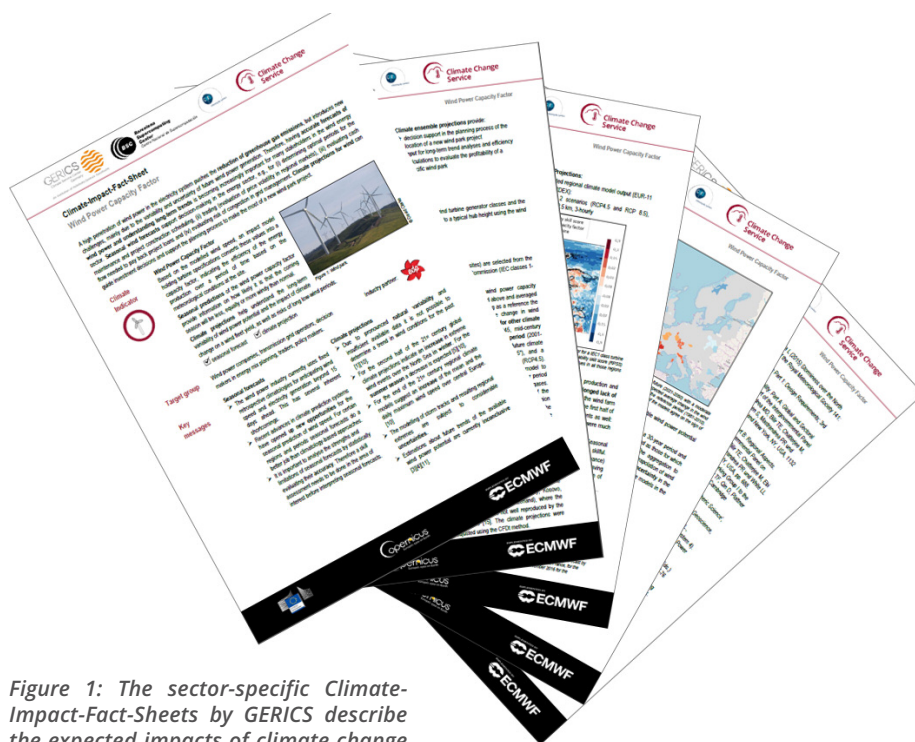


Figure 1: The sector-specific Climate-Impact-Fact-Sheets by GERICS describe the expected impacts of climate change on individual industries. The first set focuses on the energy sector

ever, there are a number of different factors that play a role to appropriately account for the regional impacts of climate change. Since energy companies focus on energy production or distribution as their core business, there is only rarely time or resources left to assess climate change in detail.

So, what if there was a place, where the most relevant information for the energy sector on regional climate change impacts was stored – easy to access and to understand?

Indeed, there is such a place: GERICS further developed its well-established methodology to create country

Climate-Fact-Sheets and designed sector-specific Climate-Impact-Fact-Sheets. The first set of sector-specific Climate-Impact-Fact-Sheets look at the energy sector in Europe (see Figure 1). In this case, a set of six Fact Sheets were developed, focusing on very specific topics (see Figure 2).

Each Climate-Impact-Fact-Sheet shows a brief summary on the first page: it outlines the purpose of the Fact Sheet in context, along with the sector of interest and introduces the indicator used to estimate the relevant climate change impacts. This is combined with a quick overview of the most important key messages regarding climate

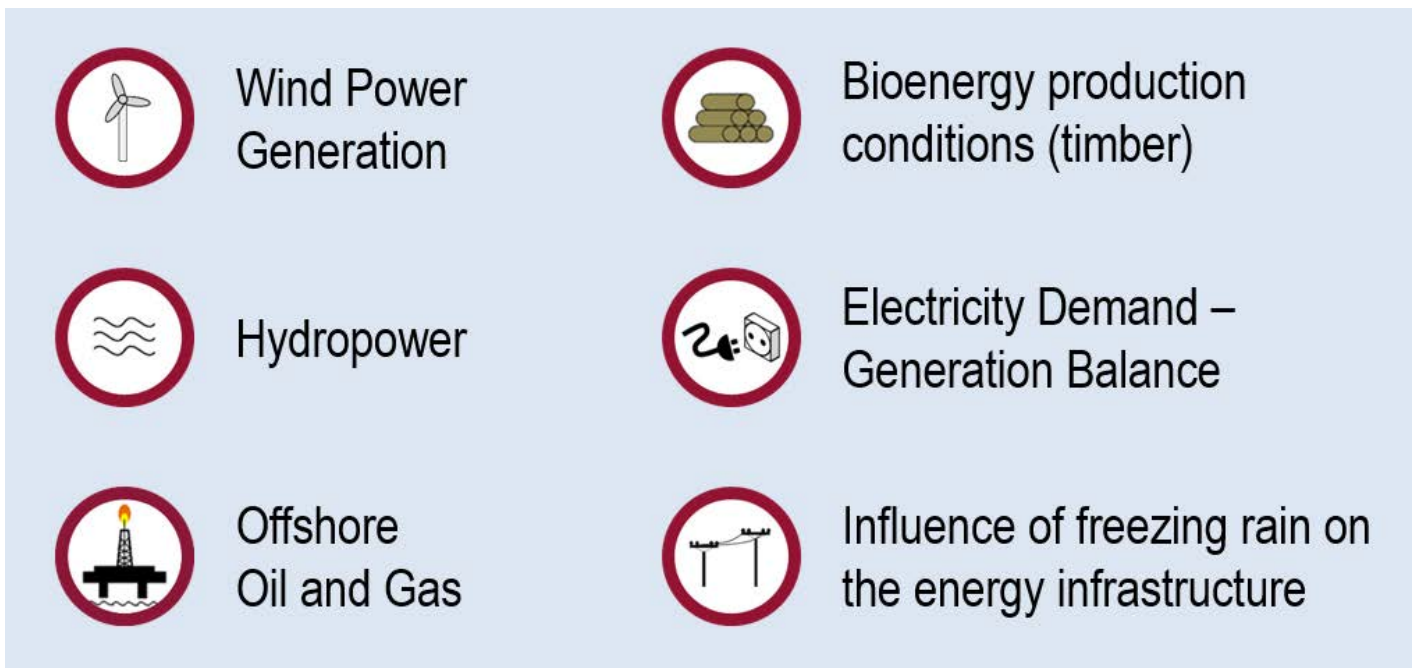


Figure 2: The sector-specific Climate-Impact-Fact-Sheets on climate change impacts are available for six topics related to the energy sector

change research for this indicator, and the practical implications for the respective industry. The following three to four pages provide more details on the methodology used to estimate the impact indicator, indeed, they show a case study highlighting some possible applications of the indicator and embed the content in the broader European context.

The Fact Sheets are complemented by a focus paper, providing a general overview regarding expected impacts of climate change on the six topics related to the energy sector shown in Figure 2. It further includes statements by representatives of the energy industry highlighting the importance of regional climate information and knowledge for their line of work.

The well-established Climate-Impact-Fact-Sheet methodology was applied in cooperation with a number of European research institutions and the energy industry, within the framework of the Copernicus Climate Change Service contract Clim4Energy. As part of the Sectorial-Information-System,

Clim4Energy is a proof-of-concept project that delivered nine energy-relevant pan-European indicators of climate trends and variability. The indicators are consistent across the different energy subsectors, allow for uncertainty estimations and are well documented. Guidance material demonstrates possible applications.

A visualization tool developed as part of the contract allows users to look at simple statistics on climate variables and energy indicators. Advanced data sets can be synthesised and downloaded in an easy and accessible way.

Clim4Energy was coordinated by the French Alternative Energies and Atomic Energy Commission (CEA). CEA partnered with the National Center for Scientific Research (CNRS), the Barcelona Supercomputing Center (BSC), the Finnish Meteorological Institute (FMI), Météo France, the U.K. Met Office, the Swedish Meteorological and Hydrological Institute (SMHI) and the German Climate Service Center (GERICS). From the industry, Clim4Energy was joined by the following energy companies:

EDPR, FINGRID Oyj, METSÄTEHO OY, Montel, RTE – FRANCE, SHELL, STATKRAFT, TOTAL and VATTENFALL.

Further information is available under <http://clim4energy.climate.copernicus.eu/>.



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Paris Agreement: How serious are we about it?

Adel El Gammal, Secretary-General of the European Energy Research Alliance (EERA) details two crucial conditions for achieving the ambitious energy goals set by the world community in 2015

“Today the world gets a lifeline, a last chance to hand over to future generations a world that is more stable, a healthier planet, fairer societies and more prosperous economies” – the words of European Commission President Jean-Claude Juncker reflect perfectly the mood that united the whole world on 12 December 2015, after 196 state parties had adopted the Paris Agreement: a mixture of optimism, relief and the acknowledgement that the big challenges were still lying ahead.

Now, almost three years later, it has become clear that we are not moving fast enough to reach even these minimum goals: to keep the increase in global average temperature to well below 2°C above pre-industrial levels by the end of the century; and to pursue efforts to limit it even further to 1.5 °C.

A recent analysis by “Climate Action Tracker”¹ indicates the emissions pathway that takes the intended nationally determined contributions into account has over 90% probability of exceeding 2°C. The pathways based on policies currently in place have even a higher than 97% probability of exceeding 2°C. In the race to cut dangerous emissions, the availability of cleaner and better energy technology stands as a necessary condition, but there are at least two other crucial conditions that must be met.

No low-carbon economy without a low-carbon lifestyle

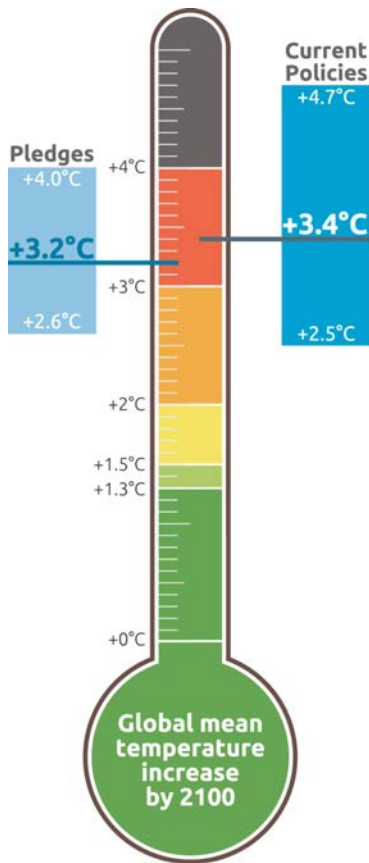
Today, economic and demographic growth are still strongly coupled with increasing carbon emissions and the progressive alignment of the poorest countries to western standards reinforces this development. We witness the Jevons paradox: thanks to technological progress, we need fewer resources, but at the same time the rate of consumption rises so that the gains are lost.



Adel El Gammal, Secretary-General of the European Energy Research Alliance

With the current limits to decoupling these parameters, achieving decarbonisation targets will require, beyond technological breakthroughs, a deep understanding of the drivers that enable us to steer the profound transformation of our core societal values.

Curbing emissions at a level compatible with the Paris Agreement will require a drastic change in the way citizens relate to energy production, conservation and consumption. This shift needs to take place much faster than lifestyle, cultural and societal changes usually do. Market mechanisms alone are highly unlikely to stimulate such a profound change, especially considering the well-known “rebound effect” through



"The world risks crossing the point of no return on climate change, with disastrous consequences for people across the planet and the natural systems that sustain them"

UN Secretary-General Antonio Guterres, September 2018



CAT warming projections Global temperature increase by 2100

November 2017 Update

which household energy savings are usually mostly converted into other carbon-rich economic activities. In that respect, we believe that social sciences and the humanities will be essential to better understand how to stimulate and drive behavioural change at a pace and to an extent that is compatible with zeroing global emissions by mid-century.

“Now, almost three years later, it has become clear that we are not moving fast enough to reach even these minimum goals: to keep the increase in global average temperature to well below 2°C above pre-industrial levels by the end of the century; and to pursue efforts to limit it even further to 1.5 °C.”

We need to invest much more

Progress beyond any expectations has been achieved in many low-carbon technologies. For instance, the cost of photovoltaics decreased by 85% over the last eight years and by 50% just during the last three years! Similar trends exist in many other low-carbon technologies, some of which have become highly competitive. To fully unleash the potential of existing and future low-carbon technologies, much more ambitious

funding programmes are needed, both at national and international levels.

Europe is right now designing its new framework programme for research and innovation. The proposed budget for a seven-year period as of 2021 amounts to around €100 billion, distributed over all scientific areas. Knowing that between September 2008 and December 2010, in the aftermath of the 2008 financial crisis, more than €4 trillion of direct aid was authorised to 215 financial institutions², this investment suggests a severe misjudgment of urgency and the absence of strong political courage and ambition to meet the goals convened in the Paris Agreement.

In line with the first recommendation of the Lamy Report³, the European Energy Research Alliance (EERA) calls for at least a doubling of research and innovation investments in the next European Framework Programme, compared to the current Programme, thus for €160 billion. Such a stimulus would speed up advances and implementation of low-carbon technologies while consolidating EU industrial leadership in the markets of the future.



Image: © Mark Dixon, licenced under CC BY 2.0 on www.flickr.com

On the occasion of the 2015 United Nations Climate Change Conference (COP21), the Eiffel tower was illuminated in reference to the ongoing negotiations

EERA is committed to supporting Europe in achieving a successful energy transition in line with the EU's Paris commitments. We firmly believe in the scientific potential to provide the technological and societal foundations required to decarbonise society.

“Today, economic and demographic growth are still strongly coupled with increasing carbon emissions and the progressive alignment of the poorest countries to western standards reinforces this development. We witness the Jevons paradox: thanks to technological progress, we need fewer resources, but at the same time the rate of consumption rises so that the gains are lost.”

About EERA

The European Energy Research Alliance (EERA) is an association of European public research centres and universities active in low-carbon energy research. Bringing together more than 250 organisations from 30 countries, EERA coordinates research activities through 16 joint research programmes. EERA is a key player and official partner in the EU's Strategic Energy Technology (SET) Plan. ■

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FROM VISION TO REALITY

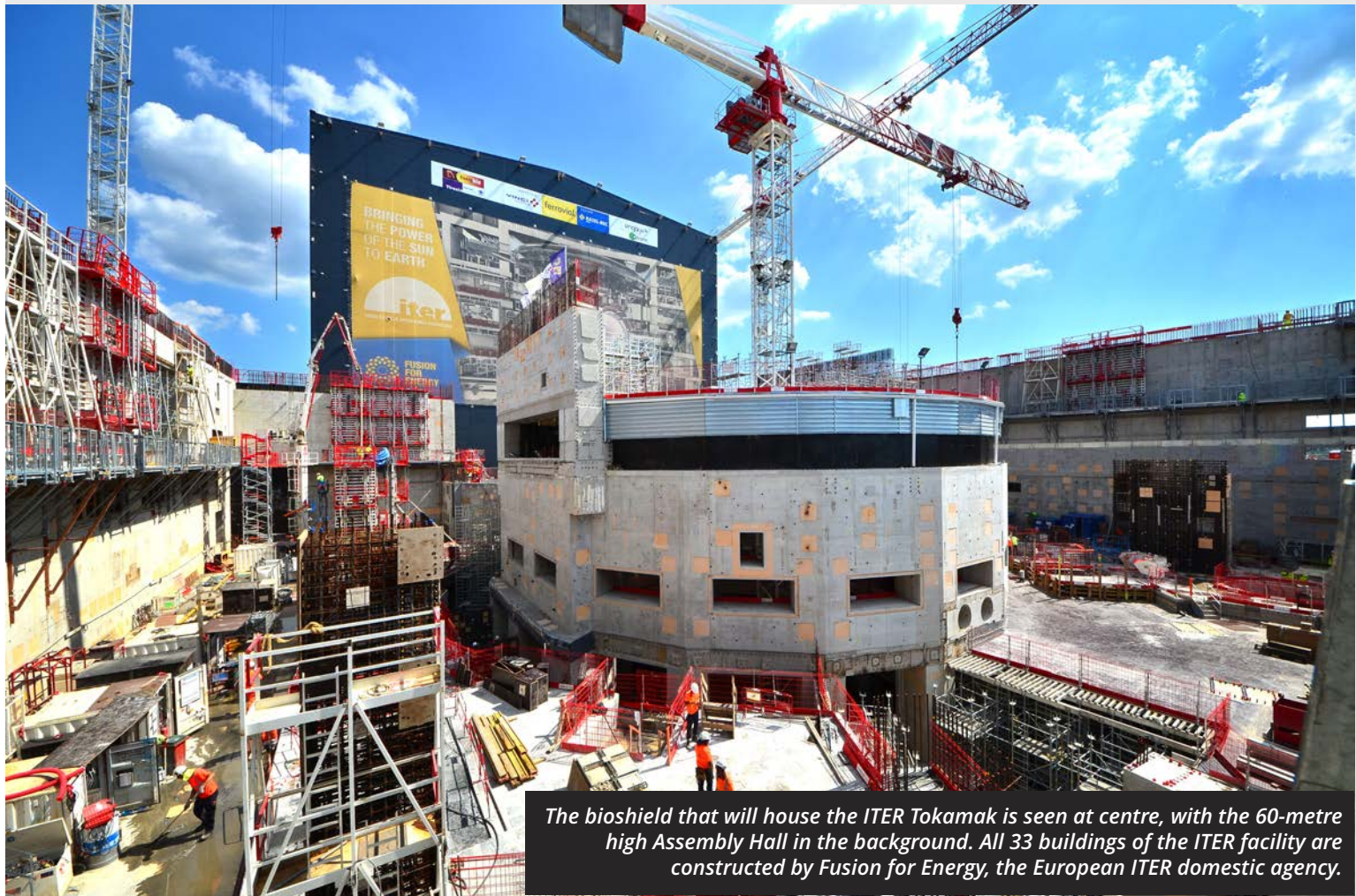
Copenhagen International School in Nordhavn has the largest building integrated PV installation in Europe. It covers all facades and supplies 50% of its yearly electricity use with solar energy.

Cenergia, which is now part of Kuben Management, will make Active House labelling, and will aim to use Prosumer level 1-4 in connection to the assessment.

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MANAGEMENT



The bioshield that will house the ITER Tokamak is seen at centre, with the 60-metre high Assembly Hall in the background. All 33 buildings of the ITER facility are constructed by Fusion for Energy, the European ITER domestic agency.

Fusion energy: Global procurement to build a star on earth

Laban Coblentz, Head of Communication, ITER provides an overview of fusion energy, focussing on the first industrial-scale fusion reactor

In the 1990s, when the ITER Project was in the early design stage, the prospect of building the first industrial-scale fusion reactor – a star on earth – had every ITER Member country lobbying to host the facility. The economic benefits were obvious and attractive. The chance to push the boundaries of innovation in many technologies, from robotics and power electronics to cryogenics, superconducting magnets, and materials science, promised major advancements for industrial suppliers.

Fierce competition led to compromise. Each Member chose critical pieces of the ITER Tokamak and its support systems as its spheres of responsibility. Most complex ITER components involve partnerships among multiple nations. Nine companies in eight countries have fabricated superconductor strand for ITER's giant magnets. The magnets themselves, each several hundred tons, are in fabrication in Hefei, China; San Diego, California; St. Petersburg, Russia; La Spezia, Italy; Kobe, Japan; and on the ITER worksite in Cadarache, France.

ENERGY



China has completed all of the winding packs for Poloidal Field magnet #6, at the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) manufacturing facilities in Hefei.



In its heavy engineering facility in Hazira, Indian contractor Larson & Toubro is manufacturing segments of the upper cylinder of the Cryostat: The giant "refrigerator" that will house the ITER Tokamak.



A segment of the colossal Central Solenoid magnet, "the beating heart of ITER," under fabrication at General Atomics near San Diego, California, USA.



Port stub extensions for the ITER Tokamak are being supplied by the Efremov Institute in St. Petersburg, Russia.

A true "visit to ITER", therefore, requires a global tour. This article shows a small sample of the ITER fabrication centres around the world. Together, 35 countries are committed to making fusion energy – the power of the sun and stars – a reality on Earth. ■

To continue your virtual tour of ITER, visit www.iter.org

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The first toroidal field magnet was completed last year at Mitsubishi Heavy Industries near Kobe, Japan.

Plasma-Jet-Driven-Magneto-Inertial-Fusion (PJMIF) – A status report

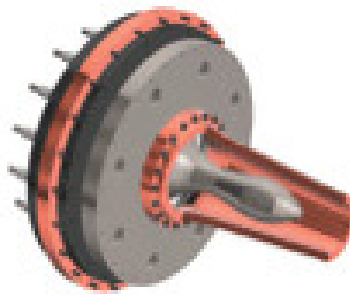
Professor Y. C. Francis Thio and Dr. Douglas Witherspoon from HyperJet Fusion Corporation, Chantilly, Virginia in the U.S. present the latest exciting developments around Plasma-Jet-Driven-Magneto-Inertial-Fusion (PJMIF)

In the previous article in this series¹, the fusion approach, Plasma-Jet-Driven-Magneto-Inertial-Fusion (PJMIF) was briefly introduced and described. We now report on the current status of its development.

While coaxial plasma guns have been used to accelerate plasma since the 1950's, notably in space propulsion as plasma thrusters, the challenges of applying plasma guns as a driver for fusion are unique. The mass density and momentum flux density (the ram pressure) of the plasma jets required for fusion application is typically several orders of magnitude higher than for conventional applications. The jet Mach number (ratio of directed jet speed to internal sound speed) needs to be greater than ten so that the jet avoids excessive expansion, and the liner formed from the jets are highly compressible, while plasma jets launched by conventional plasma guns have Mach number of the order of unity. The jet-to-jet variation in mass, mass density, velocity, temperature and the arrival time of the jets at a particular radius of the reactor chamber needs to be very low.

Our initial 3D computer simulations show that jet-to-jet variation in mass of no more than 5% can be tolerated to maintain good symmetry and peak pressure; we may eventually find that even lower jet-to-jet variations will be

required. A stringent requirement is the compactness of the jets. An aspect ratio of the jets (length-to-diameter ratio) of less than unity is required for high energy gains required for a fusion power plant. A typical aspect ratio of jets launched by conventional plasma guns is 10 or more.



The coaxial plasma gun developed by HyperV Technologies and Hyperjet Fusion is shown above. It consists of the following elements:

1. The outer electrodes and the inner electrodes, in between which the plasma slab is accelerated by the huge magnetic field generated by the currents flowing in the electrodes interacting with the current in the plasma slab;
2. A gas valve that injects the working gas into the region between the electrodes at the breech;
3. A pre-ionization system that pre-ionizes the initial gas slab;
4. A capacitor module that stores the energy and creates the huge pulse of current;

5. A set of six high-current, low-jitter, fast switches that discharges the capacitor module and;

6. The transmission manifold that carries the current from the capacitor module to the electrodes.

The following component technologies have been demonstrated:

- a. A gas valve that can open and close in 600 μ s, driven by a capacitor storing about 1 kJ of energy, and dispense a controlled amount of argon gas up to 1 mg or more with a mass variation of less than 2% from valve to valve;
- b. A pre-ionization system that uses an array of 20 capillary discharges with about 1 kJ of stored energy;
- c. A switching and triggering system that limits the gun-to-gun variation of the launch time of the jets to about 1 μ s;
- d. launching an argon plasma of up to 1 mg to velocities exceeding 50 km/s with an energy efficiency of about 25% and;
- e. A plasma jet with a density exceeding 10^{16} ions/cm³ over a length of about 10 cm but with a total length including a lower-density tail of about 1 metre.

A conical array of 7 guns have been installed on the Plasma Liner Experiment (PLX) at Los Alamos National Lab-

Table 1. A brief history of PJMIF

| Period | Description | Institutions |
|----------------|--|--|
| 1996 - 1999 | Invention, theoretical development of the PJMIF concept by Thio ² . | Massey U. (Auckland, NZ), LANL, NASA Marshall Space Flight Center (MSFC). |
| 1999 - 2004 | Early experimental exploration by NASA MSFC ^{3,4} . Concept adopted by NASA for a conceptual system study as the baseline fusion propulsion approach for a human mission to Callisto, a moon of Jupiter ⁵ . Invention of the coaxial plasma gun with contoured electrodes as a low-cost driver for PJMIF by Thio. | NASA MSFC, U. Alabama in Huntsville (UAH), U. Wisconsin–Madison. |
| 2004 - 2009 | Contoured-electrode coaxial plasma gun reduced to practice by Witherspoon at HyperV Technologies with technical contributions from Thio ⁶ . Further exploration of the PJMIF concept by a number of research groups, stewarded by the U.S. Department of Energy (DOE) Office of Fusion Energy Sciences (FES). | HyperV Technologies, U. Wisconsin-Madison, GA, MIT, Far-Tech, Tech-X, Voss Scientific, Prism Computational Sciences. |
| 2009 - 2014 | Los Alamos National Laboratory (LANL) joined the development of PJMIF and constructed the Plasma Liner Experiment (PLX), sponsored by FES ⁷ . | LANL, HyperV, UAH, U. New Mexico (UNM), Brookhaven National Lab (BNL), Tech-X. |
| 2015 - Present | PJMIF selected for development by the DOE Advanced Research Projects Agency–Energy (ARPA-E) ⁸ , and attracted private investments of Strong Atomics, LLC and one other investor. HyperJet Fusion formed to lead PJMIF development. HyperV Technologies functionally merged with HyperJet Fusion. PJMIF development initiated independently at Xi’an Jiaotong University, Xi’an, Shaanxi, China ⁹ . | LANL, HyperV, HyperJet, UAH, UNM, Tech-X, BNL, Xi’an Jiaotong University (XJTU). |

oratory (LANL), and experiments to merge the jets launched from these guns to form a piece of the plasma liner have been performed. The initial results⁸ show the formation of a series of shocks between merging jets, in qualitative agreements with our 3D computational results.

The experience with the first version of the coaxial guns indicates that considerable improvements on the gun are necessary to field 36 guns in a spherical array to perform a high-quality liner-formation experiment. Development is in progress at HyperJet Fusion of an upgraded coaxial plasma gun to improve on the earlier gun-performance metrics as follows:

- a. To reduce the open-and-close time of the gas valve;
- b. To reduce the energy required to drive the gas valve to below 0.2 kJ;
- c. To have a pre-ionization system that is more convenient and efficient and;

d. To reduce the total length of the jet including the low-density tail by more than a factor of two and increase the density by a corresponding factor over the densest part of the jet.

Our plan is to field 36 of the upgraded plasma guns on PLX at LANL during 2019 to experimentally demonstrate a fully spherical imploding plasma liner and obtain data on liner ram-pressure scaling to benchmark our models and codes.

In the next article in this series, we will present more details of the results of our preliminary experiments on merging a conical array of plasma jets we have performed so far and describe in more detail the planned 36-gun experiments on PLX, which will be the world’s first attempt at merging an array of plasma jets to form and study a spherically imploding plasma liner.

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Reducing greenhouse gas emissions: The UK's government's Clean Growth Strategy

David Taylor, Head of Corporate Affairs and Innovation at Flogas shares his views on the UK's government's Clean Growth Strategy and the extent to which this will help to reduce greenhouse gas emissions

The UK government is committed to reducing the nation's greenhouse gas emissions and has launched the Clean Growth Strategy which outlines how it plans to build a lower-carbon future for the UK.

The Department for Business, Energy & Industrial Strategy (BEIS) compiled the 167-page report and, if you'd like to read it in full, you can [download it here](#). However, if you're pressed for time, business gas specialist Flogas has provided [a neat summary](#) of the strategy's key points and what it will mean for homes and businesses nationwide.

How is the UK committed to climate change?

It's important to understand which legislation brought about the Clean Growth Strategy.

In 2008, the Climate Change Act was introduced in the UK, making it the first nation worldwide to have self-imposed a legally binding carbon reduction target. Essentially, this aimed to reduce greenhouse gas emissions by a minimum of 80% by 2050 in comparison to levels in the 90s.

“The government has committed to rolling out lower-carbon processes, technologies and systems across the nation in a bid to turn its vision into a reality and plans to do so in the most cost-effective way possible for businesses and homes alike.”

How close are we to meeting the target?

The great news is that, according to BEIS figures published in March 2017, the UK is on course to meet this target, with overall carbon emissions dropping by 42% since 1990. However, the government realises that much more work is needed and that is why proposals, including

the Clean Growth Strategy, have been introduced.

How can the Clean Growth Strategy help us reach the target successfully?

To put it simply, the policies and proposals that are set out in the Clean Growth Strategy aim to speed up 'clean growth' in two ways: by decreasing emissions and by increasing economic growth. Bearing this in mind, the two objectives which are underpinning the strategy are:

- To achieve our domestic-level commitments at the lowest net cost possible for UK taxpayers, businesses and consumers and;
- To increase the economic and social benefits for the UK from this transition.

The government has committed to rolling out lower-carbon processes, technologies and systems across the nation in a bid to turn its vision into a reality and plans to do so in the most cost-effective way possible for businesses and homes alike.

What are the key proposals of the Clean Growth Strategy?

The strategy's proposals focus on the six key areas which are responsible for the UK's carbon emissions. They are:

- Improving business and industry efficiency (25% of UK emissions);
- Accelerating the shift to low-carbon transport (24% of UK emissions);
- Delivering clean, smart, flexible power (21% of UK emissions);

- Enhancing the benefits and value of our natural resources (15% of UK emissions);
- Improving our homes (13% of UK emissions) and;
- Leading the public sector (2% of UK emissions).

You can read this [executive summary](#) for the full list of 50 pledges.

What does this mean for homes and businesses?

The government is providing support and encouragement to homes, businesses and industrial operations to successfully reduce their carbon footprint in several ways. Reassessing the fuels that we use for everyday jobs, including heating, cooking and powering industrial and manufacturing processes, while embracing cleaner, greener alternatives are high on the agenda.

This will not only mean that the uptake of renewable technologies, such as heat pumps, biomass boilers and solar panels will be boosted in the long term, but it will also favour the use of cleaner conventional fuels over those which are more polluting. For example, the strategy is planning to phase out high-carbon forms of fossil fuels, such as oil and coal, for off-grid homes and businesses. As the lowest-carbon conventional off-grid fuel, oil to [liquefied petroleum gas \(LPG\)](#) conversions will play a key part in replacing oil in the more rural areas of the country.

Natural gas will still be a popular choice for buildings that are connected to the mains network. Not only is it affordable and easily accessed, but it is also the lowest-carbon fossil fuel available. Flogas, like other companies, anticipate that this part of its business will continue to go from strength to strength.

As an expert in the energy sector, we believe that the 'green gas' phenomenon which sees natural gases injected with a proportion of environmentally friendly biogas will be in high demand as the Clean Growth Strategy rolls out.

Reaction to the Clean Growth Strategy

It is positive to see there is plenty of support from key industry figures following the Clean Growth Strategy's unveiling.

Lee Gannon, Managing Director of Flogas, says: "Through the publication of its Clean Growth Strategy, the government has made clear its intention to reduce carbon emissions from off-grid UK homes and businesses. Natural gas and LPG are affordable, versatile, widely available and – most importantly – emits significantly less carbon than the likes of coal and oil. As such, they continue to play a central role as the UK works towards cleaning up its energy landscape. We look forward to working alongside policymakers and wider industry stakeholders to make the Clean Growth Strategy the success that it deserves to be."

Finally, we close with the thoughts of the trade body, Oil & Gas UK, who also support the strategy. Mike Tholen, its Upstream Policy Director, comments: "Oil & Gas UK welcomes the government's commitment to technology in the strategy, especially with regards to carbon abatement measures such as carbon capture, usage and storage. Oil & Gas UK looks forward to working with the government to see how these technologies can further reduce emissions across the economy." ■

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Meeting the challenge of full fibre broadband for new high-rise developments

Andy Mackintosh, National Sales Manager – Fibre Networks at Power On Connections explains how the challenge of full fibre broadband for new high-rise developments can be met

In July 2018, the UK government's Future Telecoms Infrastructure Review put forward the commitment to achieve full fibre connection for the whole of the UK by 2033. This is an ambitious target and the report identified a number of key actions that will need to be taken to meet it. The most significant of these for housebuilders and developers was the proposed guarantee that all new homes built in the UK must have a full fibre connection. Whilst the legislation imposing this requirement has yet to be drafted, the housebuilding industry needs to act now to incorporate the provision of high-speed fibre broadband into future plans.

Choosing the right fibre network partner, however, is crucial. With homeowners putting an increased emphasis on the importance of a quality broadband service, both private and public sector developers risk reputational damage if they do not deliver a reliable, fast service, future-proofed to meet ever-growing customer demands. Power On Connections' combined offering of Fibre-to-the-Premises (FTTP) and Fibre Integrated Reception Systems (FIRS) for high-rise residential developments, enables developers to meet the new requirements in full whilst providing their customers with a high-quality, flexible, open-access, ultrafast fibre broadband service.

The fibre market in the UK has in the past been dominated by a very limited

number of providers, often offering poor service with long connection delays for homeowners and little incentive to respond agilely to developers' requirements. If the government's proposed connection targets are to be achieved, then this situation will need to change, with independent network operators setting new standards for service and delivery.

FTTP – delivering fibre to each home

Power On Connections provides ultrafast fibre networks, currently delivering speeds of up to 1 Gbps and capable of increasing further, in line with consumer demand. This current speed far exceeds the government's present target of 24 Mbps and enables homeowners and their families to maximise their use of the internet not only for surfing the web and shopping but also streaming music, films and television programmes; making video calls; gaming; and working from home.

Power On Connections' fibre network is open access, accommodating a greater number of Internet Service Providers (ISPs) than any other FTTP provider. This openness offers residents a real choice of provider and a range of packages and prices to suit their needs and budgets, rather than limiting them to a single provider. The fibre connection is delivered to each flat, apartment or home ready to use when the homeowner moves in. Customers can then choose which

speed of service best meets their needs knowing that the capacity is available should they require higher speeds in the future. Power On Connections provides the full infrastructure from the off-site cabinet to the on-site connection to all homes.

“Power On Connections specialises in the design, build and delivery of electricity and fibre infrastructure for high-rise, commercial, industrial and retail developments and understands the unique challenges posed by these often complex projects.”

FIRS – satellite and free to air TV

The FIRS option is ideally suited to high-rise developments. It uses a single satellite dish and aerial array to deliver satellite and free-to-air TV without the need for unsightly aerials and dishes being installed on each premises. The signal is distributed to all the homes on a development where multiple blocks exist using the installed fibre network, thereby avoiding the cost of additional cabling for the developer.

Delivering fit-for-purpose fibre networks

Power On Connections delivers full FTTP, connecting fibre all the way to individual homes rather than stopping at the basement, with homes then connected via restricted speed data cabling. The company understands the priorities of homeowners and ensures that the fibre is connected and ready



for use prior to home occupation, avoiding the frustration caused for residents having to arrange connection once they have moved in. Since it owns the infrastructure, Power On Connections has an ongoing interest in the smooth running of the fibre network, building long-term relationships with residents and landlords. Furthermore, Power On Connections' fibre network incorporates the building's fire and lift alarms, removing the need for the involvement of a second network operator.

Specialist partner

Power On Connections specialises in the design, build and delivery of electricity and fibre infrastructure for high-rise, commercial, industrial and retail developments and understands the unique challenges posed by these often complex projects. The company

works regularly with all the major developers in the UK and has a reputation for dealing with complex projects in short timescales, delivering on time and offering developers cost certainty through careful planning and detailed quotations. Power On Connections is part of the BUUK group of companies, the UK's leading provider of energy and utility infrastructure to the new-connections market. The group owns and operates over 30,000 discrete networks, serving over one million homes nationwide.

An ultrafast future to look forward to

If the government implements the recommendations of its review, then developers will need to make provision for fibre connections to all the new homes they build. Rather than settle for a merely adequate solution

now, they need to work with network providers, such as Power On Connections, which can deliver future-ready ultrafast networks that will meet their customers' technology needs for years to come.

POWER ON
connections

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Fuel cell electric vehicles: The genesis of a new era or myth-busting vehicle technology?

Arvind Noel Xavier Leo and Anjan Hemanth Kumar from Frost & Sullivan explore fuel cell electric vehicles and ask if this is the genesis of a new era or simply myth-busting around new energy vehicle technology

As the automotive world accelerates towards meeting the next generation of emission regulations and fuel economy targets, traditional emission reduction technologies related to internal combustion engines (ICE) are being rendered obsolete. The industry is in a churn with alternative fuel vehicle technologies for electric vehicles (EVs), hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) gaining momentum. Amidst the hubbub of EVs making rapid gains with consumers and improving their performance relative to ICEs, a dark horse – fuel cells – has quietly emerged from among the slew of new passenger vehicle technologies. Fuel cell electric vehicles (FCEVs) have gone through several stages of proving their efficiency, safety and reliability but have been overlooked as other battery/electric driven technologies monopolise the hype and hoopla.

On the contrary, fuel cell technology has been highly critiqued for their poor hydrogen fuel infrastructure, the complexity of design, high manufacturing and maintenance costs and inability to match the performance of EVs. So how does the system work? The fuel cell stack is connected to the electric motor which is connected, in turn, to the wheels. The fuel cell stack acts as a battery, providing electric power directly to the electric motor which then provides power to the wheels. Excess electric energy from the fuel cells is supplied to the battery, which uses the stored energy during uphill climbs or hard acceleration.

While FCEV technology is established, the question is whether the industry is ready to implement it? The answer is a resounding 'yes' as the global automotive

market is ready and geared up to adopt a new energy segment vehicle in its portfolio; however, it will be a slow yet steady start.

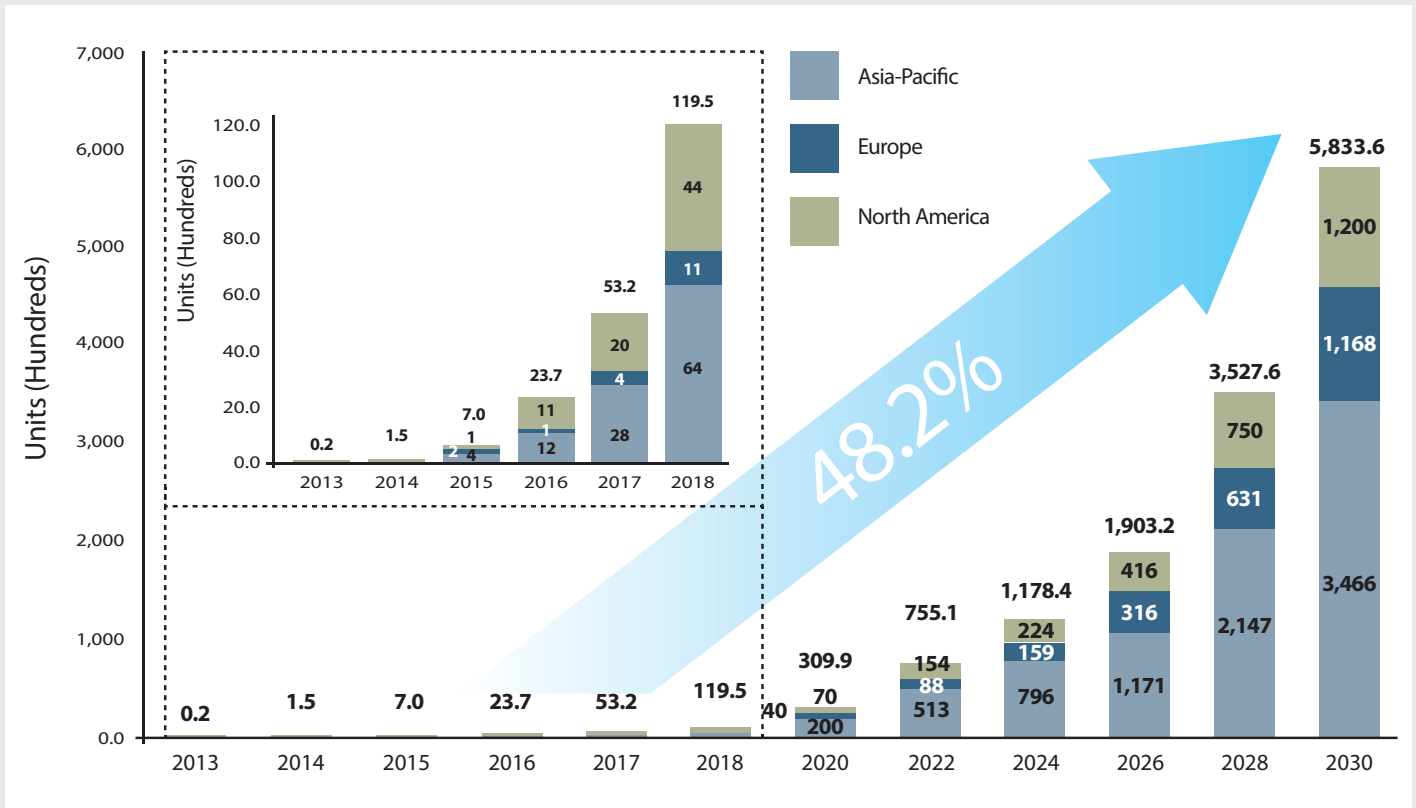
Japan paves way for new age technology

Japan has been at the forefront of adopting alternative fuel technologies. The Japanese automotive market was the first to embrace HEV technology. The Japanese government and local OEMs have pushed to standardise the use of electrified powertrains, globally. At the same time, the Japanese government has been encouraging the use of hydrogen fuel technology for large-scale deployments and transport applications. Backing such intent, the government has invested \$378 million to develop infrastructure and offers purchase incentives. Approximately \$1 million will be spent on each hydrogen station, while purchase incentives will be provided until 2020.

According to recent Frost & Sullivan FCEV research, Japan will leverage the expertise of leading automakers Toyota and Honda to drive its leadership (along with Hyundai from South Korea) of the fuel cell systems market. Higher investments and funding of hydrogen refuelling stations will result in Japan and the U.S. – particularly the state of California – emerging as major adopters of fuel cell vehicles.

The global market for FCEVs is estimated to reach about 583,360 units by 2030, with Asia Pacific (APAC) countries such as Japan and South Korea dominating the market with 218,651 and 80,440 units, respectively. FCEV markets in Europe and North America are projected to reach 117,000 units and 118,847 units, respectively, by 2030.

Fuel cell passenger car market: Vehicle sales by region midline scenario, global, 2013-2030



Source: Frost & Sullivan, the base year is 2017

The global adoption of FCEVs in emerging markets will be driven by strong incentives and government policies that will boost consumer acceptance and higher private investments by companies seeking to establish a global network of fuel cell refuelling stations. In keeping with this trend, about 20 fuel cell car launches by leading OEMs are expected in global markets over the next five years. Asian OEMs with a first mover advantage are expected to dominate the market. For instance, unit sales of Toyota FCEVs are projected at 165,000 and Hyundai FCEVs at 148,000 by 2030.

About time for OEMs to launch FCEV models

Toyota and Honda lead the industry in fuel cell technology development. Toyota has achieved the highest power output while dramatically reducing the system's price and size from previous fuel cell vehicles offerings, whereas Honda has pioneered a powerful and compact system that uses electric air turbo air compressors to produce an enhanced hydrogen and air mixture that generates the electricity required for propulsion.

Frost & Sullivan believes that the push for FCEVs is likely to start post-2020 when the subsidies for BEVs will phase out. With essential cost reductions and infrastructure in place, the growth post-2025 is expected to be exponential. Hyundai-Kia and the Honda group are expected to have the highest selling fuel cell vehicles due to their being offered as leasing options in California. More than 20 models of fuel cell cars are being launched globally, even as significant investments are being made to commercialise fuel cell stacks on cars.

Backed by government incentives, the Department of Energy in the U.S. targets having about 500,000 fuel cell cars on the road by 2030. In the meantime, with an eye on the Tokyo Olympics, the Japanese government is pushing hard for FCEVs and related infrastructure development with an order of 6,000 FCEVs and 160 stations by 2020.

The establishment of hydrogen infrastructure and positive government policies are, therefore, paving the way for OEMs to launch FCEV models.

Fuel cell passenger car market: Expected model launches by OEM, Global, from 2016 onwards

| OEM | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 onwards | Total |
|----------------|--------------|---------------------------|--------------|-----------------|-------------------|----------------------|-------|
| Toyota | Toyota Mirai | | | | | Toyota SUV | 2 |
| BMW | | | | | BMW i5 5Series GT | | 2 |
| Hyundai | Hyundai iX35 | | Hyundai Nexa | Hyundai Genesis | KIA FCV | | 4 |
| Porsche | | | | | Porsche Pajun | | 1 |
| Lexus | | | | | Lexus LS600 | | 1 |
| Honda | | FCV Clarity | | | | | 1 |
| Daimler | | | | B Class F-Cell | GLC F-Cell | | 2 |
| Volkswagen | | | | | Audi h-Tron | VW Passat VW Golf | 3 |
| Nissan | | | | e-NV FC RE | | FCV | 2 |
| Ford | | | | | FCV | | 1 |
| General Motors | | Chevy Colorado ZH2 - Army | | | | FCV | 2 |
| Tata | | | | | Magic Iris Ziva | | 1 |
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 onwards | 22 |

Source: Frost & Sullivan, the base year is 2017

Is there a clinch in the system?

OEMs need to overcome certain major challenges before fuel cell vehicles can be adopted at the same pace as EVs by the automotive mass market. These include:

- Development of infrastructure;
- Production of zero-emission hydrogen and;
- Cost of fuel cell stack.

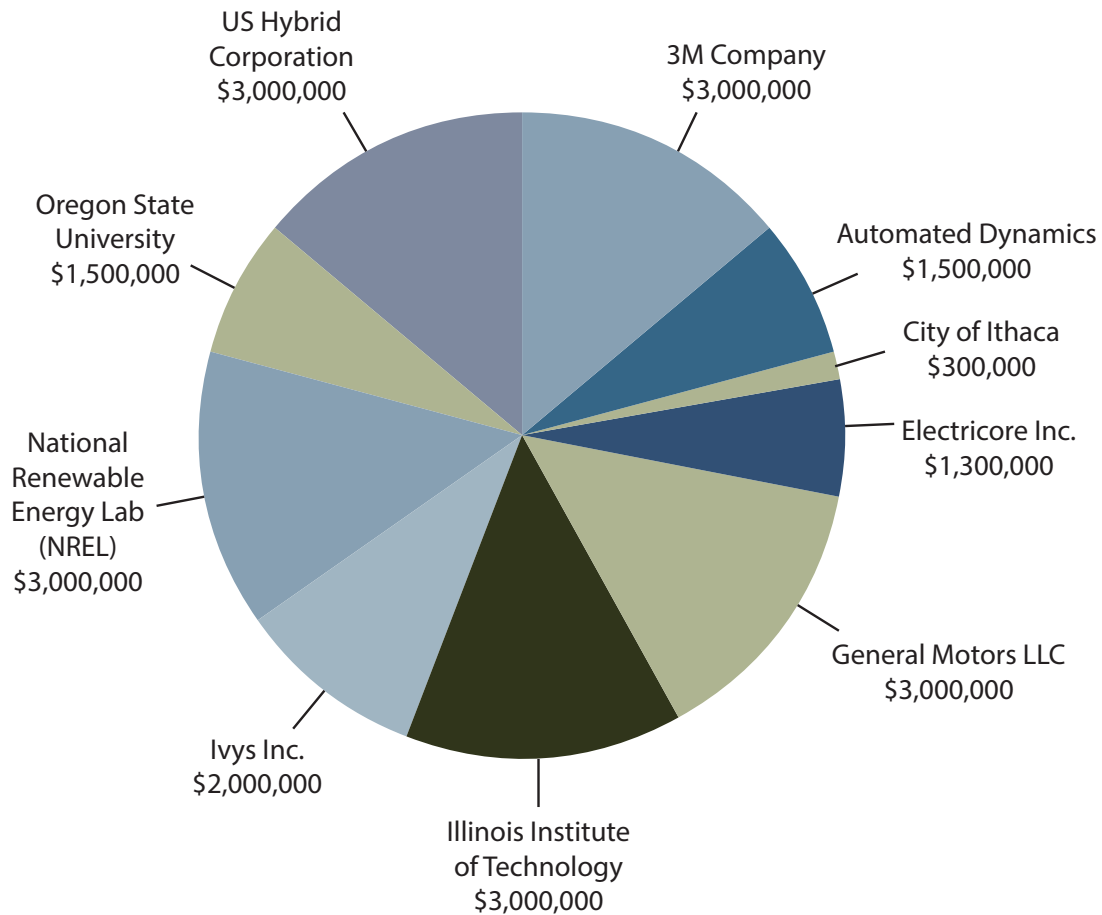
According to Frost & Sullivan, the California Energy Commission and the European Fuel Development Programme (HyFIVE) have committed to fund the H2 network globally; the pie chart shows the FC technology being heavily funded (~\$21 million in the U.S. and ~17 million in EU) by private companies in partnerships with OEMs.

The cost of implementing a variable hydrogen pressure nozzle fuel station is about \$750,000-\$1 million for storage and generation, which have been the primary

Fuel cell passenger car market: H2 station establishment targets, global, 2020-2025

| Country/Region | H2 Stations Target (year) |
|-------------------|---------------------------|
| California (U.S.) | 100 (2020) |
| Germany | 400 (2023) |
| United Kingdom | ~800 (2030) |
| Scandinavia | ~150 (2020) |
| Japan | 320 (2025) |

Fuel cell passenger car market: The technology research, development and investments, North America, 2016–2017



Participants: The UK (Coordinator), Germany, Belgium, Denmark, Italy, Austria

Project N°: 621219

Total Costs: €39,060,997

EU Contribution: €17,970,566

Duration: April 2014 to September 2017

Source: Frost & Sullivan, the base year is 2017

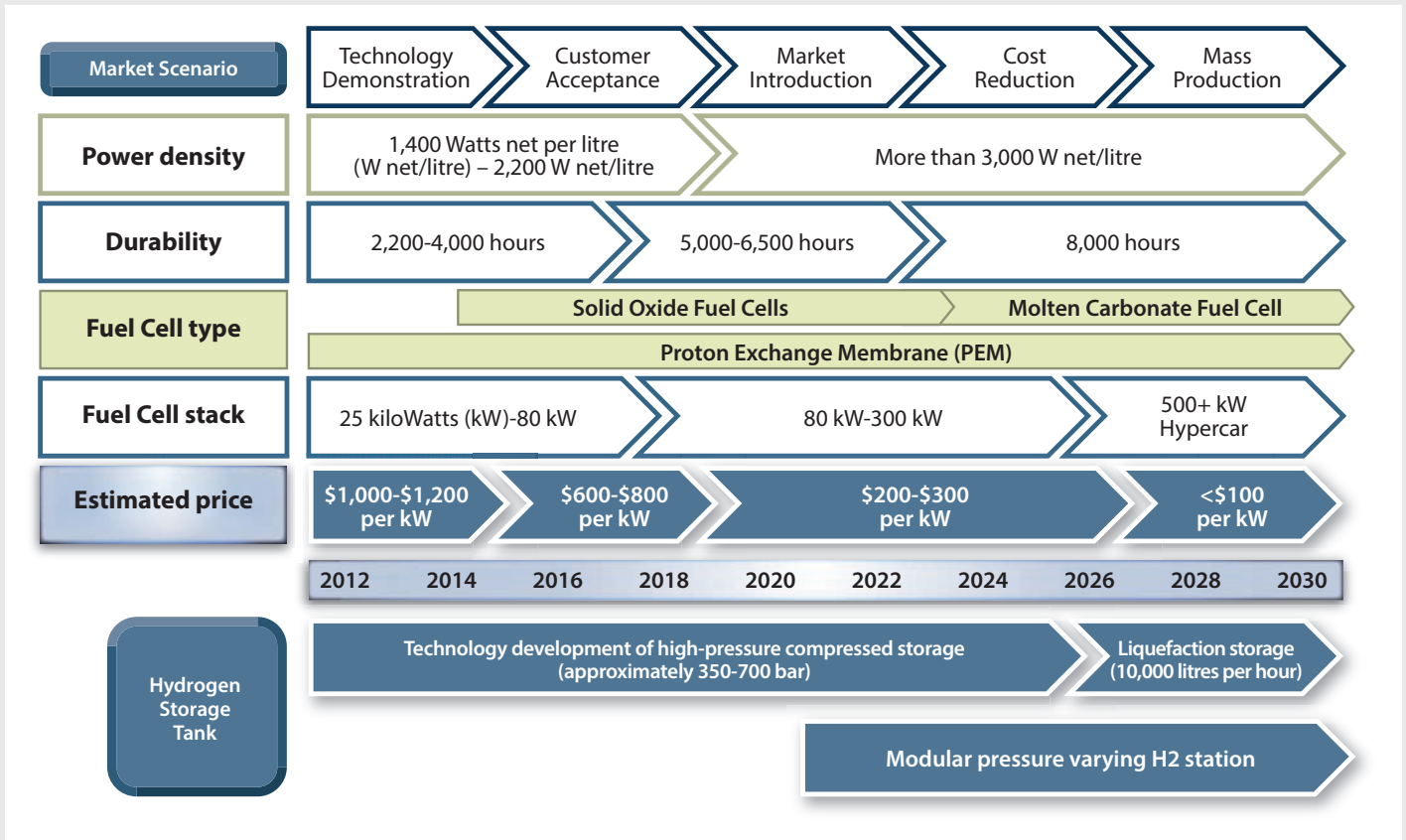
choking points in infrastructure expansion. The creation of a modular approach will be the key technology trend for hydrogen fueling stations in the U.S. as this will enable them to cater to commercial and passenger vehicles with variable pressures of 350–700 bar.

Companies and other industry entities and networks, such as Shell, Ricardo, Fuel Cell and Hydrogen Energy Association, Seven-Eleven Japan Co. Ltd, HyFIVE, Linde,

California Fuel Cell Partnership, Ballard and UK H2 Mobility have partnered with OEMs to share their expertise in hydrogen production, fuel station network deployment and investment. The co-development of fuel cell stacks and optimisation of fuel cell systems will be crucial to commercialisation.

Currently, power density and price are focus areas for FC manufacturers bidding to make fuel cell passenger

Fuel cell passenger car market: The technology roadmap, global, 2012–2030



Source: Frost & Sullivan, the base year is 2017

cars a market reality. FCEVs have about 3,500 hours of durability at various speeds while buses have surpassed the 2016 target of 18,000 hours to reach about 23,000 hours of durability. The U.S. Department of Energy aims to reduce the price of an 80 kW fuel cell stack system to about \$40–\$30. Along with reductions in the price of fuel cell stacks, efforts are also ongoing to lower the cost of hydrogen production to less than \$2 per kilogramme using the proton exchange membrane (PEM) electrolysis method. Toyota and Hyundai pioneered PEM stack cells technology that reduce the overhead cost per unit and was reported to be about \$50,000 in 2015. As production volumes increase, costs will reduce independent of the technology advancement and manufacturing process.

Investments-grip to influence

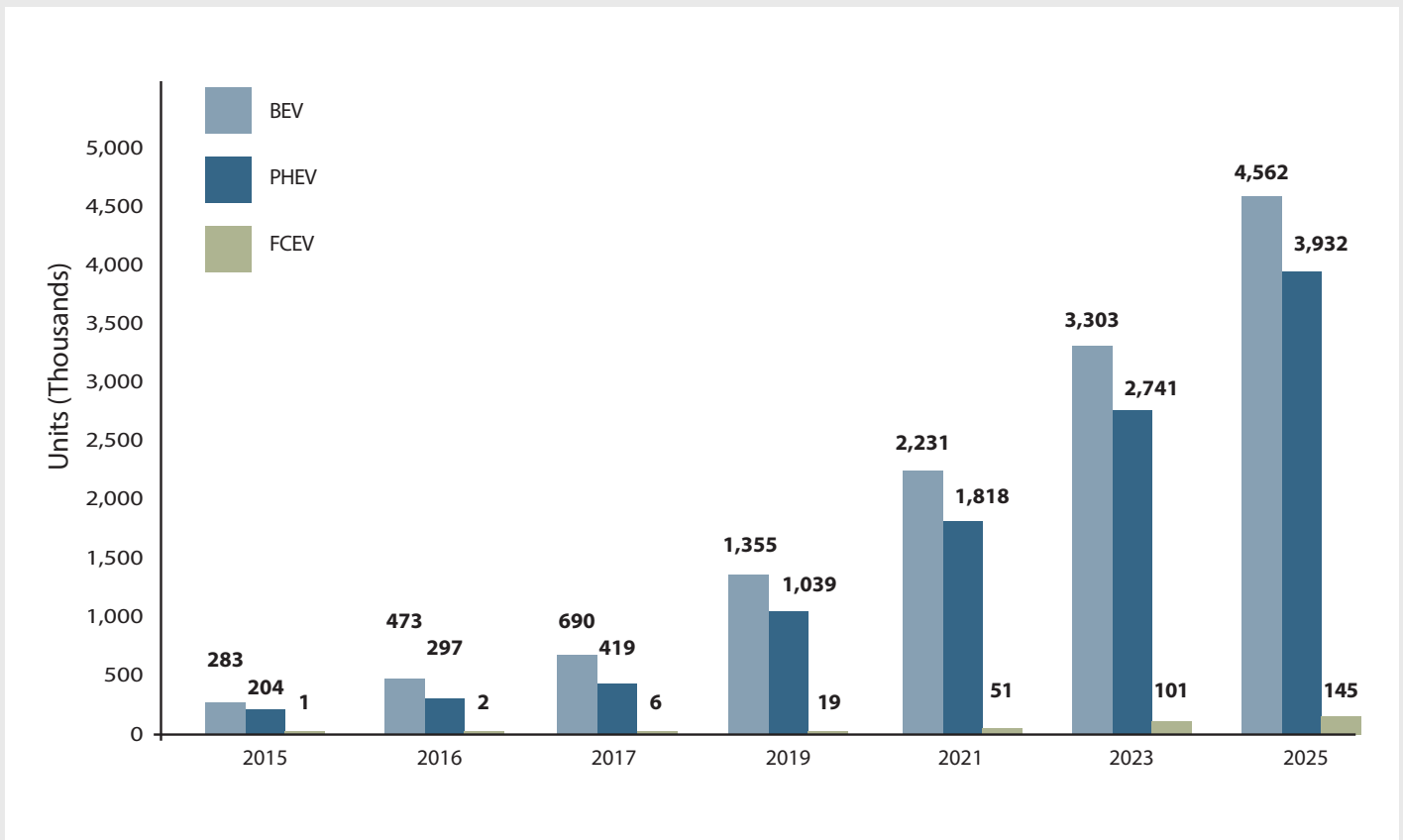
Over the next decade, an estimated \$10 billion will be invested globally in developing hydrogen technology and infrastructure by a group of private investor companies in conjunction with auto majors Toyota, Daimler

and BMW. The Californian government has approved an expenditure of \$20 million annually on hydrogen station deployments with private companies have already invested close to \$21.6 million at the end of 2017. OEMs such as Honda and GM are accelerating the march toward alternative propulsion through the co-development of fuel cell technology and the establishment of a manufacturing facility in Michigan, the U.S.

“Amidst the hubbub of EVs making rapid gains with consumers and improving their performance relative to ICEs, a dark horse—fuel cells—has quietly emerged from among the slew of new passenger vehicle technologies.”

The two companies are making equal investments totalling \$85 million in the joint venture. They plan to begin mass production from 2020, leveraging their integrated development teams and shared hydrogen fuel cell intellectual property to create more affordable commercial solutions for fuel cell and hydrogen stor-

BEV, PHEV and FCEV scenario estimations, global, 2015–2025



Source: Frost & Sullivan, the base year is 2017

age systems. Such partnerships and investments have created a new platform for FCEVs to enter the market both through leasing options (Hyundai and Honda), as well as through direct sales and support (Toyota).

Fuel cells vs battery electric technology

There is no denying that currently battery electric vehicles (BEVs) are ahead of FCEVs in the competitive stakes. To some extent, this is because, with only three FCEV models available in the global market, there is limited consumer awareness about their advantages. Fuel cell technology developers have attempted to address consumer apprehensions by proving their superior performance in terms of high mile range, better weight/volume, enhanced recharging/refuelling time and proven safety.

About two million fuel cell vehicles are expected to be on the roads globally by 2030. Japan and South Korea will be pivotal in advancing fuel cell vehicle technology as Toyota and Hyundai-Kia stake claim to becoming

global leaders in fuel cell technology. The phasing out of BEV incentives globally from 2020 paralleled by government subsidies for FCEVs in Asian countries, including China, Japan and Korea, will open the floodgates to private sector investments and herald the start of a new era in fuel cell vehicle technology. ■

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Renewable energy promotion: From wind to green gas

The Horizon 2020 project STORE&GO focuses on the remarkable potential of power-to-gas and synthetic methane as forms of renewable energy

Europe has just passed its second warmest and maybe driest summer on record. Even northern regions faced unusual drought, heat waves and even wildfires as is rather typical for Mediterranean countries. In fact, much is being discussed about climate change and global warming. Climate protection is high on the public agenda and European Union (EU) politicians are already calling to raise the CO₂ reduction target from the current level of -40% to -45% by 2030.

This ambitious goal, however, can only be met by covering large parts of future energy demand by making the most efficient use of renewable energies. One important hurdle that has to be overcome concerns wind and solar power, both of which tend to be volatile and intermittent due to their seasonal nature, and at times surpassing or not complying with demand. Thus, energy has to be storable in the long-term and available when needed.

With that in mind, 27 European research partners have gathered under the roof of the EU project STORE&GO. Their overall goal is to find solutions and innovative technologies that guarantee a sustainable path towards a low-carbon future. The focus is on power-to-gas (PtG) applications and how they fit in the European energy grid as an important step of the energy transition¹.



Figure 1: The methanation demo plant in Falkenhagen, Germany, was the first one of STORE&GO's three demo sites that went operational

Funded under Horizon 2020 and coordinated by the DVGW (German Technical and Scientific Association for Gas and Water), STORE&GO puts special emphasis on the methanation process of green hydrogen produced by hydrolysis in PtG plants. To investigate how this technology can be integrated into the energy system, the project is currently running three pilot methanation plants with different innovative power-to-gas technologies: in Falkenhagen, Germany; in Solothurn, Switzerland; and in Troia, Italy; with the Falkenhagen site being the first one in operation.

Reality check on the ground

The German demo site was inaugurated in May 2018 in the region of Prignitz in Brandenburg. Falkenhagen is

an ideal location due to its high wind generating capacity and a well-developed power and gas infrastructure that is already in place there. In this typical rural region, wind farms and photovoltaic systems generate large quantities of renewable power. However, the energy demand in this area is lower and power is transported across considerable distances, causing significant transmission losses.

The new methanation plant was built right next to an existing PtG pilot plant from 2013 that produces hydrogen and thereby stores wind energy within the natural gas grid. It offers even more possibilities for the storage for renewable energies by providing "green" methane. In this second stage, "green" hydrogen from regenerative energy sources is converted into



Figure 2: Honeycomb cylinders, the core of the Falkenhagen reactor

methane (CH₄) or synthetic natural gas (SNG) using CO₂ from a bio-ethanol plant.

For that purpose, a prototype honeycomb catalytic reactor for methanation is installed and is being tested during the project. The methanation plant produces up to 57 m³/h of SNG (at normal pressure and temperature), which equates to a gas output of 600 kW. By comparison – with the amount of gas that is produced in one hour, a modern 50 square metre apartment could be heated for a month.

The so produced green methane can contribute significantly to the success of the energy transition. Other than hydrogen, it has a wide range of uses and can flow into all markets, such as the heating or mobility sector. Moreover, it provides for the unrestricted use of the natural gas infrastructure, including for transport and storage. This stored energy is then available as a backup whenever there is an insufficient supply of solar and wind power. Moreover, the heat generated by the process is used by a nearby veneer plant.

Legal uncertainties for the power-to-gas process

What seems possible on a demo level

might be difficult in reality, so a team of STORE&GO legal experts have identified hurdles in the existing regulatory and legislative framework with respect to the deployment of power-to-gas processes and products – in both, the EU and the host countries of the project pilot plants.

“Power-to-gas is associated with various new concepts which are not yet sufficiently considered under current EU and national legislation. For example, energy storage as an asset and hydrogen and SNG as renewable energy carriers, have only recently gained attention from legislators”, explains Gijs Kreeft from the University of Groningen, which is one of the STORE&GO partners. According to his research, these new technological developments lead to various fundamental legal issues that have to be addressed.

“For example, it is not clear whether environmental authorisation procedures should consider power-to-gas plants as chemicals-producing installations rather than installations that produce energy commodities”, explains Kreeft. He adds that it is also necessary to define it and under which circumstances, power-to-gas is

a gas producing activity instead of, or besides, an energy or gas storage technology.

This lack of clear regulation and legal definitions is, according to Kreeft, due to a low level of awareness: “Policy-makers do not yet fully comprehend the power-to-gas process and its potential for the transition towards a low-carbon energy system. Consequently, power-to-gas and synthetic methane are not considered in renewable energy promotion policies to the same extent as other renewable energy technologies are”.

Action is, therefore, required at the EU and national level and as such, regulations must be harmonised and take into account the need for seasonal storage. Permit procedures have to be evaluated and clarified. Double-taxation practices should end and support schemes that are developed. Another efficient measure could be the introduction of a carbon tax, which would make renewable gases more competitive. Last but not least, research and development (R&D) have to be further supported to advance the PtG technology as far as possible in terms of both technical and commercial efficiency.

¹ See also Open Access Government July 2018, pp. 308.



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Hydrogen-powered trains: The remaining challenges for innovators

Rosie Hardy and Frank Harner at Withers & Rogers explore the exciting world of hydrogen-powered trains and detail what the remaining challenges for innovators are in this area

Hydrogen fuel cells are gaining recognition as an eco-friendly way of generating power; avoiding the use of fossil fuels, producing zero carbon dioxide emissions and offering some distinct benefits over rechargeable batteries too.

In the rail industry, hydrogen-powered trains could lead the way in green transport. However, for these futuristic trains to run on European rail networks, further innovation and investment is needed, along with a strong commitment from individual governments.

Indeed, to help cut pollution and promote cleaner fuels, the UK government has recently introduced plans to phase out the use of diesel trains by 2040. Rail experts are in no doubt that the decision to phase out these units and use alternative power will revolutionise rail transport. Whilst this deadline may seem some time away, the industry knows that it needs to start planning now because the lifespan of many diesel trains will expire before 2040.

There is understandably some debate as to what will replace diesel-only trains. Due to its cost and delays, the further electrification of the UK rail network is not considered to be a viable option. The sustainability of bi-mode diesel and electric technology is also being questioned because these trains have been found to emit higher emissions than previously expected.

Although trains powered by rechargeable batteries would create zero emissions, it seems that hydrogen trains powered by hydrogen fuel cell technology have become a favoured option. In fact, both the Transport Secretary, Chris Grayling and the Transport Minister, Jo Johnson have shown their support for the technology and have cited it as a reason for cancelling some of the UK's rail electrification schemes.

For many years, the prospect of creating hydrogen-powered trains was a technological pipedream. However, now it is actually happening. Successful trials have proven the use of hydrogen fuel cell technology to power trains and orders for hydrogen trains are being placed. Since trialling its Coradia iLint hydrogen trains in Germany, Alstom UK is now working with Eversholt Rail to deliver a fleet of Class 321 train units, converted from electricity delivered via overhead wires, to run on hydrogen. These are due to be brought into service in 2021-22.

Some industry onlookers may be surprised to hear that the UK's rail strategy is leaning towards hydrogen fuel cells when so much cross-sector dialogue is focussed on rechargeable batteries. Indeed, European patent filing data shows a huge surge over recent years in the number of applications filed for rechargeable battery technology, with over 800 filed annually since 2013. In contrast, the number of applications relating to hydrogen fuel cell technology has remained at around 200 to 300 per year.

However, whilst rechargeable battery tech may be suited to automotive vehicles, its application in the rail industry is more limited. Load and range continue to be issues for heavier trains completing longer journeys, recharging batteries at regular intervals is impractical. Hydrogen is able to match the performance of diesel because of its high energy density and it is the fuel of choice for longer journeys and heavier loads, with a range of up to 800km and top speed of 140km/h.

Nevertheless, numerous challenges with hydrogen trains still need to be addressed. An important question remains about the viability of hydrogen-powered trains in the freight sector. Freight rail transport is the lifeblood of the economy and as yet, it is not fully clear whether

“In the rail industry, hydrogen-powered trains could lead the way in green transport. However, for these futuristic trains to run on European rail networks, further innovation and investment is needed, along with a strong commitment from individual governments.”



hydrogen trains will be able to provide the pulling power for moving heavy goods along the length and breadth of the country. So, having already demonstrated its suitability for passenger transport, innovators are now rightly shifting their focus to developing hydrogen fuel technology for heavy freight.

There are also some barriers to market, especially in the UK, which need to be overcome. These mainly relate to the production of hydrogen and the refuelling infrastructure needed to support the hydrogen trains on the rail network. Under the guidance of The Hydrogen Council, energy and transport experts are working together and have committed substantial investment to tackle these issues.

Hydrogen fuel cells use hydrogen and oxygen to produce electricity. While the oxygen needed for the fuel cell can be drawn from the environment, hydrogen fuel must be brought onboard. This is produced using a process known as electrolysis, which in itself is inefficient and energy-intensive. Traditionally, electrolysis plants were powered by electricity generated through fossil fuel combustion, however there is a global drive to improve the efficiency of the electrolysis process and produce hydrogen more sustainably. Research organisations and innovators are working towards developing more efficient production methods and success has been reported. Additionally, there are now

production plants which run completely off solar or wind power – meaning that the hydrogen being produced is a zero carbon fuel.

For the moment, it seems that hydrogen fuel cells hold the key to powering the trains of the future. Their suitability for propelling large traction engines with high-range capacities means they are well-suited for use on the rail network. However, as with all emerging technologies, there are still issues to be ironed out and now is the time for the industry, innovators and governments to step up to the challenge. ■

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Norway aims for 1000 hydrogen trucks by 2023

The need for large scale projects to accelerate the transition from fossil to zero emission for heavy duty vehicles is put under the spotlight in this fascinating profile by Vegard Frihammer the visionary leader of Greenstat, a Norwegian company focusing on Green Hydrogen

Vegard Frihammer has extensive experience in the renewable sector and in particular when it comes to hydrogen. As a former head of renewable energy at the Norwegian research institute CMR and chairman of the board for the Norwegian Hydrogen Association (NHF), he is part of a large network of seasoned professionals. In addition, he has a background in the oil & gas and the maritime industries, so he has a broad knowledge of what is needed for the fundamental transformation from fossil to renewable energy.

In 2015, he founded and became the manager of Greenstat, a company with an aim to become a leading energy company in Norway and abroad, with a specialised focus on hydrogen and local energy solutions.

Inspired by Nikola Motor Norway - the ambition for 1000 hydrogen trucks by 2023

Can Nikola Motor with its hydrogen trucks start a revolution in the same way that Tesla has disrupted the EV market? By the interest growing in Norway and other countries, it looks like this is the case, especially since other manufacturers like Toyota also are presenting new concepts for hydrogen trucks. It also appears that battery electric solutions are failing when it comes to long-haul transport due to the weight of the batteries. A truck with less room for goods is not a good solution for the freight companies.



Hydrogen, a necessary part of the zero-emission puzzle

Hydrogen has some fantastic characteristics as a zero-emission energy carrier. It has a very high energy to weight density and only emits water. It can be produced anywhere from renewable energy and will work very well as a range extender in existing electrical drive lines. Hydrogen will, in combination with batteries and a share of sustainable biofuel, play an important role in the transition to a 100% zero-emission transport.

The ever-present “battery vs. hydrogen discussion” finally seems to be losing momentum, as politicians and others prefer to focus on the “fossil vs zero-emission discussion” which is far more important and productive. In Norway, there are 80,000 trucks that must be replaced by zero-emission vehicles, something that cannot be achieved by

battery and/or biofuel alone. The need for hydrogen solutions as a part of the solution seems both necessary and beneficial.

Until now, there have not been any realistic alternatives for heavy-duty vehicles, but that is all about to change with the introduction of hydrogen trucks.

Trevor Milton's visit to Norway changed the opinions of many

At the [Zero conference](#) in 2017, the CEO of Nikola Motor, Trevor Milton, was one of the main attractions presenting their new hydrogen truck, Nikola One. The truck is not sold to the customers but is leased, meaning that Nikola will also develop the overall infrastructure for hydrogen. The hydrogen will be produced from renewable energy, making it a zero-emission value chain. For the



company to succeed, it must go big and many thousand more trucks are needed to make the investments beneficial compared to other solutions. This message was well received among politicians and other participants at the conference and was also backed by a [study](#) performed by the environmental organisation Zero, in cooperation with energy consulting company, Greensight, during summer 2017.

A “1000 hydrogen trucks” plan presented in August 2018

During Arendalsuka, an annual event for the political elite in Norway, in August 2018 the Norwegian Hydrogen Association, together with Greensight launched a [document](#) showing how 1000 hydrogen trucks in Norway would affect the price of the vehicles and the sales price of hydrogen. The document shows that hydrogen trucks in these volumes can be competitive with existing solutions and then becomes a realistic alternative to diesel.

Pilot projects

ASKO, a grocery wholesaler in Norway is developing a project where they will test two hydrogen trucks based on a Scania chassis. They have already built the refuelling station which is fully

operational and will soon put the two trucks into operation.

Several Norwegian companies have also reserved Nikola trucks that are expected to be delivered around 2020. One of these companies is Tine, a dairy company, in need of these trucks that can operate a route travelling 800 km along the west coast of Norway. Two Nikola trucks is planned to go in operation as soon as the vehicles are ready for delivery.

Switzerland, France and U.S. are already doing the same

The “1000 trucks” idea is not novel to Norway, it is basically a copy and paste model from elsewhere. In Switzerland, an initiative coordinated by truck owners and gas stations will result in 1000 hydrogen trucks by 2023 and in France, a similar initiative will result in the same number of trucks within 2028. With Anheuser-Busch record-breaking order of 800 Nikola trucks earlier this year, it is evident that also companies in the U.S. are ready to order hydrogen trucks as soon as they are available for the market.

Going big gives many advantages

A total order of 1000 trucks on hydro-

gen in Norway with delivery within 2023 will:

- Together with similar initiatives in Switzerland, there will be enough to reduce the price of the vehicles substantially.
- Establish a large enough hydrogen market to make the hydrogen price competitive with diesel fuel.
- Develop a nationwide infrastructure financially sustainable, even without governmental support.
- Provide a secure market base for longer transport routes (over 400 km), so that corridor stations can be established.
- Trigger the use of hydrogen within other sectors: bus, passenger cars and possible coordination against marine projects at major production and/or bunkering locations.
- Create green jobs through projects related to zero-emission trucks and infrastructure.
- Provide Norwegian industry players with a competitive edge for the development and export of new solutions.

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Electricity is the new oil: Digitalisation and the world's energy system

Dr Christoph Frei, Secretary General of the World Energy Council discusses the impact of digitalisation on the future of the energy system and argues that electricity is the new oil

The one thing above everything else that is keeping energy leaders awake at night is the impact of digitalisation on the future of the energy system. The reality is that the way we produce and use energy is changing in all parts of the world. This is not only a challenge for developed economies who are struggling to come to terms with integrating new approaches into the existing infrastructure. Industry leaders and policymakers across the globe are considering the impact of innovation with a mixture of excitement and unease.

The energy world is undergoing a grand transition, driven by a combination of factors including the fast-paced development of new technologies, an unstoppable digital revolution, global environmental challenges, as well as changing growth and demographic patterns. Over the coming years, this energy transition will impact operating models and the economic foundation of both nation states and businesses, leading to a rebalancing across sectors and regions with knock-on effects on the wider global economy.

“The new energy world is one of more players, different rules and new markets. The way the energy sector has developed over the past 100 years is about to change significantly and we need to be ready with agile thinking, flexible investments and dynamic policy frameworks to respond to this grand transition. What are great opportunities for some represent new risks for others.”

As part of the new realities, the focus has shifted from the question of whether oil supply will peak to the discussion when energy demand will peak; how much stranded fossil resources we have as a result of a limited carbon budget; how new climate and cyber risks redefine resilience thinking; how new business



Dr Christoph Frei, Secretary General of the World Energy Council

models and digitalisation define momentum on a path of innovation which changes the way we produce and use energy in the industrialised and developing world; and how the resulting transformation drives new realities and priorities in global energy governance.

We will see a deepening of the electrification of final demand, with electricity rapidly becoming the ‘new oil’. From analysis within our 2016 World Energy Scenarios report, we expect electricity demand to double from 24,000 terawatt-hour (TWh) in 2014 and double in 2060, or from 18% of final demand in 2014 to 29% in 2060. Advances in electric storage and renewable energy, both empowered by digital capabilities are key areas that dictate the pace and the scale of the energy transition.

The dramatic increase of renewable energy capacity across the globe, notably for wind and solar PV, will

continue and further advance the role of renewable energy in the global energy mix. We expect solar & wind to rise from 4% in 2016 to between 21 and 42% in 2060. Energy leaders clearly believe that technology innovation, unleashed by effective trade and guided by coordinated climate action, is the key to a decarbonised energy future.

Natural gas is the only fossil fuel for which we see no demand peak in the next decades. However, there is a cloud of uncertainty hanging over the golden age of gas with great variance in plausible future demand dynamics according to our scenarios work. Gas provided for 22% of electricity supply in 2014. This moves to anything between 17 and 32% by 2060, which corresponds to an absolute increase of between 300 to 1500 billion cubic metres (bcm). A strong move to Asia is a trend but the question is at which point will heavy dependence on imported gas be perceived as a risk?

The electricity system is going through deep change. We will see a greater diversity in types of actors and business models, enhanced system response capability through digitalisation and more decentralisation and direct interactions between prosumers and devices enabled through technologies such as blockchain.

The combination of digitalisation, decentralisation and new technologies will drive new business models, change the way we think about supply-demand interaction and challenge our current thinking on issues such as national tax and regulatory sovereignty, privacy, price solidarity or cybersecurity.

Decentralised energy systems may not always be the preferred option for governments and certainly not for traditional energy utilities initially; governments and energy monopolies may lose control and others gain from the decentralisation of energy. Provided regulations and regulators allow the transition to happen, decentralisation can empower local communities, organisations and individual consumers, particularly

when energy consumers also produce energy – for example, through the wind and solar installations that they own.

The new energy world is one of more players, different rules and new markets. The way the energy sector has developed over the past 100 years is about to change significantly and we need to be ready with agile thinking, flexible investments and dynamic policy frameworks to respond to this grand transition. What are great opportunities for some represent new risks for others.

“The dramatic increase of renewable energy capacity across the globe, notably for wind and solar PV, will continue and further advance the role of renewable energy in the global energy mix. We expect solar & wind to rise from 4% in 2016 to between 21 and 42% in 2060.”

Learning from other industry transformation cycles, the energy digital transformation will go through the same disruptive journey making the status quo not an option any more.

In such a context of technology democratisation and a changing energy system, we must re-think the role of the state and of companies in ensuring access to secure, affordable and environmentally sustainable energy. ■

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Energy technologies and manufacturing: America at the forefront of innovation

When it comes to energy technologies and manufacturing, America aims to be at the forefront of innovation, as Open Access Government finds out

In September 2018, the U.S. Department of Energy (DOE) shared the news that 42 projects were selected to support advanced vehicle technologies, with a total amount of \$80 million in funding to support this. It is hoped that these projects will facilitate more affordable mobility, reduce dependence on foreign sources of critical materials, strengthen domestic energy security and enhance the country's economic growth.

This important aspect of the DOE's work supports their ambition to invest in early-stage research of transportation technologies that can provide businesses and families with a greater choice in how their mobility needs are met. Commenting on this important part of

DOE policy, U.S. Secretary of Energy Rick Perry says: "Improving the affordability of transportation for American consumers and businesses keeps our economy moving. By investing in a broad range of technologies, DOE is ensuring America remains at the forefront of innovation."

When it comes to batteries and electrification, the funding for these projects totals \$31.9 million. These projects set out the technologies which will recharge multiple electric vehicles speedily and at considerably high "extreme" power levels. Materials and the research projects total \$8.4 million and these intend to develop models that predict corrosion in multi-material joints

for materials in high-temperature combustion environments that can be used to accelerate the introduction of new materials into advanced vehicles, as well as lightweight vehicle structures.

Another part of this funding for transportation technologies concerns projects worth \$10.1 million around engines and fuels. We find out that these projects will research advanced multi-mode (spark ignition/compression ignition) engines with co-optimised fuels for bio-derived blendstocks for diesel engines for medium- and heavy-duty vehicles, as well as light-duty vehicles.

“Improving the affordability of transportation for American consumers and businesses keeps our economy moving. By investing in a broad range of technologies, DOE is ensuring America remains at the forefront of innovation.”

One last example is the \$3.4 million funding in place for off-road and fluid power systems, the projects of which will focus on improving the energy efficiency of off-road vehicles used in agriculture, construction and mining applications.⁽¹⁾

Manufacturing

Other energy technologies supported by DOE include LED bulbs and solar panels, as well as electric vehicles which were discussed earlier in this article. When it comes to manufacturing in the U.S., this is the lifeblood of the economy because it provides jobs for hard-working families and also helps to increase U.S. competitiveness, according to the DOE. In addition, the DOE is supporting manufacturers to increase their productivity in energy by implementing energy efficiency measures.⁽²⁾

Research & development consortia

Staying on the subject of manufacturing, it's worth noting here that the DOE's Advanced Manufacturing Office (AMO) brings together a number of actors to pursue coordinated early-stage R&D in high-priority areas around energy in manufacturing. These include manufacturers, small businesses, universities, national laboratories, as well as state and local governments. While these consortia have distinct technology focus areas, they are all working towards the common goal

of securing the country's future by means of manufacturing innovation, collaboration and education.

In addition, AMO's five institutes are part of Manufacturing USA, which is a network of regional institutes, each of which has a specialist technology focus area. We know that these institutes facilitate the transition of information, innovative advanced materials and process technologies to industry. This approach enables manufacturing scale-up and helps to develop national capabilities that enable workforce development and future global leadership in advanced manufacturing.⁽³⁾

Closing thoughts

Finally, it's worth noting that the energy technologies and manufacturing discussed here are just two examples that strongly support the overall mission of the DOE, which is: “to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.”⁽⁴⁾ Certainly, the DOE is working towards ensuring America's Energy Future by various means, including the ones described here.

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Clean energy: The U.S. Energy Department's priorities for wave, tidal and hydropower resources

The work of the U.S. Energy Department is examined here by the Editor of Open Access Government Jonathan Miles in respect to clean energy and the remarkable potential of wave, tidal and hydropower resources

The U.S. Department of Energy began its life in 1977, but it traces its lineage to the Manhattan Project effort to develop the atomic bomb in World War II and to a number of energy-related programmes that were dispersed throughout various Federal agencies.

At the time of writing, the Department is led by Secretary of Energy Rick Perry who serves as the 14th United States Secretary of Energy. This article will examine some aspect of the Energy Department's work, with a focus on clean energy, including their support for the development of wave, tidal and hydropower resources.

Clean energy

One area of the U.S. Department of Energy's work concerns clean energy; indeed, we find out that a revolution of this kind is taking place across America, supported by the steady expansion of the country's renewable energy sector. We know that the clean energy industry generates hundreds of billions of dollars in economic activity and is expected to continue to grow at a rapid pace during the years ahead. The economic opportunity for the countries that invent, manufacture and export clean energy technologies is tremendous.

We go on to learn that the responsible development of all the U.S.'s rich energy resources will help to ensure the country's continued leadership in the field of clean energy. The energy resources here include solar, wind, water, geothermal, bioenergy and nuclear. Looking ahead, the Energy Department aims to carry on driving strategic investments in the transition to a cleaner, more secure and domestic energy future.

Water

Untapped sources of energy in America include wave, tidal and hydropower resources which have a vast potential to expand electrical generation in the future. As such, the Energy Department is determined to drive forward critical research and development efforts from these clean energy resources.

“The Energy Department announced \$116 million in funding for 263 research and development grants for 184 small businesses in 41 states - including four grants for water power projects. Funded through DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, Phase I grants enable small businesses to research the technical feasibility innovations that advance the Department's mission.”

This policy ambition includes investments in existing hydropower facilities to enable the necessary infrastructure to produce electricity and leading marine and hydrokinetic technology advancements to generate energy from water.

On wave and tidal energy, we know that the efforts of the Water Power Program's marine and hydrokinetic research and development (R&D) focus on advancing technologies that capture energy from America's rivers and oceans. In contrast to hydropower, marine and hydrokinetics represent an emerging industry with hundreds of potentially viable technologies. As such, the Program is leading efforts to evaluate technical and economic viability; prove functionality; and generate cost, performance and reliability data for a number of devices.

Also, we are told that marine and hydrokinetic energy technologies convert the energy of waves, rivers, tides and ocean currents into electricity. The Department of Energy's [Marine and Hydrokinetic 101 video](#) reveals how these technologies work and underline some of the Water Power Program's R&D efforts in this area. This Program consists of three categories: market acceleration and deployment; technology development; plus, resource assessment and characterisation.

“We know that the clean energy industry generates hundreds of billions of dollars in economic activity and is expected to continue to grow at a rapid pace during the years ahead. The economic opportunity for the countries that invent, manufacture and export clean energy technologies is tremendous.”

Research and development

In recent news, we learn that the Energy Department announced \$116 million in funding for 263 research and development grants for 184 small businesses in 41 states – including four grants for water power projects. Funded through DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, Phase I grants enable small businesses to research the technical feasibility innovations that advance the Energy Department's mission.

One example of the research funded here is for Creare, LLC of Hanover, New Hampshire, who plan to develop a technology for low-cost desalination that concerns the process of removing salt from seawater in coastal regions afflicted with water scarcity by harnessing power from the ocean and tidal currents. Another example is Resolute Marine Energy, Inc. of Boston, Massachusetts, who intend to research a wave energy-powered, fresh water production solution that can solve water security problems facing underserved markets in a cost-effective manner. Such small businesses are playing a very important part in spurring innovation and creating jobs in the U.S. economy.

The importance of clean electric power

In closing, it is worth highlighting the that clean electric power is vital to the Energy Department's aim to meet their interdependent security, economic and environmental goals. While supporting aggressive emission

reductions, the traditional market drivers such as reliability, safety and affordability must be enhanced and maintained, as we are told in [Chapter 4 – Advancing Clean Electric Power Technologies](#). We also find out how the current portfolio of electric production is characterised and the importance of technological advances to meet energy needs in America.

“The current portfolio of electric production includes a combination of coal, nuclear (with five new reactors under construction), hydro, growing natural gas and rapidly advancing renewable generation sources. Complementing this evolving generation mix, technologies to enable higher efficiencies, pollution control and carbon capture and storage are essential aspects of the RDD&D portfolio.”

“A combination of flexible technology options will be required to meet increasing power needs in the U.S. and globally. The Quadrennial Technology Review focuses on technological advances to meet U.S. energy needs and challenges, recognising that these also offer opportunities for cooperative research that will expedite the international deployment of these technologies.” ■

For more information on the Energy Department's extraordinary range of work, please visit: www.energy.gov.

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Radioiodine in the environment: The importance of natural organic matter

Peter H. Santschi, Regents Professor at the Department of Marine Sciences, Texas A&M University – Galveston discusses radioiodine in the environment, focussing on the importance of natural organic matter

There is a single stable isotope of iodine, ^{127}I , and two environmentally relevant iodine radionuclides, ^{131}I and ^{129}I , both of which have been primarily introduced into the environment because of human activity since the dawn of the nuclear age. ^{131}I has a half-life of just eight days (the duration required for it to radiologically decay to half of its mass) but is a threat to human health immediately following a nuclear accident, such as Chernobyl or Fukushima, because of its high inventory, and bio-concentrates in the thyroid gland. Because of its short half-life, ^{131}I levels usually fall below detection in environments contaminated by nuclear event shortly after the release (about two months).

In contrast, ^{129}I is much less of an immediate health risk because it has a much longer half-life (16 million years), however, it is problematic as a contaminant associated with nuclear waste disposal. Another important reason that ^{129}I is a key risk driver is that there is the uncertainty regarding its biogeochemical fate and transport in the environment and such uncertainty requires that conservative assumptions about its associated risk must be included in our risk models. Its risk is considerably higher than that of ^{99}Tc , which receives most of the attention in the US [Fig. 1].

As a consequence of some of these characteristics, ^{129}I has a very low

Drinking Water Standard, DWS, which is set at 0.04 Bq/L, the lowest of all radionuclides in the US Federal Register. Thus, ^{131}I is a significant and immediate health hazard associated with large-scale nuclear events, whereas ^{129}I poses a challenge in terms of environmental remediation and the long-term stewardship of nuclear waste (Kaplan et al., 2014).

Stable iodine is a required nutrient for human health. About 90% of the iodine in the human body exists in the 14-g thyroid gland, where it is an essential component of several thyroid hormones. When radioiodine enters the human body, it mimics the behaviour of stable iodine and concentrates on the thyroid gland but can be a carcinogen.

The World Health Organization (2006), reported that the Chernobyl nuclear power plant accident resulted in 5,000 thyroid cancer cases of people who were under 18 years old at the time of the accident. Radioactive iodine was deposited in pastures eaten by cows who then concentrated it in their milk which was subsequently drunk by children. This was further exacerbated by a general iodine deficiency in the local diet causing more of the radioactive iodine to be accumulated in the thyroid. Since radioactive iodine is short-lived, if people had stopped giving locally supplied contaminated milk to children for a few months following

the accident, it is likely that most of the increase in radiation-induced thyroid cancer would have been averted.

Iodine exists in multiple oxidation states, primarily as molecular iodine (I_2), iodide (I^-), iodate (IO_3^-) or organic iodine (org-I). The mobility of iodine in the environment is dependent upon its speciation and a series of redox, complexation, sorption, precipitation and microbial reactions. Over the last 15 years, there have been significant advances in iodine biogeochemistry and geobiology, largely spurred by a renewed interest in the fate of radioiodine in the environment and advances in detecting these various species at environmentally relevant concentrations. The biogeochemistry of iodine, with particular emphasis on the microbial processes responsible for volatilisation, accumulation, oxidation and reduction of iodine, are reviewed in Yeager et al. (2017).

The key environmental factor influencing radioiodine's fate and transport in the environment is natural organic matter (NOM) that consists of residues of decaying plant matter and freshly produced exudates from microbes (Santschi et al., 2017a). Recently, great progress has been made in understanding the impact NOM compounds and microbial processes on the fate of different radionuclides in Japanese and U.S. soils. It has been shown that NOM not only influences the fate and

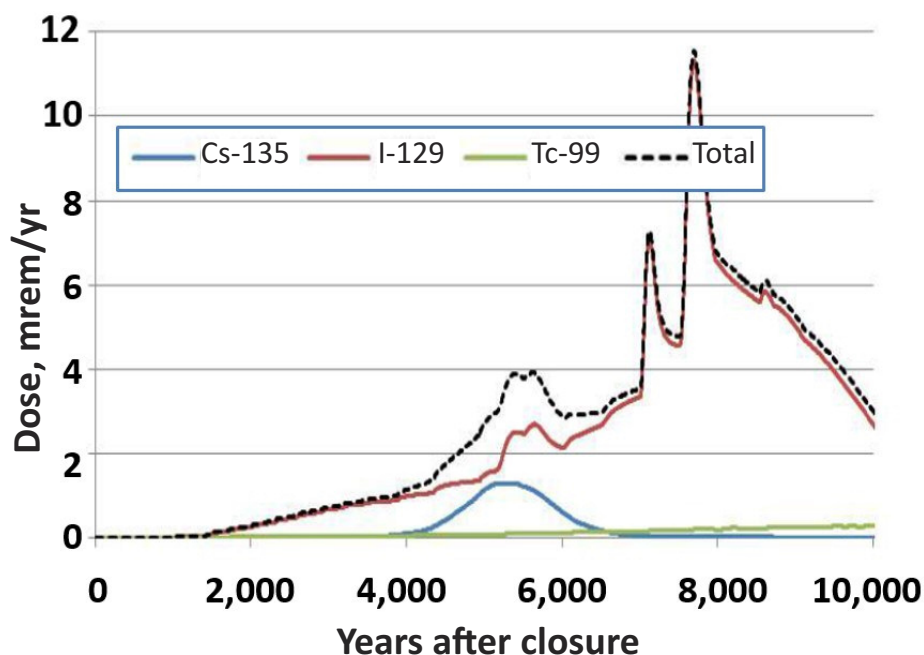


Fig. 1. Example of calculated risk associated with the disposal of low-level waste in cementitious waste forms (WSRC-STI-2007-00306)

transport of radioiodine but also many other radionuclides. However, there still remains great uncertainty in predicting NOM-radionuclide interactions because of a lack of understanding of radionuclide binding to the wide array of specific binding sites (organic moieties) within NOM, as NOM is polymeric, polyfunctional, containing pH and redox reactive moieties that can be controlling radionuclide behaviour in the environment.

The architecture of macromolecular organic matter requires that thermodynamic constants for binding to macromolecular organic matter will have distribution functions rather than discrete values, which is a challenge for modellers. While radionuclide-NOM studies have been conducted using model organic compounds or elevated radionuclide concentrations, the results of such studies might provide compromised information related to true environmental conditions.

Therefore, sensitive techniques are required not only for the detection of radionuclides and their different

species, at ambient and/or far-field concentrations, but also for potential trace organic compounds that are chemically binding these radionuclides (Santschi et al, 2017b). Recent analytical chemistry advances (based on GC-MS and AMS) have demonstrated that iodine forms strong bonds with NOM by covalently binding to aromatic functionalities. These recent studies have led to a more mechanistic understanding of radioiodine biogeochemistry.

Different from other high risk radionuclides (Cs, Sr, and U) that have been attenuated, ¹²⁹I continues to leave the source at a rate that may have been exacerbated by the initial remediation actions (Kaplan et al., 2014) that ignored the strong pH and redox control of its organoiodine formation and mobilisation/immobilisation that is opposite to that of many metal radionuclides.

In another example, the Fukushima Prefecture surficial soil ¹²⁷I content was significantly and positively correlated to soil OM content, regardless of land

use type and showed strong correlations (negative to pH, positive to Eh) to soil ¹²⁷I content, suggesting that soil OM might be an important factor affecting iodine biogeochemistry. These observations have far-reaching implications for remedial actions and demonstrate the need for additional understanding of the impact of NOM interactions on the fate and transport of radioiodine.

Acknowledgements

Work on radioiodine reported here was funded by the U.S. Department of Energy (DE_SC0014152.), while some work on other radionuclides by the U.S. National Science Foundation (OCE0851191).

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Ocean sciences in the United States

The role of the National Science Foundation (NSF) in supporting the ocean sciences in the United States is examined here by Open Access Government

The National Science Foundation (NSF) is an independent federal agency in the U.S. that supports fundamental research and education across all fields of science and engineering.

This article looks at the work of NSF's Division of Ocean Sciences (OCE), within the NSF, who exist to support research, education and infrastructure that advance our understanding of the global oceans and ocean basins, including their interactions with the integrated Earth system and human beings. Within this division is the Marine Geosciences Section, which has a Chemical Oceanography section and one for Marine Geology and Geophysics (MG&G).

Firstly, the Chemical Oceanography Program supports research into the chemistry of the oceans and the role of the oceans in global geochemical cycles. Areas of interest here include:

- Chemical exchanges between the oceans and other parts of the Earth system;
- Chemical composition, speciation and transformation;
- Internal cycling in oceans, seas and estuaries plus and;
- The use of measured chemical distributions as indicators of biological, physical and geological processes.

Secondly, the Marine Geology and Geophysics Core Program is concerned with all aspects of research around the geology and geophysics of the present ocean basins and margins, plus the same for the Great Lakes. This Program supports science that includes the following fascinating areas, to name a few:

- The structure, composition, evolution and tectonics of the oceanic lithosphere;
- Marine hydrogeology, seeps and gas hydrates, water-rock interaction and hydrothermal vent and fluid formation and geochemistry;
- Marine sedimentology and coastal processes, stratigraphy, sediment transport and diagenesis;

- Paleooceanography, paleoclimate and sea level change;
- Submarine volcanology, petrology and geochemistry of the oceanic crust and upper mantle and;
- Marine geohazards (such as earthquakes, mass wasting, geological aspects of tsunamis).

Added to this, we know that the Marine Geology and Geophysics Program is concerned with supporting new ideas and cutting-edge research. Field, analytical, and laboratory experimental projects; methods development; modelling; and the re-analysis and/or synthesis of existing data are supported by this Program. Also, the Program interfaces with NSF programs across the geosciences and across the Agency. ⁽¹⁾

New connections between climate change and warming oceans

In recent news from the field, NSF recently highlighted the work of scientists from the University of Toronto who have drawn new connections between climate change and the warming oceans.

Uli Wortmann, a professor in the Department of Earth Sciences in the Faculty of Arts & Science at the University of Toronto and co-author of the study explains more about what this study reveals in his own words. "Our study shows that global warming is not only about extreme weather events, or hotter summers, but it has the potential to alter the ocean structure with unknown consequences for fisheries.

"We show that the last time large amounts of CO₂ were injected into the atmosphere, not only did the planet get hot – which is known as the so-called Paleocene-Eocene Thermal Maximum, about 55 million years ago – but it also changed the chemistry of the ocean quite markedly."

The research discovers that as the oceans warm, oxygen decreases while hydrogen sulfide increases,

which makes the oceans toxic and puts marine species at risk. ⁽²⁾

How calcifying organisms will respond to ocean acidification

Another piece of research highlighted by NSF's Division of Ocean Sciences (OCE) suggests that size is the key factor that predicts how calcifying organisms will respond to ocean acidification. Allison Barner, who carried out the research while completing her PhD in integrative biology at Oregon State University shares her thoughts on ocean acidification. "Decades of research have shown that calcifying species are negatively affected by ocean acidification...But even closely related species can have different responses to acidification and not much was known about the drivers that shape this variation."

Added to this, we learn that around 30% of the carbon dioxide in the air ends up in the sea, where it causes a reduction in carbonate ions – a key building block for a variety of calcifying organisms, including not only the algae in the study but also animals such as oysters, mussels, sea stars and corals. As well as running experiments that simulated future ocean acidification conditions, Barner and colleagues measured a suite of properties for each species, including its habitat distribution along the Oregon coastline and its size, surface area and shape.

"All of the species had declining calcification with short-term increases in acidification," says Barner, who now works as a postdoctoral scholar at the University of California, Berkeley. "And the findings supported the hypothesis that organismal size is the best predictor of an individual's physiological performance under acidified conditions. Importantly, we can rule out the scenario that each species might have a different response to ocean acidification." ⁽³⁾

The links between carbon and plankton

One project, announced in June this year concerns a joint project between the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF) which aims to study the life and death of microscopic plankton, tiny plant and animal organisms that play a vital part in removing carbon dioxide from the atmosphere and the oceans.

While the major pathways of how carbon moves through the ocean are known, how much of it is transferred along these pathways and how much they depend on ecosystem characteristics, are not as well known. Providing us with more detail on this, Mike Sieracki, a Biological Oceanography program director in NSF's Division of Ocean Sciences (OCE) says: "The carbon that humans are putting into the atmosphere is warming Earth...Much of that carbon goes into the ocean and is transported to the deep sea, where it will not return to the atmosphere for a long time. This project will help us to understand the biological and chemical processes that remove that carbon, and to monitor these processes as climate changes." ⁽⁴⁾

Closing remarks

Many further examples of NSF supported research could be discussed here if space allowed, such as how a new study challenges scientists' presupposition about the carbon cycle ⁽⁵⁾ or how nutrient pollution makes ocean acidification worse for coral reefs ⁽⁶⁾. In closing, we have seen some fantastic examples of just one area that the NSF supports when it comes to basic research and the people to create knowledge that transforms the future of our world. ⁽⁷⁾ ■

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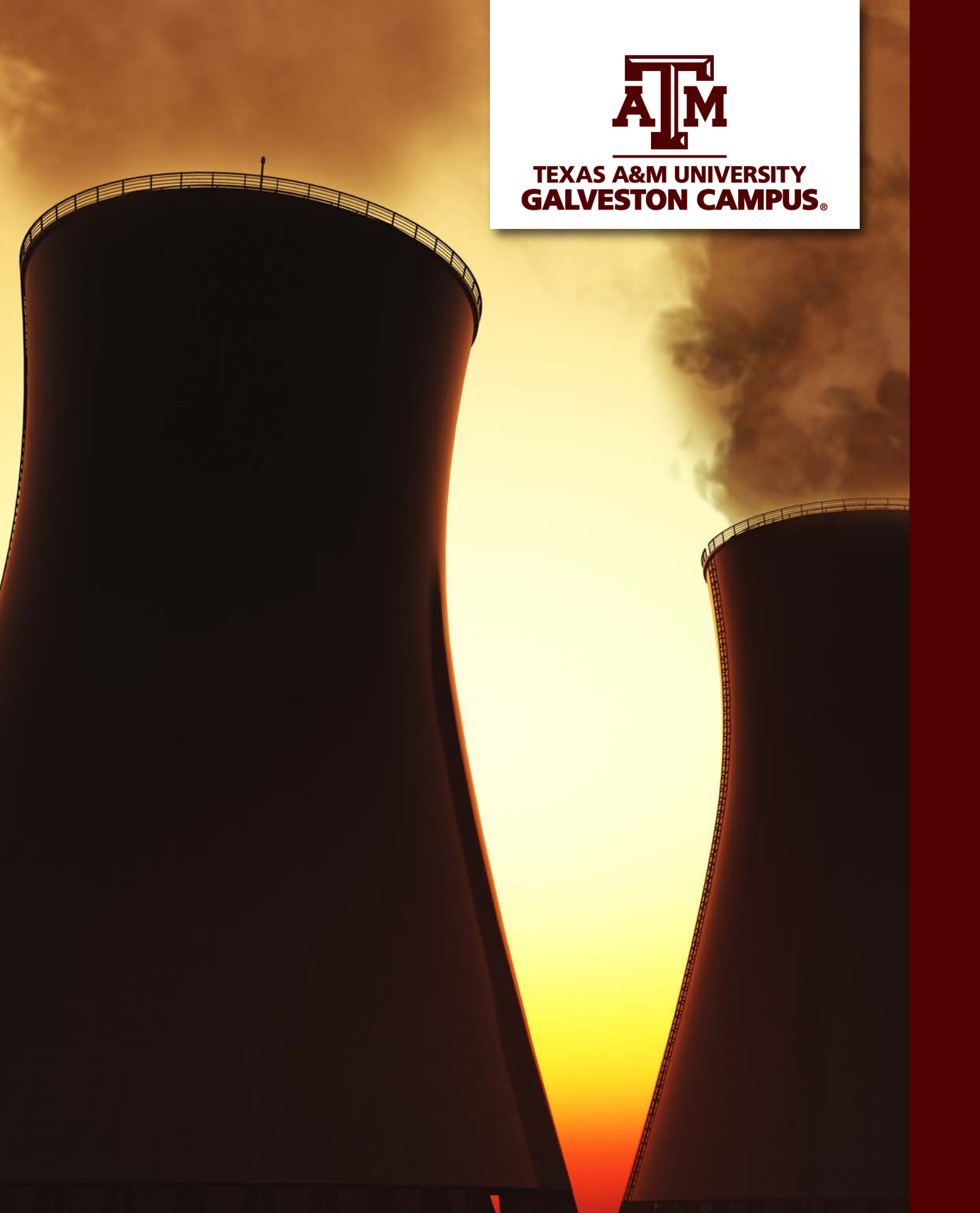
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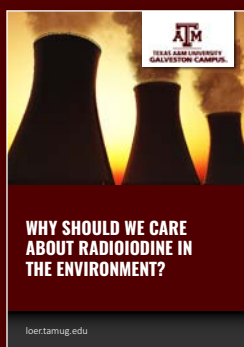
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WHY SHOULD WE CARE ABOUT RADIOIODINE IN THE ENVIRONMENT?

Peter H. Santschi from the Department of Marine Sciences at Texas A&M University – Galveston and **Daniel I. Kaplan** from Savannah River National Laboratory share their views on radioiodine in the environment.

In this analysis, the focus is given to the pathways, from source to human risk and presents questions about radioiodine mobility in the environment today.

One of the many fascinating facts revealed here is that according to an article published in Scientific American (Fischetti, 2011), risk factors (in number of premature deaths, including accidents, per 100 gigawatts power produced per year) for nuclear power are extremely low (0.7), compared to fossil fuels such as natural gas (719), crude oil (937) and coal (1200).



Click here to read the full ebook

Millennials and aviation: Developing sustainable technologies

Jürgen Wiese, Chairman of European Business Aviation Association (EBAA) states the case for why millennials should fly with us, including the role of developing sustainable technologies in the aviation sector

The word 'millennial' and the term 'business aviation' are rarely found together in the same sentence, but when they are, they tend to get on very well.

At EBAA, the industry association for business aviation, we see many millennials working in jobs throughout the sector. But we wanted to learn more about their views on business aviation and the future of flying. So we surveyed them.

With the help of ThinkYoung, a research and advocacy group for young people, we spoke to 2,000 people between 18 and 25 in four key European countries – Germany, France, the United Kingdom and Switzerland. We wanted to find out what this generation really thinks not just about flying, but bigger questions about transport and the world.

What did we find? Millennials have much to tell us. They are hopeful and idealist about what sort of world they expect to live in. They are also pragmatic about how they see transport: this is a generation which has always known about cheap flying. These are people who can get to where they want more easily than any previous generation and they believe that flying will become simpler and cleaner in years to come.

There were three key findings from the survey:

- Millennials associate transport closely with the environment: 40% describe climate change as the megatrend with the biggest impact on the development of sustainable personal air transport. Artificial intelligence (AI) and digitisation come next. They also expect most research on innovation in aviation to focus on making air transport more sustainable.

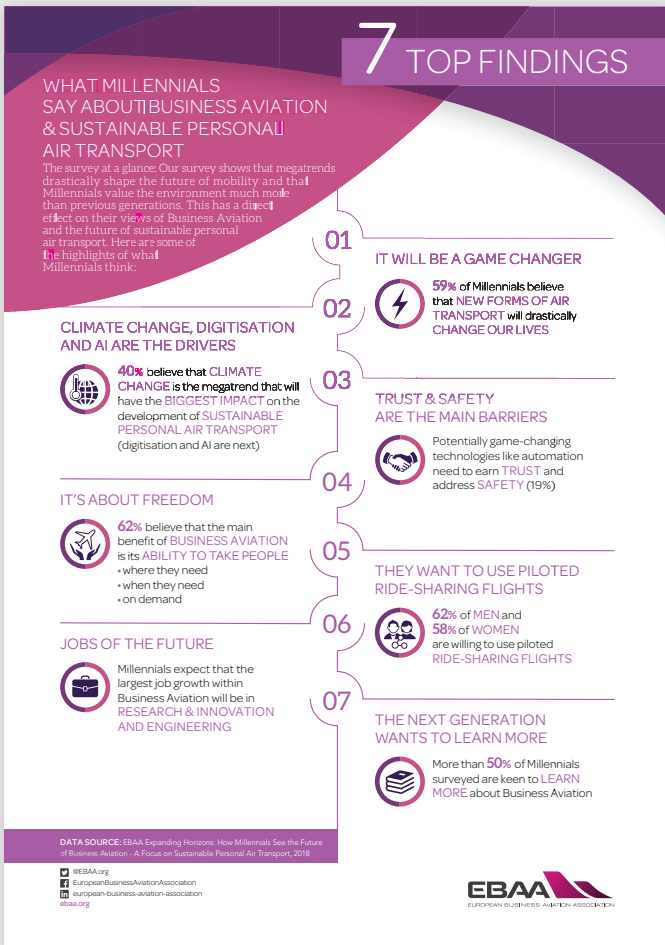
- Millennials say the best thing about business aviation is the freedom and flexibility that it offers: 62% believe that the main benefit of business aviation is its ability to take people where they need, when they need.
- Millennials believe that while technology will find solutions to mobility questions, there will still be concerns about cost, trust and safety. For example, 60% of millennials are ready to use ride-sharing air services, but only 46% are ready to use automated ride-sharing air services.

“This is a pioneering industry which is constantly investing in research and technology to ensure it has the ambition to shape the future of personal air transport.”

All in all, millennials see the value of business aviation as part of a range of modern, environmental, mobility options. They also recognise its potential for driving technological change in the entire aviation sector. They can see its increasing accessibility and democratisation. And they can see its appeal as a career choice for young talent interested in technology, digitalisation and innovation.

These findings reflect the optimism and idealism of the younger generation. They reveal how millennials see mobility as a choice between different modes for different journeys. And how they balance their right to travel with their responsibility to look after the planet.

Millennials have values and interests that they cherish: they love to travel; they are early adopters of new technologies and they believe strongly in a cleaner environment. These are also the values and interests of business aviation.



- Secondly, we are continuing to invest in research and technology to ensure we are a pioneering industry. We want people to travel fast, quietly, safely and with minimal impact on the environment. Innovations are helping achieve that, with technologies like winglets, new avionics systems and new composite materials to build stronger and lighter aircraft.

“Millennials have much to tell us. They are hopeful and idealist about what sort of world they expect to live in. They are also pragmatic about how they see transport: this is a generation which has always known about cheap flying. These are people who can get to where they want more easily than any previous generation and they believe that flying will become simpler and cleaner in years to come.”

- And thirdly, we are becoming more open and accessible than ever before. Business aviation is often seen as an exclusive realm but chartering a plane has never been easier. And for people thinking of a career in business aviation, there are more diverse job opportunities than ever before.

This is a sector that is by definition taking people to places that might otherwise be out of bounds – and chartering a plane has never been easier.

This is a pioneering industry which is constantly investing in research and technology to ensure it has the ambition to shape the future of personal air transport.

And this is a community committed to developing sustainable technologies to lower carbon emissions and reduce its impact on environmental resources.

After hearing when millennials had to say, we took their messages on board. And we are ready to make commitments to them. Here is what we pledge:

- Firstly, on climate change, we share millennial concerns about the damage that air transport can have on the environment. We recognise that we are not only part of the problem but can play a vital role in the solution. We have committed to reducing our emissions through the use of fossil fuels. This commitment does not just apply to our energy use, but our manufacturing, our infrastructure and our operations.

These are our commitments to millennials. We listened, we learned and now we want to fly with you.

[Read our full report here.](#) ■

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The rise of sustainable aviation fuels

Dr Simon Blakey, Senior Lecturer in Mechanical Engineering at the Low Carbon Combustion Centre, The University of Sheffield explores the rise of sustainable aviation fuels

Globally, in the last 24 hours more than 90,000 flights and more than 6 million people have been lifted up, high in the air and have been transported in thin, cold air in which we could not survive and landed safely at their destination and the only thing concerning us is how long the queue will be at the baggage carousel.

To allow this remarkable feat to happen, jet fuel is moved through the global distribution system at over 7,000 litres a second throughout the day and night. This colossal volume of aviation fuel requires an efficient,

quality controlled and a well-managed delivery system. Above all, a safety-first approach is required throughout the system, from production to use.

The civil aviation sector has spent much of the last 60 years optimising the design of aircraft and engines to reduce aviation fuel consumption and lower CO₂, noise and NO_x emissions. The sector has had significant success in this undertaking, however, during this period the composition and properties of aviation fuel have been taken as a constant. This has effectively meant that the sector has been optimising hardware around a range

of average, or worst-case fuels available. The use of these fuel sources represented no change on the sources used for gas turbines since the beginnings of the jet age and as such was the “Jet A-1 everybody knows”, based on accumulated experience.

The sector is now challenging itself even further and has imposed upon itself a range of emissions targets to further reduce its environmental impact: An average improvement in fuel efficiency of 1.5% per year from 2009 to 2020, a cap on that aviation CO₂ emissions from 2020 essentially being carbon-neutral growth and a

reduction in net aviation CO₂ emissions of 50% by 2050, relative to 2005 levels. The achievement of such goals is requiring a continuation of technical and flight management improvements and attention has turned to the fuel used for flight. Moves towards fuels from a non-fossil sources are increasing and are supported globally by the establishment of market-based measures by UN-ICAO through the CORSIA scheme, which is currently voluntary for UN member states. Importantly, this is the first sector to place upon itself such stringent import targets and many member states are scaling up the production of fuels from a range of different sources to allow this to be achieved.

“To allow this remarkable feat to happen, jet fuel is moved through the global distribution system at over 7,000 litres a second throughout the day and night. This colossal volume of aviation fuel requires an efficient, quality controlled and a well-managed delivery system. Above all, a safety-first approach is required throughout the system, from production to use.”

Significantly, many of these more novel fuels offer significant advantages to the engine emissions performance, they have a higher energy density and consequently a lower CO₂ emission for an equivalent energy release, they are cleaner burning and produce significantly less soot emission. The debate concerning the uptake of such fuels should be extended to cover these other, non-CO₂ related benefits which will undoubtedly improve the

case for the use of such fuels. In fact, such considerations lead to the conclusion that the fuel ought to be considered as an enabler of such future gains in emissions reduction, rather than a bought in the commodity to achieve flight and should be considered fuel and engine as one, a whole system which needs optimising.

The approval of fuels for use is, like the provision of fuels, a safety-first approach, which seeks to ensure that any candidate fuel is technically suitable for use in existing aircraft through the ASTM D4054 process. The University of Sheffield and the research staff at the Low Carbon Combustion Centre are involved in a wide range of alternative fuels research activities specifically related to aviation and the approval of alternative fuels. The team has been working on the technical assessment and the suitability technical suitability of candidate fuel since the early 2000s and has gained experience in analysing and assessing any fuel both using established techniques used for conventional fuels and new research-based techniques, where the established techniques are challenged by the novel fuel composition.

This work is continuing with a range of International and European funded projects develop a better understanding of the impact changes in fuel chemistry have on the performance of airframes and engines. Along with partners around the globe, The University of Sheffield is continuing to conduct research both for the aviation

and increasingly for the automotive sector. If you would like to find out more about our work please get in touch.

Biography

Since 2004, Simon has worked as part of the growing team at the Low Carbon Combustion Centre at the University of Sheffield focusing on the technical suitability of alternative and conventional fuels and fuel system hardware for the aviation sector. Simon is Director of the Low Carbon Combustion Centre, Working Group Leader on Alternative Fuels for ECATS, a European Network of Excellence for the development of sustainable fuels for the Aviation Sector and part of the University's Energy 2050 initiative. Simon manages a number of aerospace industry-facing research programmes focusing on the technical suitability of alternative and conventional fuels, as well as methods for the assessment of the performance of fuel system engine hardware.



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Providing a comprehensive response to the UK's national security

John Wright, Global Director of Public Safety & Justice at Unisys shares his thoughts on how UK government policy helps to provide a comprehensive response to the country's national security

First of all, on the plans for MI5 to declassify and share information on UK citizens suspected of having terrorist sympathies in a bid to prevent terrorist plots, we know that the launch of the government's revised counter-terrorism strategy, [Counter-terrorism strategy \(CONTEST\) 2018](#) supports this. As the National Coordinator of Prevent for six years, the police lead responsible for [CONTEST 2013](#), John Wright, now Global Director Public Safety & Justice at Unisys is very well placed to share his thoughts on this important policy development and its background.

John begins by explaining that when it comes to UK citizens suspected of having terrorist sympathies, this must be dealt with in the most appropriate way that is commensurate with the threat posed. A proper assessment of that threat should take place, based on a wide range of information and data. There are caveats around this, in that such activities must comply with the relevant legislation around data protection and human rights, for example.

John explains that the new counter-terrorism strategy (CONTEST) 2018 is a consolidation of CONTEST 2013 and as such, the security services and agencies are looking to extend what has already been done, albeit in a more limited capacity. John details this crucial point to us further, in his own words.

"Most of this information is needed for a variety of reasons, including the way the information is collected, who provides it (it could be data that has been collected by other agencies outside of the UK). There is a whole range of factors whereby that information will in most cases, need to be kept on a 'need to know basis'. This has changed since the development of the Prevent strand of CONTEST that goes back to its very conception. In this vein, getting ahead of the terrorist

organisations and individuals in groups was always one of the primary motives.

"Since 2001, the focus has really been on arresting ourselves out of this issue around terrorism and I think as the strategy evolves, we have learnt lessons from actual events themselves but also around the way different partners and agencies react. Elsewhere in the world, there is a greater realisation that the security agencies can only deal with the very highest levels of threat. There has been a great rump of people who have been involved in investigations but are only on the periphery or are likely to become involved in investigations where the resources are not there and not likely to be in the future.

"CONTEST really does recognise the level of capabilities, but the evolution of the strategy does really reflect how the UK itself is evolving on the national scene. If you look at how the UK ranks a threat, one interesting element is that while ISIL is still a number one threat. At one time, many people thought that Al-Qaeda was no longer the threat it once was. So, I do think there is a recognition in CONTEST that this threat may increase significantly over the coming years."

"These agencies are probably not the right people to deal with radicalisation processes, but they can identify the threat and the drivers. When it comes to remediation, that is diverting people from potentially committing a terrorist act, this is not within the skillsets of the agency. So, if you are going to have your arms around all of this threat, you need to bring in other agencies who have the expertise and the resources to actually manage these threats."

John then tells us that (CONTEST) 2018 has introduced a new category which is called 'closed' or 'closing'



subjects of interest, which means that once the risk has been assessed, they are closed down as a threat or they are seeking to close them down. It is about maintaining an understanding that these groups do not resurface or become a threat in the future, but also that such investigations carry on in a way that is not down the traditional surveillance route.

On the counter-terrorism strategy (CONTEST) 2018, John is keen to explain what this aims to do. Building on CONTEST 2013, it is a very comprehensive and well thought through strategy, John notes. This is true when you consider how this strategy has been implemented in the UK and abroad. Over the last two or three years, lessons have been learned from terrorist incidents, especially in the UK as well as abroad.

“The aim is to incorporate these areas into (CONTEST) 2018 and provide a holistic approach, but that would suggest that nothing dramatic has changed. Having said that, I think that there are some elements within

the strategy that show us two things. The first is the recognition that the threat has changed and evolved and secondly, this comprehensive approach focuses even more on prevention. Thirdly, there is more information here that deals with national security that can be made available to the broader partnership and the public.

“So, from these, I would pick out three elements. The first is that there is a change in emphasis and a willingness to for us to be more open, in that the strategy does recognise in terms of the evolution of the threat, for example, the impact of ISIL in Syria wasn’t anticipated to the level in which it manifested itself. That was a recognition that the UK government’s assessment of a threat is never going to be perfect and was less pre-emptive and predictive.”

When it comes to John’s time the National Coordinator of Prevent for six years, the police lead responsible for CONTEST 2013, he reveals that setting up a review of

this is a major piece of work for the [National Counter Terrorism Security Office](#) in close liaison with the [Prime Minister's Office, 10 Downing Street](#). John notes that this is a very sensitive engagement, with much planning and preparation involved and a great deal of information gathered. In addition, various different agencies are asked to have their input into the review of CONTEST 2013.

“Since 2001, the focus has really been on arresting ourselves out of this issue around terrorism and I think as the strategy evolves, we have learnt lessons from actual events themselves but also around the way different partners and agencies react. Elsewhere in the world, there is a greater realisation that the security agencies can only deal with the very highest levels of threat.”

“For example, I was responsible for the section on the police’s contribution and there was also a section about the police’s overall response in terms of CONTEST 2013. It was my responsibility to carry out this work within the [Counter Terrorism Policing](#), in that we provided a comprehensive response that fitted in with the overall structure of CONTEST 2013.

“In terms of how that worked, when the last CONTEST 2013 was updated the UK government were looking for examples of what went well and what didn’t, but crucially it concerns the types of initiatives and interventions that we thought would be most effective in terms of taking (CONTEST) 2018 forward. Much of this work involves going around the Counter Terrorism Policing network, speaking to professionals there and within the partnerships at a local level to pull out the things that frustrated them and what they wanted to change and update.

“(CONTEST) 2018, therefore, provides the opportunity to do things differently. For example, intelligence operations around national security are led by [MI5 – The Security Service](#) who are a premier agency in terms of major threats to national security, but a lot of the interventions were led by the police. There was a recognition that not all investigations would have a be covered

by the resources of MI5, so the intention was not to replicate but do provide a similar level of management for an incident or operation, in relation to a lower threat investigation.”

John explains that when it comes to terrorist groups such as domestic right-wing extremists, the capabilities of law enforcement are different and can reach into communities. [The Counter Terrorism Internet Referral Unit](#) is another example of a very police-led response to challenging extremist views on the internet and to take down such sites if necessary, John reveals, hopefully, before any real attempts are made to radicalise or influence anybody in a negative way.

In closing, John also underlines that the UK is recognised as a leader in Europe and globally in how to provide a comprehensive response to national security.

“CONTEST really does recognise the level of capabilities, but the evolution of the strategy does really reflect how the UK itself is evolving on the national scene. If you look at how the UK ranks a threat, one interesting element is that while ISIL is still a number one threat. At one time, many people thought that Al-Qaeda was no longer the threat it once was. So, I do think there is a recognition in CONTEST that this threat may increase significantly over the coming years.

“Ensuring that the threat is properly covered, by learning lessons in terms of, for example, Syria wasn’t as well anticipated as it could have been. On the threat of Tahrir al-Sham (HTS) in Syria, if things move forward politically there and such organisations are marginalised then the focus moves away from internal struggles there to the UK and Western Europe. The message to convey here is, therefore, one of vigilance.” ■

John Wright
Global Director of Public Safety & Justice

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Do we need to rethink how we design public spaces, with smarter integrated security?

Ian Robinson, Director of Business Development at RWS Ltd, has managed and installed key security projects for the national infrastructure and government agencies worldwide. He asks if we need to rethink how we design public spaces, with smarter integrated security in mind

Protecting our public infrastructure and the people within them has never been easy, but at least we had a good idea of the likely targets. But now the threat and focus have shifted.

Security has always been a challenge, but attention has mostly centred on public infrastructure, government buildings and business. That is because they are obvious targets, but also because that is exactly where criminals or terrorists have focused their efforts on.

In the past decade, terrorist tactics have changed. The targets are less about symbols of the West and more about maximum damage. This has led to crude but deadly attacks in public spaces not previously

optimised for security, such as the vehicle attacks in Berlin, Barcelona, Nice and on Westminster Bridge.

This creates a huge challenge for designers, planners and security professionals. Not only do current public spaces need to be retrofitted with security measures, but new spaces also need rethinking – not to mention the fact that while we all want to be safe, we also want to be in pleasant environments rather than be continuously reminded of the peril we may be in. Therefore, we must address this design challenge as early in the process as possible.

An evolving approach

We have already seen changes in our public spaces



SECURITY

has dominated the overall building design with an architects' concern for the working environment being compromised by security provision and the security expert worrying about the lack of security provision during the concept phase.

A simple solution that we implement is to have a security expert engaged during the concept phase and working closely with the design team to ensure security is woven into the fabric of the building or public space. This ensures all teams involved will achieve the common goal of keeping the public safe.

As the CNPI says in its Integrated Security report, those responsible for designing should: "Consider the project requirements for protective security at the earliest possible design stage. There is a need to innovate and design integrated solutions that not only protect sites deemed to be vulnerable to vehicle-borne threat, but that are also considerate to the functionality and aesthetics of their surroundings."⁽¹⁾

Incorporating integrated security in existing public spaces

The market has been slow on the uptake of integrated security measures due to the inability to combine existing security software and physical technology. Open space security has been built up over the past 25 years and as these standalone systems come to the end of their lifecycle innovative municipal councils and commercial organisations have realised the opportunity to take a holistic approach.

Integration with other key government departments and the emergency services has provided the ideal opportunity to look at streamlining disparate security systems and bring them all under one roof.

This smart approach, however, does not rely purely on CCTV, but on any information system that can store abnormalities from the norm. The key is the system being able to interpret the data or abnormalities.

In an integrated system fit for the modern age, this information is interrogated by software capable of recognising irregularities. Should a threat be detected, then a host of deterrents can be activated to slow the individuals and notify the correct response team.

following terrorist attacks in urban areas across the world. Perhaps the most prominent are bollards and barriers designed to prevent vehicle access to a public space or prevent a vehicle mounting the pavement.

These are sensible measures but are reactive in their nature. They have been installed after and in response to an event. Security and counter-terror measures are always changing to meet the changing threats, but we must also adjust our mindset, so we think about security and design more holistically rather than two opposing forces where compromise is seen negatively.

Security is a design issue that must be incorporated at the initial concept design phase. Traditionally, aesthetics



Systems that can be intelligently integrated this way might include communication systems, transport and traffic management, emergency incident alarms (fire, smoke detection, explosion detection) and public lighting.

For example, consider a system that can identify a vehicle near a public space that is behaving erratically. The software would mark the vehicle as a potential threat or irregularity and, in this instance, alert traffic management teams and transport officers. Additional traffic calming measures could be initiated while the relevant human teams assess the situation.

If the threat escalates, emergency alarms could sound in public spaces, along with a change in the lighting, to alert those in the vicinity to take precautions and move out of the area.

This is a very simple example, but you can begin to see how fairly basic system integration can provide much more advanced threat detection and, crucially, alert authorities and the public to the potential danger.

By integrating existing technologies on a single command and control platform, the combination of a digital and physical infrastructure to secure and manage key assets and public areas will ultimately improve the security of existing public spaces and the lives of residents.

Designing security for new spaces – a new mindset

There are limits to what can be done in existing spaces, which is why it is imperative we ensure the same limitations are not built into new public spaces.

The best approach is to incorporate security at the design and planning stage and get a security consultant on board – this will ultimately save time, money and lives.

Integrated security means a change of mindset and will lead to better results. As the CNPI report on integrated security goes on to say, “successful security is most effective when implemented on a number of geographic layers”.

This is the mindset we must adopt – we must look beyond the individual asset or area we want to protect. Rather than simply thinking about how we can stop a threat once it arrives at its intended target, we must look at how we can prevent or disrupt the threat beforehand.

Of course, not everything will be in our control, but this is all the more reason for deploying an integrated security system that can communicate with others, reducing the risk of missing a threat or being too late to stop it.

However, there are still measures that any planner or designer should consider when it comes to public spaces. The degree of security installation should be proportionate to the threat. This could mean, for example, the first layer of protection is at the district layer.

This immediately changes the dynamic around planning, design and security – so consideration must now be given to wider site planning, traffic management and vehicular access control in the surrounding area as opposed to just the vicinity of the public space.

Looking to history

This way of thinking about security is not new either. Look at any well-designed and constructed castle – the castle and grounds did not just house VIPs or military assets (although they were certainly most protected), but would often include shelter for villagers, markets and more; particularly during times of war.

The defence of the castle started well ahead of the walls. Layered defences were designed to weaken and grind down the enemy as they approached the perimeter. The castle grounds would often be placed on a hill to give the defending forces a height advantage and an excellent field of view. Knowing where your enemy may attack and indeed knowing the attack is coming in the first place, is key to mounting a successful defence – comparable to an advanced surveillance system today.

Additional perimeter defences were also seen, such as moats, effectively forcing the attacking forces into predefined, narrow approaches to the castle. This has the simultaneous effect of slowing the enemy down but also allows the defending forces to concentrate their resources on a few large targets rather than

spreading their resources thinly. Many of these tactics apply today and can be replicated in a modern, less militaristic context.

For instance, simple measures such as incorporating bends and chicanes into the surrounding road system create a ‘natural’ mechanism forcing vehicles to slow down and prevent direct access. This approach provides protection to the perimeter and subsequently to the asset.

In addition, Vehicle Access Control Points (VACP) can be raised at times of increased threat, further reducing the need for other more intrusive countermeasures and allow more discreet protection at the asset layer/building threshold.

The incorporation of physical barriers does not have to be intrusive either. There are excellent examples of public spaces and other key assets incorporating sculptures, public seating, raised landscaping or natural barriers, such as trees and water features, as part of the security infrastructure.

A mixture of these approaches and a change of mindset when it comes to designing and planning will increase the deterrent and provide a more publicly accessible, inclusive and altogether safer environment. Integrated security in public spaces requires engagement with local government and may have onerous costs to local business and their daily operations, but the payoff is surely worth it. ■

<https://www.cpmi.gov.uk/system/files/documents/40/20/Integrated%20Security%20Guide.pdf>

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Aesthetics must sit at the heart of landscape security design

Jaz Vilku, Managing Director for Marshalls Landscape Protection argues that aesthetics must sit at the heart of landscape security design

Securing public spaces and infrastructure against terrorist attacks has become a key priority for architects over the last couple of years in planning and designing buildings and public spaces. Jaz Vilku, Managing Director for Marshalls Landscape Protection, argues that the profession should give greater consideration to the aesthetic design of security measures, as opposed to the concrete blocks and barriers that have been installed in urban areas across the UK and Europe.

Protecting against vehicle attacks, or Hostile Vehicle Mitigation (HVM), has become a key concern for architects and according to last year's Terrorism and Trends Report, the number of concrete and steel barriers installed around landmarks, infrastructure, buildings and public spaces has risen sharply as a result. There are numerous examples across the UK, with installations in place at Windsor Castle and to protect parts of Manchester, Edinburgh and Westminster city centres. But the problem with this type of fortification is that while it shows that authorities are taking the terrorist threat seriously, it serves as a constant reminder of the risk that exists.

The issue is that this type of measure could, for example, deter the general public from shopping on the high street, attending a music event or visiting a city centre. It's a human psychology issue, which constitutes a



vicious cycle where the greater perception of risk results in an individual feeling more threatened. This is no temporary reaction – it's hard-wired to the human brain – when we're anxious our attention is drawn towards something threatening and away from everyday life.

A balanced approach

Reducing the threat of a vehicle attack is the clear priority, but this doesn't have to come at the expense of how individuals feel about using a particular space. What is needed is a multi-layered, balanced approach that will enhance a landscape while providing the adequate level of security required.

In the UK, there has been significant progress on this front and we're starting to see more architects consider

this methodology. In a recent study of 698 landscape architects, designers and land security professionals, facilities managers and specifiers which Marshalls published in partnership with IFSEC Global, 79% said they had seen the number of projects requiring an aesthetically pleasing protective landscape protection increase over the last three years. Almost all were confident that this trend will continue moving forward.

The security products used as part of this innovative approach integrate protective, crash-tested technology into carefully designed landscape furniture, such as planters, seating, bollards, litter bins, cycle stands and lighting columns. They act as a far subtler line of protection than steel barricades or concrete blocks and are



built to PAS 68/IWA 14.1 certifications – the latest Publicly Available Specification (PAS) for barriers and bollards to assist in terrorism prevention. This sets a standard for the products and their foundations when subjected to impact and can be tailored depending on the risk architects are looking to protect against. For example, a correctly specified, single piece of furniture can stop a 7.5-tonne articulated lorry travelling at 50mph.

In addition to the PAS 68 BSI test standard, the Centre for the Protection of National Infrastructure (CPNI) expects that all security designed to protect against vehicle attacks comply with the International Workshop Agreement (IWA) rating. This ensures that each model is standardised, no matter where they are built and installed in the world, to keep the specification process as simple as possible.

These products are used most effectively as the final line of defence, but the planning and designing of security products into a new or existing space

should not come last on the list of priorities. It should be considered at the outset of a project with the goal of reducing risk. This can be done by integrating restricted width lanes, chicanes and water features into the road infrastructure to reduce vehicle speed and at-risk areas with high footfall.

Delivering an aesthetic HVM project

This approach was adopted for a new 5,000-capacity sports facility in Ravenscraig near Glasgow, which was developed to be used as a venue for the 2014 Commonwealth Games and training base during the London 2012 Olympics.

Its planned use for future sporting events, such as the Olympic affiliated ‘International Children’s Games’ in 2021, meant that security was a key issue when it came to designing the facility. As part of the risk assessment, the planners and architects decided that given the potential for large crowds outside the venue and local

road infrastructure, measures were required that could withstand an impact of a 2.5-tonne vehicle travelling at 40mph. The architects specified 28 bollards for installation around the front of the site, protecting major pedestrian access points. Lifting bollards were also placed on the road network around the centre to restrict vehicle access on a temporary basis when an event is on.

The rising threat from hostile vehicle attacks means we can expect architects to place greater priority on security when it comes to designing and specifying new urban spaces, particularly those with high footfall. Rather than erecting concrete barriers or steel barricades to protect the public, this approach will play a key role in ensuring people are safe but not scared, providing the protection that the public need, while making sure security measures don’t impact on the appearance and feel of a landscape.



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The future of copyright law in Europe

Daniel Dalton MEP of the European Conservatives and Reformists Group shares his thoughts on the key issues on the future of copyright law in Europe

The future of copyright law in Europe will be decided in negotiations this Autumn, although after more than two years of intense and at times controversial negotiations, no one can be confident of a smooth path to a final agreement when national governments and the European Parliament sit down for talks.

The Commission's copyright proposals have, unusually for a piece of fairly dry legislation, attracted so much attention because they are that rare thing, when a law that will actually dramatically change the lives of ordinary citizens.

At the core of the copyright proposal are two radical changes to copyright practice in Europe. Firstly, it places a new general obligation on internet platforms and websites to pre-monitor user content on their website for copyright infringements, secondly, it creates an entirely new ancillary right for news publishers, in addition to the traditional copyright of individual authors. Both of these changes are well-intentioned as

they aim to try to strengthen the position of creators, but crucially they fail to recognise the impact of the digital revolution on society and risk severely damaging both European consumer interests and the continent's small businesses.

The Commission's proposal to make platforms and websites obligated to pre-monitor all content posted by users for copyright infringements, regardless of whether the rights holder has indicated a desire to prevent the use of their work, represents a paradigm shift to established copyright practice.

Until the 2016 proposal copyright law, which has existed in various forms for 300 years, it has always been based on the principle that it is the responsibility of the copyright holder to enforce their own copyright.

Now however, the Commission would like to make websites of all shapes and sizes responsible for enforcing copyright, which is a substantial shift from the present and historical situation where rightsholders communi-

cate with sites about infringements they wish to be removed from the internet.

This dramatic change in liability would force websites to take a safety-first approach, inevitably leading to content that potentially doesn't infringe copyright being taken down. Similar to recent arguments about controversial Twitter users, the new copyright arrangements would leave websites as both judge and jury over millions of users' content and freedom of speech.

Critically, only once content had been removed would users have the opportunity to appeal that decision, which is a huge new challenge to freedom of expression in the 21st century but with troubling implications for online creativity.

The publisher's right is the other key controversial plank to the Commission proposal and appears to be based on the idea that if you make it harder for people to read news online, then they will start buying more newspapers, a utopian fantasy that ignores the reality of news in the internet age. Unamended, the legislation could block anyone from posting a snippet of an online article, or even a link to the article, on any other website or social media platform unless that site has already negotiated a licence with the media organisation.

This approach has in fact already been tested and proven a dismal failure, in both Germany and Spain in the last five years. In Germany, media organisations could choose to opt-out of the ancillary right and hundreds did. In Spain, which had a mandatory regime, the effects were notably harmful to small Spanish publishers and news aggregators, with a sharp decline in traffic and some folding, leaving consumers with less easy access to online news.

Despite the evidence from Spain, the Commission chose to adopt the mandatory approach. This route also risks making the problem of fake news worse. The distribution of links to real news events will be blocked by publishers while fake news, for which no licences would be required, will be able to circulate freely as potentially the predominant source of news on social media platforms.

What the proposals fail to grasp is that an entire generation of young people have grown up consuming news in one way – online via multiple website and new aggregators – and their ability to inform themselves on world events would be decimated by the mandatory ancillary right, to society's cost.

If wider society is to be collateral damaged to the ancillary right, it would at least be good to understand what precisely the problem the right is trying to address is, as to many experts it appears non-existent. The fact is that sharing links to articles on other websites pushes traffic directly to the publisher's website and acts as free advertising for the article. Social media acts as a speed dial to many news organisations, generating vast visitor numbers. If they do not wish to monetise that traffic with advertising, a publisher is already free to block access to the article through a paywall.

The ancillary right and the general monitoring obligation are two paradigm shifts to European copyright law, but they are far from the only controversial elements being debated – with text and data mining provisions, in particular, uniting the scientific community in opposition.

The core problem is a common theme with this Commission's digital legislation, it is attempting to squash the internet into a framework that cannot possibly fit a mass user age. So, the final agreement on the copyright legislation needs to avoid slaying paper tigers and focus on pragmatic solutions to rights holders' concerns, without harming the interests of the wider world and upending 300 years of copyright legislation in one fell swoop. ■

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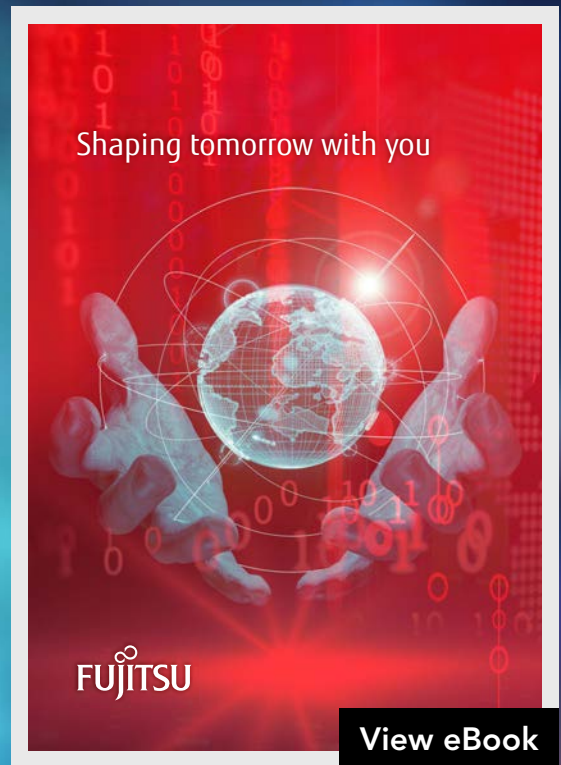
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The Fujitsu logo is positioned in the bottom left corner of the page. It features the word "FUJITSU" in a white, serif font, with a stylized infinity symbol above the letter "J". The background of the entire page is a vibrant, abstract digital landscape with a color gradient from red at the top to blue at the bottom. It is filled with glowing binary code (0s and 1s), a green 3D bar chart with a line graph, and various geometric shapes and light effects that create a sense of depth and movement.

FUJITSU



Shaping tomorrow with you

Andrew Cowling at Fujitsu Scanners explains how local government can benefit from document management technology, as well as his thoughts on GDPR-compliance.

How independent software vendors can help drive the dream of digital transformation

Andrew Cowling, Channel Marketing Services at Fujitsu Scanners explains how independent software vendors can help drive digital transformation

Digitalisation is not a new subject; it's an area of key importance for businesses looking to improve profitability through digital transformation, which itself has become a hot topic over the last few years. The driver is to improve efficiency in the workplace through technology and enable the adoption of cloud-based systems that employ exciting new technologies such as automation and artificial intelligence (AI). The goal is greater efficiency and it can also enable worldwide connectivity and the possibility of entering new markets, all of which will ultimately help improve the bottom line and ensure business growth in today's (and tomorrow's) increasingly competitive global marketplace.

Growing customer expectations and stricter regulations

Organisations are not only adopting these new technologies to increase the efficiency of internal processes and maximise profits: they are also bowing to growing customer expectations and stricter compliance regulations. Now that everyone uses a variety of mobile and fixed-location devices, customers expect to see everything they need in a convenient manner on any screen, wherever they happen to be, and providers must adapt accordingly.

This has impacted the Channel, as everyone wants to be the go-to solu-

tion provider capable of successfully supporting customers throughout his or her digitisation journey. Competition is high, but one way that Channel partners can offer benefits through consulting with their clients to understand the challenges they face and then creating a plan to implement a holistic solution that is specifically tailored to their needs.

“As technology develops, hardware vendors such as PFU can support ISVs by creating software development kits (SDKs) to enable the implementation with their hardware, allowing ISV's to develop and programme software specifically for that product and improving the overall technology offering for customers.”

Specialist technology solutions

In addition to offering a sales channel for many different technologies, Independent Software Vendors (ISVs) can differentiate by developing their own specialist solutions. Although most are usually subject matter experts in one particular technology area, ISVs can increase their chances of gaining market share if they align their own solutions with other vendor offerings so that compatibility and integration are straightforward.

If a whole solution can then easily integrate with an enterprise customer's existing enterprise resource planning (ERP), then the ISV is able to support

its digital transformation. Another example is the bring your own device (BYOD) trend, where customer-facing technology must be safe for use and compatible on all devices. If ISVs can enable BYOD and its benefits within a solution, then they can enable an enterprise customer to deliver on another key part of their digital dream.

The challenge of the digital journey for companies

The digital journey can be challenging, and some companies face barriers as they approach this change. As not all businesses are large enterprises with in-house technology experts, there can be a knowledge gap in understanding and choosing the best technology to implement, or how to implement those technologies into the business.

Resistance to change is a barrier in itself and may take various forms, including the fear of replacing existing and comfortable processes with a new technology full of unknowns and learning curves. There is also the strong and understandable desire to sweat all existing assets to ensure return on Investment (ROI) is maximised. Third party partners need to approach these situations and empower smaller business through informing, consulting and gaining a true understanding of the business. Only at this point can they then advise on a suitable technology transformation programme.



The benefits of implementing new technologies

When faced with resistance to change and wariness of implementing new technologies, ISV's counterposition should be to cite customer success stories, which prove their track record for providing solutions to similarly sized companies in the same situation. User reference sites illustrating technology adoption are crucial and need to demonstrate ongoing user support, customer service and training.

ISVs are playing an increasingly important market role and their position will continue to develop into enablers of technology and the go-to suppliers in bridging the gap between owned technology offerings, technology vendors' solutions and their customers' needs.

The digital technology of the future

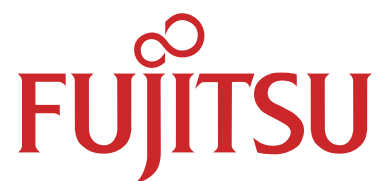
As digitisation progresses and the workplace becomes a more secure environment for productive digital work, employees will be able to

exchange information, host data and approve or sign critical documents and more. Future AI and automated processes will be able to analyse and extract information from business documents. It's an exciting prospect, but for this to be possible, paperwork must be in digital format. ISV's can support enterprises as they progress along this digitalisation path by learning about how to successfully implement efficient imaging solutions that enable employees to share, edit and manage hard copy documents in a digital format.

“Now that everyone uses a variety of mobile and fixed-location devices, customers expect to see everything they need in a convenient manner on any screen, wherever they happen to be, and providers must adapt accordingly.”

As technology develops, hardware vendors such as PFU can support ISVs by creating software development kits (SDKs) to enable the implementation

with their hardware, allowing ISV's to develop and programme software specifically for that product and improving the overall technology offering for customers. In turn, this will build and help to cement customer satisfaction and loyalty – which is what it is all about at the end of the day.



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Building a digital future for all in Europe

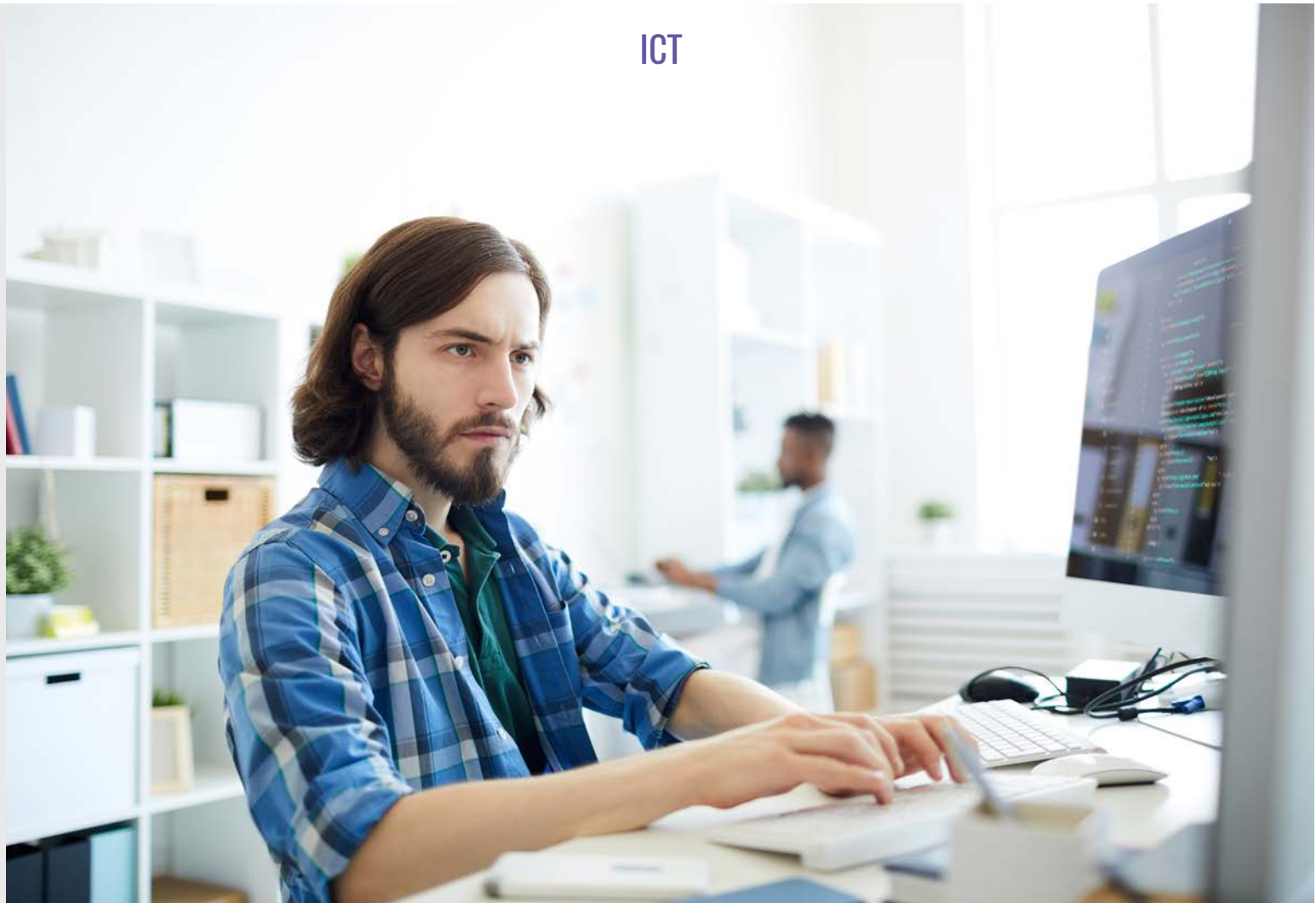
Mariya Gabriel, European Commissioner for Digital Economy and Society explains how building a digital future for all in Europe can be achieved

In Europe, we believe that the future is digital. In 2015, the European Commission launched the [Digital Single Market strategy](#), making digital technology and digitisation one of the key priorities of the political agenda. Since then, we have seen nearly 60 initiatives delivered, including 29 legislative proposals from which 17 have already been agreed in the European Parliament and the Council of the European Union.

More importantly, some of the implemented rules are already showing positive tangible effects on the lives of our citizens. One of the greatest successes of Europe's digital agenda has been to put an end to roaming charges. Since last year, citizens can commu-

nicate via their mobile phones and devices wherever they are in the EU, without being obliged to pay additional and often disproportionately high tariffs. Other good news is the portability of digitally subscribed content. Since April 2018, our citizens can watch their favourite TV series or listen to their preferred music they have subscribed to at home while travelling across the EU.

There is still more to come, with other proposals and plans being adopted. The Commission has recently finalised the negotiations with the European Parliament and the Council of the European Union on other important reforms, including regulatory frameworks on electronic communication, audio-visual media



services and the free flow of non-personal data. On the 5G telecommunication system and network, we have set the target to make this coverage available across Europe by 2025.

Whilst the Digital Single Market legislative work has been rolling out and delivering, we at the same time see the crucial need for our citizens to have the skills that match and fit the inevitable digital transformation of Europe. This ranges from basic online competencies, such as accessing communication services and managing personal online administration, to advanced programming and technical expertise. Digital skills are today as fundamental as reading and writing – they have become a means of citizen empowerment and work advancement.

The digital transformation is also having a major impact on industries and the labour market as we see its implementation across sectors – from agriculture and transportation to healthcare and education. In fact, today, 90% of jobs require some level of digital competencies. Local and national companies, as well

as international corporations, are increasingly seeking IT skilled workers, including highly-skilled information and communication technology (ICT) experts, who have the ability to rethink and innovate the companies' products and services.

“With a digital future in perspective, it is my mission as the Commissioner for Digital Economy and Society to ensure that all Europeans – regardless of gender, age, nationality and socio-economic circumstances – can enjoy the possibilities and benefits of digital technology through well-targeted EU policies, focused initiatives and appropriate investment.”

However, 40% of businesses looking for ICT specialists have difficulties in finding the right candidates. There are currently more than 400,000 open vacancies for ICT specialists in Europe. To close this gap, the Commission put digital skills among the ten priority actions of the new “Skills Agenda for Europe” launched in June 2016. Named “Digital Skills and Jobs Coalition”, this plan commits private and public organisations as well as education providers to offer more short-term and

long-term ICT training schemes, develop digital jobs placement programmes and motivate young people to pursue ICT related careers. The Coalition currently counts over 390 members and 102 pledges to boost digital skills and provided over 7.5 million digital skills training, greatly exceeding our initial target of 1 million.

Focusing specifically on equipping the young generation with digital competence, the Commission also launched the [Digital Education Action Plan](#) in January 2018. With this programme, we want to help education systems by adapting to the digital age and integrating digital technologies in teaching methods, thereby increasing digital competencies among students. Using digital tools in teaching also enables young Europeans – often enthusiastic users of the web, apps and online games – to be aware of the underlying structures and algorithms behind technology.

“The digital transformation is also having a major impact on industries and the labour market as we see its implementation across sectors – from agriculture and transportation to healthcare and education. In fact, today, 90% of jobs require some level of digital competencies.”

We need to help our future generation to become active digital creators and innovators. That is why the Commission launched the Digital Opportunity traineeship initiative, which facilitates cross-border traineeships in digital areas for 6,000 students and recent graduates between 2018 and 2020. I would also like to see greater participation of schools in initiatives such as the [EU Code Week](#), promoting computational thinking, coding and tech-related activities. With last year’s record participation of 1.2 million people in more than 50 countries, I hope that by 2020, 50% of schools across Europe will be joining in.

But policies and initiatives alone cannot ensure a successful and smooth digital transition of Europe.

This also requires a sustained and solid support of concrete investment programmes. And this is why the Commission in May 2018 proposed to create the first ever Digital Europe programme and thereby invest €9.2 billion between 2021 and 2027 into Europe’s key strategic capacities. These capacities include super-computing, artificial intelligence (AI), cybersecurity and advanced digital skills, as well as increasing the accessibility of digital technologies to the private and public sectors. This long-term budget proposal reflects our commitment to Europe’s digital success.

With a digital future in perspective, it is my mission as the Commissioner for Digital Economy and Society to ensure that all Europeans – regardless of gender, age, nationality and socio-economic circumstances – can enjoy the possibilities and benefits of digital technology through well-targeted EU policies, focused initiatives and appropriate investment. ■

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The future of the digital world in Europe

Andrus Ansip, Vice-President of the EC in charge of Digital Single Market shares his thoughts and concerns about the future of the ever-changing digital world in Europe

During a speech in late June this year by Vice-President Ansip at the European Trade Union Confederation conference, he discussed how prevalent digital has become in our everyday lives. The picture he paints of today's digital world is one where smartphones, mobile internet and online shopping are commonplace. Add to this, artificial intelligence (AI) services and the storage of your documents in a personal cloud. You can have all of these in your pocket, use them on the go on your way to work or as a way to get to work. Ansip then says that just as people get used to one new technology, a brand new and faster one comes along. He goes on to explain this point and the concern around it in his own words.

"But many others feel frightened, a little out of control, afraid that humans will be overtaken. In Europe, opinion polls show that 70% of people worry that a robot will take their job. Some even fear mass unemployment because of a looming robotics revolution. These concerns are completely understandable. We cannot – and should not – ignore them. But it is inevitable that some jobs will change. Some will also disappear. However, I do not believe in the mass unemployment scenario."

Ansip then shares his belief that the scenario for the future in this vein is one of innovation, adaptation and new skills. He also believes that future-oriented technologies can support global efforts to reduce greenhouse gas emissions. One example he cites is that agriculture today is at the forefront of technological change and uses of data, artificial intelligence (AI) and the Internet of Things (IoT).

As this article comes to a close, let's focus on the theme of employment. Ansip explains in spite of the many studies around employment, he does not think that anybody really knows how much digital change will affect jobs in the future. He shares an interesting



Image: © European Union 2018. Mauro Bottaro

Andrus Ansip, Vice-President of the European Commission in charge of Digital Single Market

thought about just how robots could actually be of benefit to us in the future, in terms of assisting us with arduous tasks.

"It is sometimes easy to forget that by helping with repetitive, unpleasant or dangerous tasks at home and at work, robots improve daily life. They allow workers to carry out better and more rewarding activities. Surely that is a plus, not a minus... A high number of factory robots does not necessarily mean high unemployment. Germany, Sweden and Denmark are in the world's top six countries with the highest robot densities in manufacturing, according to the International Federation of Robotics." ■

These fascinating areas and more are discussed deeper in a speech by Vice-President Ansip at the European Trade Union Confederation conference: "[The World\(s\) of Work in Transition](#)" on 28 June 2018.

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Cybersecurity monitoring: A critical concern

Alysson Bessani, LaSIGE – Faculdade de Ciências at Universidade de Lisboa, details the importance and limitation of current cybersecurity systems

Cybersecurity has become a critical concern for most organisations due to the potential losses caused by successful attacks and the emergence of regulations such as GDPR. Organisations currently monitor and manage the security of their IT infrastructures by setting up security operation centres (SOC) to answer questions such as, “Is there an intrusion in the organisation?”, “which system is under attack?”, “what has been compromised?” and “where has an access breach occurred?”.

SOCs rely on security information and event management (SIEM) systems to have an integrated view of the monitored infrastructure. SIEMs collect logs and security-related events from multiple sources through the organisation, normalise and correlate them and produce alerts, summarised measurements, data trends and different types of visualisations for the SOC team. The complexity of SIEMs comes from their nature and the functionality they provide, which requires their integration with a large number of diverse devices that produce thousands of events per second that need to be promptly processed. Such complexity translates in high deployment and operational costs for SIEMs.

According to Gartner, the SIEM market is expected to reach \$6 billion in 2021. There are many high-quality products from large IT vendors, such as IBM



QRadar and Splunk. Despite their widespread use and the impressive market growth, current SIEM systems still have many limitations:

1. The threat intelligence capacity of SIEMs is still in its infancy. Consequently, existing SIEMs are unable to automatically recognise new threats that may affect (whole, or parts of) the monitored infrastructure, requiring considerable human intervention to react to changes in the threat landscape. This happens despite the availability of rich and up-to-date security-related information sources on the internet (e.g., social media, blogs, security newsfeeds), which current SIEMs don't use.

2. Existing systems can show any “low-level” data related with the received events but have little “intelligence” to process this data and extract high-level information. These low-level data (e.g., number of failed logins in a server) are only meaningful to security experts and hard to translate to high-level metrics for C-level managers, who are responsible for making decisions on security expenditure but usually are not well versed in such technical details. This impacts the capacity of SOC teams to justify the return of investment in security for its organisation.

3. Most data visualisation techniques in current SIEMs are rudimentary. This can severely impact the ability of the

SOCs to react to incidents as and when they happen.

4. The event correlation capabilities of SIEMs are as good as the quality of the events fed to it. Imprecise and contradictory events generated by imperfect monitoring devices will be taken as correct by the SIEM and the uncertainties associated with these events are never communicated.

“Cybersecurity has become a critical concern for most organisations due to the potential losses caused by successful attacks and the emergence of regulations such as GDPR.”

5. Due to storage and event processing constraints, SIEMs are incapable of retaining the collected events for a long duration. This limits their use in conducting cybersecurity-related forensic investigations in the long run.

The **Diversity-enhanced SIEM (DiSIEM)** H2020 project aims to address these limitations by enhancing SIEMs with a set of components for acquiring information from diverse data sources, feeding enhanced events to the SIEM and generating better reports and metrics to support SOCs.

Instead of proposing new SIEM architectures, the project addresses the above limitations by extending current systems in production, leveraging their built-in capacity for extension and customisation. The objective is to improve SIEMs with several diversity mechanisms, organised in five main contributions:

1. Integrate diverse OSINT (open source intelligence) data sources available on the web to SIEMs. Examples of such sources are NIST’s National Vulnerability Database, vulnerability and

patch databases offered by vendors, threat intelligence data that organisations share with each other (e.g., internet addresses blacklists, URLs and files reputation databases, malware domains lists), security blogs and social networks (e.g., Twitter); collaborative platforms used in the Dark Web (e.g., Pastebin), standards-based Indicators of Compromise platforms (e.g., MISP and OpenIOC), among others. This data needs to be fetched and automatically processed (e.g., by using machine learning methods) to identify new relationships, trends, indicators and anomalies and hence to help to react to new vulnerabilities or even predict possible emerging threats against the monitored infrastructure.

2. Develop probabilistic security models and multi-level risk-based metrics to help security analysts to decide which infrastructure configurations offer better security guarantees. This will increase the capacity of SOCs to communicate the status of the organisation to C-level managers and to justify cybersecurity budgets.

3. Design visualisation methods to analyse the collected data, for better supporting the extraction of high-level security insight from the data by the security analysts working with the SIEM. In particular, the project is developing new User Behaviour Analysis (UBA) tools to better understand the human actions rendering the organisation vulnerable to malicious actors.

4. Integrate diverse, redundant and enhanced monitoring capabilities into the SIEM ecosystem. For instance, the project is building enhanced sensors composed by different intrusion detection systems to monitor the same asset. The objective is to have a

much higher confidence sensor by voting on the alarms generated by such systems. Likewise, the project is devising new anomaly detectors to improve SIEM’s visibility of business-critical applications.

5. Add support for long-term secure archival of events in new cloud-of-clouds storage services being developed in the project, i.e., [Vawlt](#). The events are encrypted and spread to multiple diverse clouds, ensuring any sensitive information is securely stored.

These contributions are being materialised through a set of components, that are currently being tested in three real SOCs, integrated into their SIEMs. More information about the project can be obtained from the website: <http://disiem-project.eu>

DiSIEM is supported by the European Commission through the H2020 programme under grant agreement 700692. The project consortium is composed by seven partners: FCIências.ID, City University of London, EDP, Amadeus, DigitalIMR, Fraunhofer IAIS, ATOS.



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Addressing modern slavery through building supply chain resilience

Howard Kerr, Chief Executive, BSI shares his views on addressing modern slavery through building supply chain resilience

Clothing, household goods, hand car washes and food retailers have made the headlines recently regarding the working conditions and rights of workers in their supply chain. This is a global issue and pressure is being exercised through lobbying, human rights advocates and ethical trading initiatives to improve international labour conditions and prevent such headlines as 'Corporate leaders must do more to stop modern slavery'.

The fact such headlines are considered newsworthy shows how human trafficking and slavery has changed, sliding beneath the notice of many individuals and organisations. Modern slavery is less about people owning other people but more about people being exploited and controlled. U.S. Government agencies describe [modern slavery and human trafficking](#) as umbrella terms for both trafficking and compelled labour by recruiting, harbouring, transporting, providing or obtaining a person through the use of force, fraud, or coercion.

The sheer scale of modern slavery is daunting: according to the International Labour Organisation (ILO) there are 21 million people globally trapped in some form of forced labour, whereas The Walk Free Foundation's Global Slavery Index, has estimated 45.8 million people are in some form of modern slavery in 167 countries. In the UK alone, an estimated 13,000 people are working as slaves across a variety of sectors. The UN considers modern slavery and trafficking the second-largest criminal industry in the world.

Slavery in the supply chain

Today we transport, source, manufacture, procure and retail products from all corners of the world where

our procurement systems need to manage logistics, quality, product safety and traceability with behaviour issues associated with security, workplace conditions, slavery, counterfeiting, ethics and environment. As a consequence, one of the key concerns of CEOs and policymakers is the resilience of supply chain policies and procedures and the risk and reputational consequences of disruption.

Government legislation hopes to increase the transparency and in turn, test the resilience, of supply chains by pushing forced labour up the corporate agenda. In May 2018, security ministers from the Group of Seven (G7) countries, in Toronto, agreed to coordinate a series of efforts to combat modern slavery across the globe. In the UK, the Modern Slavery Act, introduced in 2015, contains a corporate reporting requirement aimed at increasing transparency around modern slavery and human trafficking in the operations and supply chains of large companies. The Act requires that any business or part of a business, with a global turnover of £36 million or more supplying goods or services in the UK, must publish an annual slavery and trafficking statement disclosing what steps have been taken to ensure there is no slavery in any part of its business and supply chain. Businesses now have a legal obligation, as well as powerful moral and commercial drivers, to manage supply chain risk effectively with the ramifications widespread, impacting many countries and not just the UK.

Controlling every link in the supply chain presents enormous challenges and senior business leaders often see the risk of modern slavery as something that is out of their direct control; entailing their global supply chains and involvement with business partners.



This is a global issue with enforceable regulations such as The California Transparency in Supply Chains Act and the UK Act increasing the urgency for establishing sound practices to support public disclosure requirements on the subject.

Supply chain resilience and transparency – the role of policymakers

In order to confront and eliminate human trafficking and modern slavery, we need a way to measure the extent and details of the issue on a global basis. Not surprisingly, research has shown that supply chain management is more challenging for larger organisations. And the more complex the organisation, the more important it is to monitor the supply chain. Policymakers and CEOs alike need to tap into the wealth of information available from the [Trafficking in Persons Report \(TIP\)](#) from the U.S. Government to BSI's [Trafficking and Supply Chain Slavery Patterns Index](#).

The visibility of such data can encourage firms to push beyond their first level of connections and delve deeper to obtain a thorough insight into the people and systems that they and their suppliers employ. A well-designed due diligence programme will consist of:

- Policies and procedures that clearly define organisational requirements and work instructions;

- Systematic means to communicate throughout the organisation and stakeholder network;
- A means to develop and strengthen the necessary skills of practitioners and suppliers;
- A system to measure compliance, impact and progress towards goals and;
- A well-governed management system which means involvement and enforcement on the part of leadership and an integration between risk management practices and commercial/operational decisions.

In supporting progressive organisations to embed a culture of resilience across their supply chains, senior leaders can help to address not only the 20 million trapped in modern slavery, but also generate significant reputational and commercial benefits for the businesses they oversee; ultimately making their organisations more socially responsible and resilient. ■

Howard Kerr
Chief Executive

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Breaking barriers: The journey to digitally transforming public services

Shawn Kingsberry, VP, Digital Government and Citizen Services at Unisys charts the journey to digitally transforming public services

In today's technology-driven world, there is a lot of discussion as to how the public sector can deliver their services at scale by implementing new technologies and digitally transforming their operations.

In fact, CIOs in the government and public sector ranked digital transformation as their most important priority, according to [Gartner's 2018 CIO survey research](#) published earlier this year, which interestingly was a higher-level priority than private company CIOs.

As a result, public sector organisations are now realising the benefits of digital transformation and are increasingly using digital devices, analytics, automation and new infrastructures to achieve benefits such as faster response time, improved customer experience and more complete situational awareness.

However, as public sector organisations rush to digitally transform, there could well be a number of overlooked issues that need addressing beforehand.

Technology is not the silver bullet

Additionally, in Gartner's 2018 CIO Survey, CIOs believe that corporate culture is the biggest barrier to digital transformation. Furthermore, from my experience, many cite that such digital transformation projects are a failure due to a lack of executive support.

When applying such findings to public sector organisations, it is clear that technology is not the miracle solution that will solve problems and increase efficiency solely, rather it acts as an enabler for doing so.

Often in public sector organisations, there are technologies and practices that have been implemented for over 15 years, with the employees set in certain ways of working. As a result, public sector organisations first

of all need to address their organisational culture in order to facilitate change.

One such way of doing so is by building a [culture of constant change and innovation](#). Effectively, this notion states that change simply does not happen overnight – rather, there needs to be a continual momentum that is built in the public sector organisation that reflects the new reality of the world in which they operate in.

Such organisations cannot expect, upon implementing digital transformation strategies, to reap rewards immediately – changes need to be executed over time, with a degree of persistence and patience with a series of 'small wins', to build confidence and momentum. Therefore, technology is the vital enabler, but only if management is committed to change.

The customer is king

Many public sector and government organisations have traditionally adopted an analogue approach when delivering services. For instance, across many such organisations, data and knowledge are siloed to individual departments, which results in less efficient operations.

This process and approach is no longer current, it is time for organisations to think digitally.

Consumers want and expect 'anytime anywhere delivery of service', enabling them to interact with public sector services in the same way as consumer goods applications, such as Netflix.

There has, however, been progress in moving towards a digital approach. Take the government's [Verify](#) identity assurance scheme for instance, though there has been reported teething problems, the incentive and



purpose are valiant, to ensure citizens have a safer, quicker and easier to access government services, such as submitting tax returns or checking the information on your driving licence.

“Many public sector and government organisations have traditionally adopted an analogue approach when delivering services. For instance, across many such organisations, data and knowledge is siloed to individual departments, which results in less efficient operations. This process and approach is no longer current, it’s time for organisations to think digitally.”

As noted before, change takes time and Rome certainly wasn’t built in a day – as Nic Harrison, Government Digital Service (GDS) Director of Service Design and Assurance, notes when addressing criticisms of Verify, he called for patience over the scheme’s slow take-up, arguing similar schemes in other countries have taken up to six years to gain traction.

Such schemes are also widely accepted by the public too – our recent survey of more than 3,500 Europeans

which investigated consumer opinions on federated identity, revealed more than half would be open to adopting a federated identification system, with a single log-in, to improve the speed to service. These findings indicate there is a willingness of the public to share information with government departments.

Whilst the journey to implementing a digital model for public and government organisations may be long and arduous, it is one that must be taken, which stands to benefit not only the consumer but the organisations themselves. ■

Shawn Kingsberry
VP, Digital Government and Citizen Services

Unisys

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Countering the rising cybersecurity threat

An investigation by security researchers⁽¹⁾ reveals that at least one in four UK councils have been hit by cybersecurity breaches resulting in the loss of data over the past five years. Sungard Availability Services looks at this growing problem and how to mitigate the risks

Between 2013 and 2017, there were more than 98 million cyberattacks on councils, which store data relating to millions of residents. Last year alone, councils were hit by over 19 million cyberattacks, many of which involved viruses and other malicious software or 'phishing' activity. Local authorities are among the bodies most commonly featuring in fake emails designed to trick citizens into believing they come from a trusted source so that they hand over passwords, credit card details and other personal data.

Cyberattacks are a growing problem for both the public and private sector. With business transacted over the internet worth an estimated \$966.2 billion – equivalent to 6% of GDP in 2014⁽²⁾ – no organisation today can afford not to be connected. This is especially true for businesses in the UK, whose economy is the most internet-dependent, accounting for 10% of GDP.⁽³⁾

However, as with the public sector, being connected brings risks and almost half of all UK businesses identified at least one cybersecurity breach or attack last year.⁽⁴⁾ Household names that have hit the headlines for all the wrong reasons in 2018 include Adidas, Dixons Carphone and Ticketmaster.

According to the [Sungard Availability Services-sponsored BCI Cyber Resilience Report 2018](#), this is a challenge that is likely to grow even bigger in years to come due to a higher adoption of Internet of Things (IoT) technologies, government-sponsored cyberattacks and cryptocurrencies.

“Sungard AS has developed a five-step plan to help public and private sector organisations build their cyber resilience.”

Dr Sandra Bell, Head of Resilience Consultancy EMEA for Sungard AS, notes: *“Since the publication of the first BCI Cyber Resilience Report three years ago, we have seen cyber threats and the havoc they can cause, transition from being an interesting subject within the specialist technical press, to headlining the business pages of the broadsheets. Organisations are now not just suffering localised operational disruptions due to the corruption or lack of business data, but they are experiencing highly public, severe financial and reputational impacts at a scale and scope that threaten their very existence.”*

Some 574 respondents in 77 countries were surveyed for the authoritative BCI report, which found that two-thirds of respondents had suffered at least one cyber disruption over the past 12 months.

The top five causes of an incident were:

1. Phishing, spear phishing and social engineering (72%);
2. Malware (54%);
3. Ransomware (31%);
4. DoS/DDoS (28%) and;
5. Out of date software (26%).

The main effects of a cybersecurity incident were:

1. IT and telecom outages (36%);
2. Reputational damage (18%);
3. Profits hit (11%);
4. Supply chain disruption (9%) and;
5. Physical security concerns (8%).

However, a cyberattack differs from many of the disruptive threats and hazards that organisations face in one significant way. Unlike a flood, fire or power failure, a cyberattack is a 'risk with an adversary'. This means they need to be agile, flexible and strategic in their response and executives ready and able to lead their organisations through the complex and uncertain situations that a cyber-attack can cause.

The executive team needs to be intimately involved in the preparation and planning to ensure that the whole organisation is able and ready to adapt their response as and when necessary.

Encouragingly in this respect, the report reveals more than half of organisations enjoy commitment from those at the top, as well as a greater involvement outside the IT department. These findings reflect Sungard AS' own experience in that its experts are increasingly being brought into the boardroom to coach the cabinet in crisis leadership and prepare the whole authority to respond to cyberattacks.

Fighting back

The good news is there are measures organisations can take to counter the cybersecurity threat. Dr Bell elaborates: "To counter such a threat an organisation needs to bring many forces to bear. Technical information security, such as firewalls, anti-virus and DDoS protection, together with good IT system housekeeping, regular patching and user awareness training, provides an excellent foundation that will almost certainly reduce a council's vulnerability. Likewise, a strong disaster recovery and business continuity stance will ensure, that should defences be breached, the organisation is ready and able to continue critical business processes."

With the UK government working to make public services digital by default as part of its transformation strategy and the unveiling of the newly-announced Digital Pledge ⁽⁵⁾, this has never been more important. Sungard AS has developed a five-step plan to help public and private sector organisations build their cyber resilience:

1. Identify your risks – not just your vulnerabilities – Likewise, consider your **people, processes and culture** – not just your IT systems. Once you've assessed your risks and

know what you're up against, develop a cyber resilience roadmap, so you know what you need to do to succeed and how to get there.

Things to think about: Cyber risk assessment and cyber resilience roadmap.

2. Create a robust yet agile IT infrastructure – This will reduce the chance of an attack but, more importantly, ensure you're in the best possible shape to respond when it does.

Things to think about: ICT transformation & service continuity, information security consulting, business continuity consulting and disaster recovery.

3. Develop contingency plans and capability to meet operational targets despite inaccessible or corrupted data. This should include ensuring cabinet members have the crisis leadership skills and competencies that are so often needed following a cyber incident.

Things to think about: Masterclasses, executive coaching and cyber scenario exercises.

4. Build a cyber resilience culture – Cyber resilience is a complex problem and can only be solved by a variety of approaches. Likewise, threat awareness measures are consistently shown to be more effective than technological security controls. ⁽⁶⁾ Therefore, a culture that takes account of the sociotechnical aspects of security is needed.

Things to think about: Culture change, coaching, training & awareness.

5. Practise so you can think on your feet – Exercise regularly so you're prepared to adapt your response in real-time because your attackers will adapt their strategy in response to your defensive moves.

Things to think about: Crisis scenario exercises

To discuss how Sungard AS' resilience consultants can help your organisation build its cyber resilience, call: +44 (0)800 143 413 or email: government@sungardas.com

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Increasing productivity through online collaboration

Jason Fahy, CEO, Knowledge Hub explains how organisations are increasing productivity through collaboration

For public sector professionals, Knowledge Hub is the place to go to collaborate online.

For some, 'collaboration' might seem a tad soft or lacking in focus and a more social than professional activity. This isn't so for the Knowledge Hub community, where collaboration is synonymous with increased productivity. Whether sourcing content for research, seeking a rapid answer to a local challenge that is likely to already have been solved elsewhere, or crowdsourcing input to service redesign, the result is increased productivity.

"We talk about our desire to make a difference as a business and it feels as if we can now achieve this on a global level by increasing the productivity of 100 RC member cities through collaboration."

One recent example is the collaborative approach taken by Scottish local authorities who came together to collectively respond to the GDPR regulations that recently came into force. Their shared approach to this common challenge was facilitated by the Digital Office for Scottish Local Government whose Readiness Project helped to remove duplication and save more than £1 million. Knowledge Hub was used by 30 of the 32 Scottish local authorities participating in the Readiness Project to share challenges and find collective solutions to implement-



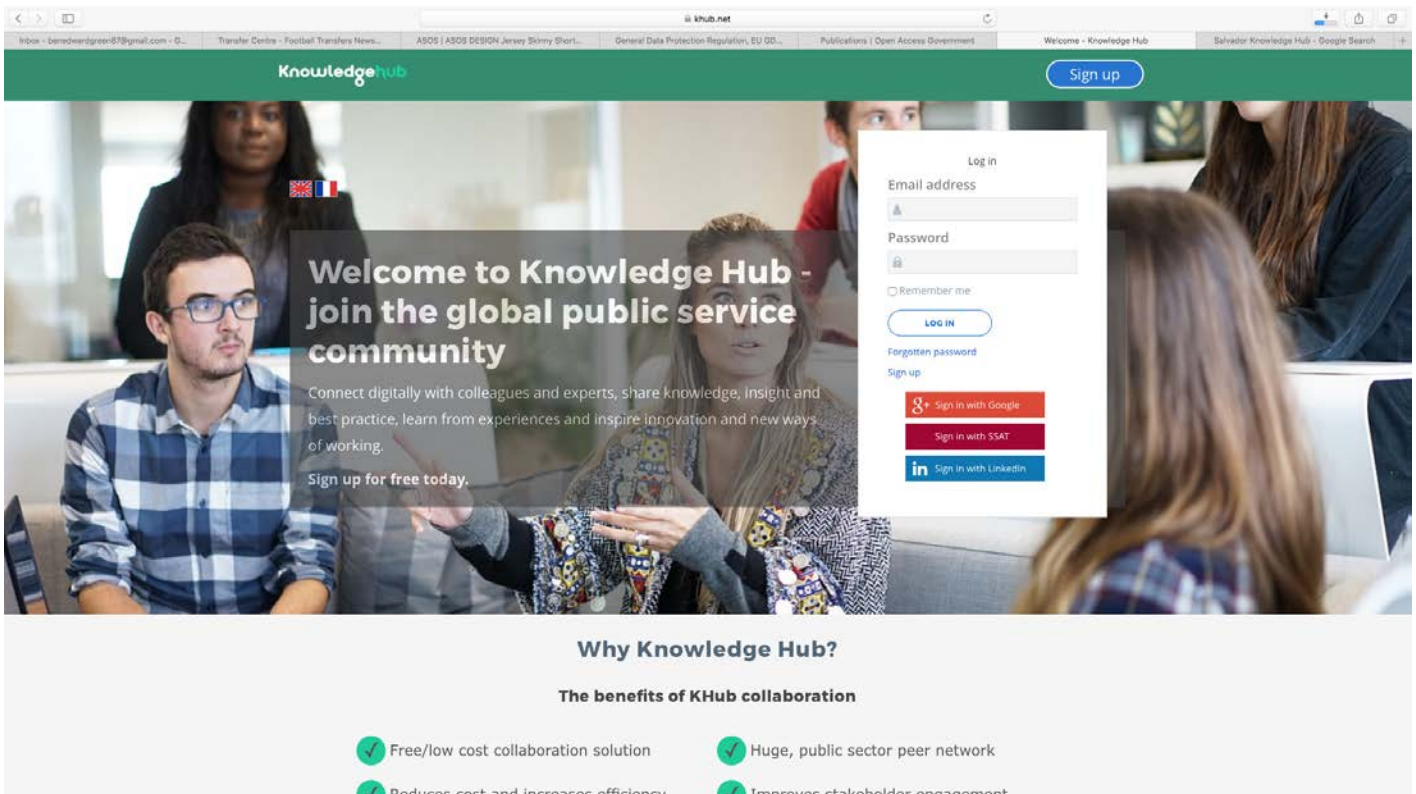
ing GDPR. The Digital Office reported that this helped to sizably reduce any duplication of effort and ensure a consistent approach between the 30 councils in the Local Government Digital Partnership.

The need to stretch limited public service resources is adding momentum to the growth of the Knowledge Hub community. The reported successes, such as those described in Scotland provide a growing global audience with tangible evidence of the rapid and significant return on investment. The use of Knowledge Hub to harness collective approaches to common global challenges is fast emerging.

With the recent announcement of its appointment as a platform partner of 100 Resilient Cities – pioneered by the

Rockefeller Foundation, Knowledge Hub seeks to support the 100RC network of Chief Resilience Officers with the implementation of resilience strategies by making it easy to engage with stakeholders, partners and local communities in the various initiatives.

Salvador, in Brazil, has been the first of the 100 Resilient Cities to seize the opportunity. Salvador is a vibrant coastal city with strong shipping, industrial manufacturing and tourism sectors. Its population of 2.7 million has been swelled by an influx of domestic migration that has taxed public services including education, healthcare and transportation, while the ensuing overpopulation has increased unemployment, informal settlements and poverty. New initiatives have been enacted to increase



foreign investment to increase job opportunities, while a government agency was created to provide job training and assist in connecting employers with residents searching for work.

“Knowledge Hub was used by 30 of the 32 Scottish local authorities participating in the Readiness Project to share challenges and find collective solutions to implementing GDPR. The Digital Office reported that this helped to sizably reduce any duplication of effort and ensure a consistent approach between the 30 councils in the Local Government Digital Partnership.”

Salvador experiences regular heavy rainfall that can lead to devastating urban landslides. During the last 10 years, the Municipal Civil Defence and other government agencies have assisted in over 19,000 landslide related occurrences, providing support to rebuild property and in many cases relocate citizens. Further engi-

neering work is underway with federal support to stabilise landslide-prone neighbourhoods, but rapid population growth increases the possibility of future risks. Salvador will launch their Knowledge Hub network in early June and begin to engage their communities in tackling identified shocks and stresses covering crime & violence, disease outbreak, inadequate educational systems, landslide, population growth & overpopulation, poverty and rainfall flooding.

Fahy commented that Knowledge Hub is extremely proud of its association with 100 Resilient Cities and excited that Salvador has moved quickly to adopt the platform. He explained that the technology will be deployed in Brazilian to enable engagement in the native language. We talk about our desire to make a difference as a business and it feels as if we can now achieve this on a global level by increasing the productivity of 100 RC member cities through collaboration.

Knowledge Hub is free to public service and not-for-profit organisations and their employees who can access the platform at www.khub.net/sign-up.



Knowledgehub

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Digital transformation, collaboration and innovation: Making government work better for everyone

Kevin Cunnington, Director General of the UK's Government Digital Service (GDS) provides an update on how digital transformation is helping to make government work better for everyone

The Government Digital Service (GDS) exists to make government work better for everyone. As part of Cabinet Office, we're well-placed to support departments as they transform their services.

We set a high standard for ourselves through our past work. Since 2012, we've achieved £1.2 billion savings through spending controls and we've saved £100 million through merging 1,884 government websites into the award-winning GOV.UK.

The Digital Marketplace is transforming the way government buys technology and digital services by opening the market up to small and medium-sized enterprise (SME) suppliers. To date, in excess of £4 billion has been spent through the Digital Marketplace in just under six years, with close to half (45.1%) of that spend going to SMEs.

We've been focusing on how to make GDS a great place to work and reflect the society we serve. To achieve this, we have mandatory black, Asian and minority ethnic (BAME) representation on interview panels and a gender-balanced senior management team.

We created the Digital, Data and Technology (DDaT) Framework to help us identify gaps in talent across the Civil Service and to build the capability we need to deliver ambitious transformation.

To complement this work, we launched the GDS Academy which teaches civil servants the digital skills they need to transform public services. By the end of this year, we expect that 10,000 people will have attended GDS Academy courses. More widely, the Civil Service also

offers graduate schemes, internships and apprenticeships, including a new software developer apprenticeship, to grow talent in-house.

Our work at GDS is guided by three themes: transformation, collaboration and innovation. Transformation allows an organisation to redesign its ways of providing a service; collaboration creates an environment where working together is the norm, and innovation means that we can really make a difference in people's lives.

The result of these is an empowered, connected and digital workforce who can deliver to the standards expected in this digital age.

Transformation

We help departments to transform by sharing our expertise, standards and ways of working and our exit from the European Union (EU) has accelerated the need for transformation. To support transformation we've offered advice, seconded staff, set up an EU Exit board and more.

We published, together with the Infrastructure and Projects Authority (IPA), the 7 Lenses of Transformation. This guide shares first-hand experiences of those who have led transformation projects in government. The Transformation Peer Group, a cross-government network, meets regularly to support business transformations across government.

With about 30% of the most critical EU Exit issues having a significant DDaT element, delivering on the EU Exit is a GDS priority. GDS experts have been seconded to assist those departments most affected by the EU

Exit. The GDS Academy has prioritised courses for departments impacted by the EU Exit and we set up an EU Exit board to support GDS' work across government.

We also held a consultation and responded to the incoming accessibility guidance from the EU which requires UK public sector body websites and apps to make their websites and apps more accessible. This can be found on GOV.UK.

“The Digital Marketplace is transforming the way government buys technology and digital services by opening the market up to small and medium-sized enterprise (SME) suppliers. To date, in excess of £4 billion has been spent through the Digital Marketplace in just under six years, with close to half (45.1%) of that spend going to SMEs.”

Collaboration

GDS' flagship conference, Sprint 18, made a triumphant return this year championing transformation, collaboration and innovation across the government. The thing that it really emphasised was just how much is gained when the government works together.

Attendees heard how the Foreign & Commonwealth Office has transformed online applications for emergency travel documents. We also heard from the Driver and Vehicle Standards Agency on using GDS' step-by-step navigation approach.

The UK Hydrographic Office talked about the automatic detection of previously unknown shipping hazards with machine learning. This technology was developed with help from GDS and the Data Science Accelerator Programme.

The pace of change at GDS has really increased in the past few years. GOV.UK Notify is now used by over 300 services and organisations and GovWifi has had over 10 million transactions.

Innovation

The government needs to be able to solve complex challenges and understand which technologies can help them. The government launched the GovTech Catalyst so that technology companies could easily pitch to solve public sector challenges.

The £20 million three-year programme is live and has been hugely oversubscribed. Minister for Implementation, Oliver Dowden, champions this work. To find out more, visit the [GovTech page](#) on GOV.UK.

Finally, innovation is a major area of work for us. We published the Technology innovation in government survey with a map of all innovation activity across government. For the first time, we now have visibility over all innovative work across government, such as artificial intelligence (AI), biometrics and distributed ledgers.

GDS is now leading on the Innovation Strategy, which will be published in Spring 2019. We are meeting academics, businesses and leading innovators, both at home and abroad, to develop our strategy. It will set forth our vision on how government can use emerging technologies to deliver exemplary services.

GDS is committed to showing what good looks like and solving the hardest problems. We are undertaking a huge piece of work to document the taxonomy of GOV.UK. This makes the website easy to read by technologies such as Alexa and Siri, and will allow us to future-proof GOV.UK.

It has already been a busy year for GDS. I am proud to represent GDS and talk about the work the team is doing to help the government make real change. The work we are doing now makes me certain that we are prepared for the challenges and opportunities ahead. ■

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Kevin Cunnington **Director General**

Government Digital Service (GDS)

www.gov.uk/government/organisations/government-digital-service

www.twitter.com/gdsteam

Agile Digital Services: A Success Story

We're living in an ever-changing and increasingly digital world, which is having a significant impact on the very nature of organisations and how they operate.

To be successful, organisations need to be Agile and able to react quickly to an ever-evolving business landscape and fierce competition.

And it's not just the private sector. Governments and local authorities have a great opportunity to embrace the shift to digital and revolutionise services they provide to citizens.

From personalised services in health and social care for the elderly at home, to tailored learning in education and access to culture, the tools, techniques, technology and approaches of the internet age offer greater opportunities than ever before to improve services.

The UK has already made good progress and the UN has recognised the UK as the world leader in digital government. Since the publication of the Government Digital Strategy (GDS), the UK Government and several local authorities have made significant progress in building online services.

Central to the development and delivery of effective digital services is the Agile philosophy and supporting approaches.

APMG is delighted to be working with the Agile Business Consortium to deliver the AgileDS™ training and certification scheme, supporting the new handbook published by the Consortium.

APMG has been working in partnership with the Consortium since 2009, developing the popular certifications:

- AgilePM® (Agile Project Management, 2010)
- AgilePgM® (Agile Programme Management, 2014)
- AgileBA® (Agile Business Analysis, 2015)

and accrediting training providers around the globe. AgilePM has since established itself as the world's leading framework and certification for Agile project management, with over 97,000 exams sat since its release in 2010.

Feedback from the private betas have been very valuable

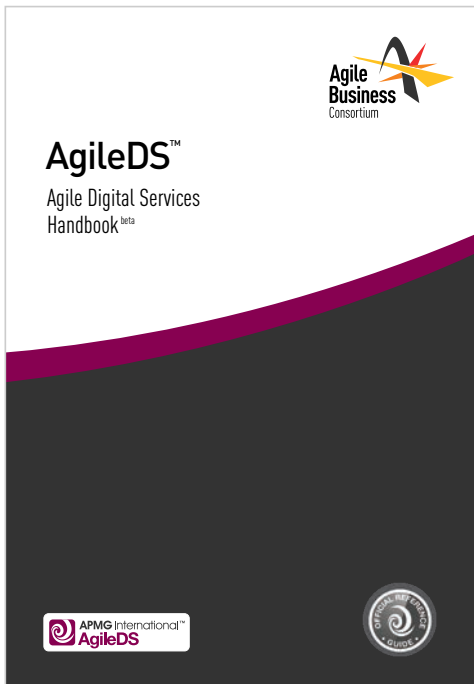


"Agilesphere is delighted to see AgileDS enter public beta. Our public sector clients, in particular, have been looking to close the gap between the existing Agile qualifications and the reality of delivery of government digital services. AgileDS closes this gap and provides a rigorous qualification that recognises the commitment of both the individual and the organisation to developing digital skills." - Jeremy Renwick, CxO, Agilesphere LLP

The new AgileDS handbook has been specifically designed to complement the Government Digital Service (GDS) which, since its creation in 2011, has had a transformative effect on the design and development of digital services in the UK Government.

This handbook is a great innovation that blends AgilePM, the GDS Service Design Manual, and some emerging thinking from the Agile Business Consortium around business agility. It offers practitioners involved in the design and delivery of digital services a mature Agile approach that embraces Agile product and service development in the context of Agile business change-focused programmes and projects. It allows users to gain the benefits of a rapid, responsive approach without introducing governance and control-related risks.

Alongside the new guidance, APMG has developed an official supporting syllabus, along with Foundation and Practitioner examinations to offer practitioners an exciting opportunity for professional development in the field of Agile digital service delivery.



The new AgileDS handbook has been specifically designed to complement the Government Digital Service (GDS)

Approved training courses are offered by APMG's network of accredited training organisations (ATOs), certified to highest standards for training delivery.

Both APMG International and the Agile Business Consortium are committed to delivering quality solutions for practitioners. The AgileDS materials and training have been through a rigorous development process, incorporating extensive beta and public testing. This ensures a high quality and valuable training and certification experience, enabling candidates to immediately implement knowledge and practices acquired during that training.

AgileDS provides candidates with a structured framework for managing digital projects successfully. We look forward to continually supporting the initiative and the successful delivery of digital services by central and local government.

- Richard Pharro, APMG

"Developing this new Agile Digital Services course in an Agile style has been a fantastic experience. Delegates have loved the empowerment and ability to help shape the training for future delegates and the courses have been highly interactive as a result. The most recent course I delivered just seemed to be "spot-on" with the content being so relevant to the delegates' needs, and finally taking away all the pain that used to exist and that triggered this whole exercise in the first place."

- Peter Stansbury, Lead Author AgileDS handbook
Director - Business Transformation, Evoco

About Agile Business Consortium:

The Agile Business Consortium is a not-for-profit member organisation leading, promoting and enabling business agility worldwide.

For more information, visit agilebusiness.org/digital-services



Richard Pharro:

CEO of APMG International, the award winning examination institute which accredits training and consulting organisations to deliver courses from its broad portfolio of professional training certifications.

An experienced Civil Engineer, having worked on projects in the UK and the Middle East, Richard was a member of the Programme Management Team responsible for the redevelopment of the London Docklands in the 1980s.

Leading, promoting and enabling business agility worldwide



Accelerate the digital transformation journey

Mark Hastings of Rainmaker Solutions offers public sector leaders some thoughts on how to accelerate their digital transformation journeys

Very few of you would argue against the seemingly irreversible trend for digital technologies and applications to reinvent and shape the way we work; the way we live our lives and the way we deliver public services.

The reality is, we can't ignore it. We are being challenged daily to deliver better services, despite limited money and resources. Getting there requires departments to think and behave differently. But success will never be achieved through a one-off transformation programme.

If you are coming to the end of a long-term contract with a large Systems Integrator, or if you are wanting to use digital technologies to help deliver better services for less, here are our top five areas to focus on.

Understand where you are (situational awareness)

Every department will be starting their journey from a different place and with differing levels of digital maturity. We have learnt that situational awareness is a critical step in any transformation journey, but one that is often neglected.

If you don't understand where you are, you can't begin to plan how you are going to get to where you want to go. This is why we co-create visual maps of how users, processes and technology components interact to meet the



Mark Hastings

organisation's needs. It is these maps which help the department understand the environment in which it is operating and which will highlight how opportunities for strategic change may be exploited.

Understand where you are heading (clarity of purpose)

Every department needs a clear articulation of its vision; one that describes its desired future. To spell this out is to provide an aspirational destination for the organisation to head towards. Without clarity of vision and purpose, ambiguities are more likely to arise on the journey, leading to expensive changes of direction and increasing the time it takes to deliver.

Vision statements must be co-developed by listening to the views of those within an organisation, not simply imposed from the top without consultation. Done well, they will unite key stakeholders and provide a clear governance framework to support transformation delivery.

Focus on the user

At the heart of all transformations are people, not technology. Successful transformation starts by understanding user needs, pain points, user journeys and personas. It requires a service design approach to ensure that the services being designed meet those user needs. This involves working collaboratively across disciplines, engaging users and citizens to define, develop and embed transformation.

Too often, we see tools, systems and programmes being implemented without conducting sufficient user research, also known as 'technology-led change'. This results in services which aren't fit for purpose and which causes users to disengage from the service as their needs have not been met. In short, user research is essential. It crystallises the understanding around what users need to be able to do their jobs more easily or use a service with less effort. It means we are able to deliver more fundamental transformation by re-imagining services, rather than salami slicing existing services and cutting them to the bone.

Define a roadmap

The quickest route to failure is to try and fit new technologies to existing ways of working. In the long-term, it simply doesn't work. True transformation must also address culture, workplace skills, leadership, governance and supplier relationships. It must be able to adapt



to changing business requirements and changing user needs.

Having taken a user-centric approach to understanding where the department is and where it is headed, a transformation roadmap helps the department explore the path it needs to take to achieve its vision. They help it understand the way its people, processes, data and technology should combine to deliver value to its users. They inform decisions on where to act and why.

Iterative delivery

Collaboration is key. We like to call it ‘working out loud’. This is vital if transformation isn’t just to be ‘for Christmas’. It encourages all stakeholders to buy into the transformation plan, creating a culture which adopts digital at its core. It ensures the plan can endure ongoing iteration as circumstances change, whether due to market forces, product availability, organisational vision, performance or changing user needs.

It is through a detailed understanding of the department and its users, combined with a map of how their needs connect with technology, that

we are able to work together to create a change in mindset, embedding digital change and transformation. Sometimes the answer will be ‘Agile’. Sometimes it won’t. But we start on that journey on day one and begin making real differences from the outset.

Flexibility

In a world where departments need to iterate constantly, a more flexible model for investing in technology and skills is needed. A framework that can respond to a more volatile, uncertain, complex and ambiguous world. Gone are the days of large outsourcing contracts, often single vendor arrangements, lasting from five to ten years. They no longer represent value for money and they constrain departments from achieving their visions.

Using proven partners and ‘as a service’ type models, which provide rapid access to skilled resources and the ability to scale according to the roadmap, can be a powerful way of achieving required outcomes. They allow departments to benefit from knowledge transfer in key skills like user research and analysis, agile project management and financial modelling. They avoid departments having to risk large

investments in specialist in-house skills that may become irrelevant. If you hire a group of .NET developers, then they’ll see everything as a .NET development problem, whether that’s the right solution or not.

Conclusion

As a digital and business transformation business, we have helped many departments, agencies and local authorities accelerate their digital transformation journeys by taking a user-centred approach to transformation and using the department’s vision and values to guide it.

Most often, success stems from leadership teams who are prepared to question the status quo. From leaders who want to reimagine service delivery and ways of working. From leaders who want to challenge target operating models that are out-of-date as soon as they are implemented.

If you want to understand better where you are on your own journey, you can find us at rainmaker.solutions.



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Digital transformation done right for UK government departments

Peter Miller explains how Visionist helped the Department for Business, Energy & Industrial Strategy (BEIS) and the Department for International Trade (DIT) transform their digital capabilities, processes and people

BEIS' legacy network was set up to be secure but proved limiting in terms of external connectivity. Like many government departments, services were delivered via the public services network (PSN), where the network itself was a secured 'OFFICIAL' environment, and all service providers were required to adhere to the PSN Code of Connection.

The legacy PSN services were restricting the department's ability to exploit modern digital services and collaboration opportunities – technology that could help BEIS work more efficiently.

BEIS engaged with Visionist to:

1. Validate the business requirements and;
2. Engage with the department's Change and Engagement supplier to develop an end-to-end digital service with ServiceOps and DevOps functions.

The end-goal? To enable the department to move from a traditional service integrator/prime contractor model to an in-house, civil-service-resourced model with appropriate governance and processes.

As the department's technical delivery partner, Visionist designed, developed and delivered a secure, internet-only, and loosely coupled commodity-

based service. This system enhanced the department's ability to exploit digital transformation while maintaining the high levels of security set by the National Cyber Security Centre.

Utilising the Gov WiFi wireless infrastructure and an innovative suite of products to separate and secure application data, users now enjoy new freedom of movement without hindrance and a vastly improved end-user experience. They can now connect to modern digital services and collaborate with partner organisations and departments.

Dealing with complexity

Even with the new cloud-based network in place, BEIS and DIT still needed to be able to access a multitude of business applications via the legacy PSN network.

The new infrastructure thus needed to deal with two types of communication systems:

- **Client-to-system** – the communication between the end-user device and the capability to consume services and;
- **System-to-system** – the communications between the legacy service and the new services to conduct user authentication and access applications.

Here's how Visionist did it:

To enable both sets of communications (client-to-system and system-to-system), Visionist established a secure route from the new cloud-based Amazon Web Services (AWS) environment to the encrypted PSN environment.

For the technical-minded among us, this involved:

- Securing Visionist's virtual private network (VPN) into AWS and;
- Establishing virtual routing and forwarding between the unencrypted and encrypted networks to form an interoperability gateway, compliant with the PSN Code of Connection.

By creating this linkage, Visionist created a 'system-to-system' communications network that allows Active Directory Trusts to allow users to consume services between the directory services in the new AWS environment and the legacy application directory services in the PSN domain.

What about security?

To maintain high levels of security, this model utilises the principle of securing the endpoints rather than the bearer network. To enable secure user traffic, Visionist needed to ensure that the traffic from the end-user device over the internet is secured up



to the point where it interfaces with the AWS reach-back virtual private cloud (VPC).

After a considered product selection process, the consultants decided to use Zscaler Private Access, a product which uses a combination of policies to establish a dynamic, secure connection from the end-user device to the termination point in the AWS-PSN VPC, a 'VPN-like' capability. The advantage of the AWS-PSN VPC set-up is that the connection is created across the Internet dynamically, providing a more flexible solution over traditional 'static' VPNs.

Seamless solutions

The expert consultants at Visionist designed, developed and deployed the end-user devices in such a way that:

- Core services such as identity management and web security are hosted out of AWS and Microsoft Azure;
- Staff can benefit from the seamless, connected cloud-based network;
- At the same time, Visionist provisioned the network in such a way

that the departments can continue to access their business-critical applications through a secure 'reach-back' mechanism and;

- Most importantly, accessing this legacy information appears seamless to the user.

The benefits for BEIS

Visionist enabled BEIS to migrate from its legacy service to a new cloud-based service in their required timeline with the ability to have access to their business applications in the legacy PSN environment while maintaining the appropriate security controls around the disparate services.

Replacing expensive legacy infrastructure with a modern and capable infrastructure for the future will save BEIS money in the long-run – if the department continues to exploit the cultural changes required, then its invest-to-save strategy will result in net present value (NPV) of £8 million.

What BEIS say:

"I was reminded today of how efficient and effective Visionist are in the work they undertake. I for one am delighted with my new Cirrus kit. I'm still learning how to get the best from it but to be able

to function close to 100% from day one is remarkable in my experience of IT projects." – Programme Director, BEIS.

About Visionist

Founded in 2003, Visionist Consulting has over 15 years' government delivery experience and extensive experience in delivering digital solutions to large organisations and not for profits. Visionist helps organisations achieve their business goals through strategic leadership and digital innovation.

Visionist has over 100 permanent staff with a wider resource pool of over 800 subject matter experts. Many have worked with Visionist for a number of years across multiple projects, complementing the permanent team with additional niche subject matter expertise or delivery experience.

With a new partner, Smarter Business, Visionist is also able to offer a host of other business services, such as business energy, telecoms solutions, facilities maintenance, smart building monitoring and more.

To digitally transform your organisation, let's talk: +44 (0)20 3883 8201, or visit www.visionist.consulting



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The Internet of Things (IoT) security on the city scale: Integrating the digital world

Jon Geater, Chief Technology Officer at Thales e-Security shares his expertise on the Internet of Things (IoT) security on a city-wide scale and how this integrates the digital world

One major impediment to the creation of smart cities is the lack of trustworthy communication between devices. The vast technical challenges and the high cost of interoperability between the many makers and operators of internet-enabled devices are putting a brake on our digital society. Blockchain and smart contracts technology have the potential to unpick much of this Gordian Knot.

In these times of heightened tensions and tales of fake news dominating the popular headlines, Russia might be an unexpected place from which to draw inspiration for the security of our future smart cities and connected infrastructure. But there's an old Russian proverb that is already well known to us as a model for ensuring national security interests. It's *Доверяй, но проверяй*: "Trust, but verify".

Most famously used by Ronald Reagan during the nuclear debates of the 1980s, this phrase has enjoyed popularity in any number of fields of society and politics since, most recently being adopted (and variously adapted and immortalised in t-shirt form) by the bitcoin and blockchain communities.

To see why this philosophy is important to guide our future connected infrastructure designs, one needs to look to the recent past for examples of where things have gone wrong. Possibly the simplest example and a favourite of the cyber-physical security community is Stuxnet. Pulling off Stuxnet was incredibly sophisticated, there is no question about it. Stealing the signing keys that were essential to the attack wasn't quite as easy as simply 'finding them under the mat'. But still, once inside the Stuxnet code was trusted to do whatever it wanted.

Because the code was signed the Siemens PLCs simply accepted it and because the Siemens PLC issued the instructions the centrifuges simply followed them. Then because the feedback systems said everything was okay the safety infrastructure simply believed it.

Again, Stuxnet wasn't quite that simple but it does teach a clear lesson about the way we should build secure industrial systems. Blind faith in central authorities and once-trusted certificates is very fragile. To see why, we can take another very familiar example: Transport Layer Security (TLS), the technology behind the 'browser padlock'.

“We need a way to make trust in things cheaper and easier than it is in today’s all-PKI or fragmented walled garden approaches. We need an architecture that enables a wide variety of devices to connect and communicate and trust what they’re telling each other to do. We need an architecture that enables device makers, owners and operators to see what’s going on and react rapidly to threats and maintenance issues before they become a problem.”

There is little wrong with TLS in principle. The idea of extending trust by having someone you know to introduce you to someone you don't know makes sound logical sense and after all, TLS on the internet does work. But the problems begin when the concept is stretched too far. Browser TLS essentially has just one job to do: that is to ensure that the information you exchange with a website is only going to or coming from that intended site.

Even with such a limited mission, we have problems in any number of dimensions of scale: a proliferation of certificate authorities with different areas of focus or qualities of Know Your Customer (KYC) processes; ill-advised reuse of this 'almost right' technology for adjacent use cases that are just a bit too different from websites to really work; a vast array of options that are theoretically strong but lead to insecure defaults and lazy configurations; and a trust model that more-or-less assumes that one end of the communication is

significantly more trusted than the other, with an all-knowing central authority that is more powerful still and where a compromise is catastrophic for everyone. The result is a 'weakest link' problem where an attacker only needs to find one way in to be all in. They are trusted, but not very well verified.

To counter these problems, some early entrants to the IoT space have had a rather extreme reaction, locking things down into end-to-end walled gardens where everything is fully under central and vertical control with the agent on the 'thing' and the servers in the cloud – all under control of a single operator. Unfortunately, though, nice though it is to have end-to-end, chip-to-cloud security locked into devices, there's a clear interoperability problem looming, which leads inexorably to a brake on progress in deploying city-scale IoT.

And then there's maintenance. Deploying a system is one thing, but once it is in place how do we manage it? How do we keep the system patched and up-to-date and trustworthy within city budgets and capabilities? How do we monitor and enforce good practice in software-defined civil infrastructure to keep ourselves safe while enjoying the benefits of connected living? It's all very well deploying a device that was built secure in the factory with strong control systems and a nice reliable digital birth certificate. That part is essential. But from the second it's out in the field, trust in that device begins to degrade as software gets out of date and attacks start to mount. After a year in the field, can you really trust what that 'thing' is telling you? Or what it's telling the power grid to do? Or a convoy of vehicles? Again, blind trust in a device that was trustworthy once is not good enough: it needs constant verification.

We need a way to make trust in things cheaper and easier than it is in today's all-PKI or fragmented walled garden approaches. We need an architecture that enables a wide variety of devices to connect and communicate and trust what they're telling each other to do. We need an architecture that enables device makers, owners and operators to see what's going on



and react rapidly to threats and maintenance issues before they become a problem. We need security services and city officials to be able to see this happening and to verify that companies are operating within the bounds of best practice.

Enterprise blockchain offers an answer to this by knocking out some of the crucial features of internet security that are so threatening to IoT. Just like in TLS, the security of cryptographic keys and the quality of digital identity technology are vitally important, but unlike TLS, most of the responsibility for that security is explicitly pushed to the edges of the network, closer to the real risk owner and to the knowledge of the use case and spreading the risks of compromise.

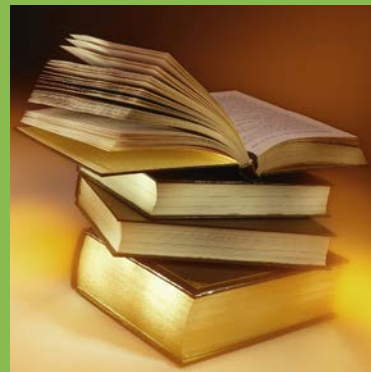
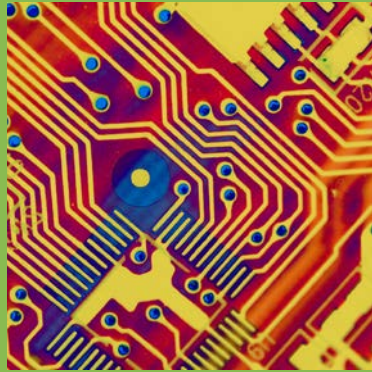
Just like the normal internet, we need back-end servers and databases that hold and process and protect most of the long-term data but unlike current cloud-borne systems, everyone gets a verifiable record of the interactions that have taken place. And just like the alternatives, the ultimate power of any IoT system lies in the

size and diversity of the ecosystem that supports it and here the low costs and low friction of joining a blockchain network again provide an advantage, especially when it comes to attracting smaller players to the club.

We cannot let the security of the internet become the security of the IoT. By combining the best historic lessons of strong cryptography and identity management with new models of low-friction access and communications brokerage, blockchain offers an answer for trustworthy, verified, connected cities. ■

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Blockchain: Benefits for the supply chain

Chris Burruss, the President of the Blockchain in Transport Alliance (BiTA), explains how blockchain can benefit the supply chain

Currently, moving goods from origin to destination is complex and lacks a single source to store and track all transactions and participants involved. That can potentially be solved with blockchain technology.

Blockchain can simplify the complex and fragmented processes commonly found within the supply chain. Blockchain can create smart contracts and transparency in documents and transactions, increasing supply chains' efficiency, agility and innovation. Smart contracts are computer code hosted on a blockchain that defines/executes the terms of an agreement between parties.

For every shipment, numerous parties are involved; transactions get executed (bills of lading, invoices, proofs of delivery, etc.). Blockchain records transactions, tracks assets and creates a transparent and efficient system for managing those documents. Each transaction becomes a permanent ledger record that is easily validated.

The Blockchain in Transport Alliance (BiTA) is a consortium of transportation and supply chain leaders developing industry standards for blockchain use. BiTA members share a common mission to develop a standards framework, educate the market on blockchain applications and encourage the use of those applications.

BiTA is investigating use cases and developing a common framework the industry can use to build blockchain applications. Through think-tank events, networking, meetings, webinars and online collaboration, members work with peers on common issues and share best practices.

The BiTA community's focus is on community aspects (networking, education, marketing and commercial outcomes). It is BiTA's voice to members, external organisations and stakeholders. The BiTA Standards

Council provides a forum to develop industry standards and best practices. It focuses on data formats and the interoperability of blockchain platforms. It is a separate industry group governed by a standards board.

The Council is developing industry standards that: improve trust and enable transparency in the supply chain; and drive technological efficiency, ideally resulting in cost savings for those that adopt the standards. BiTA is not defining a single technology solution; it seeks interoperability and compatibility between solutions used across the supply chain. BiTA standards will be open source and royalty-free.

The key issues that concern leading companies in the freight technology industries that have a vested interest in the development of blockchain technology

While there are challenges that blockchain can solve, it will not solve every problem. Questions to consider about blockchain are: can traditional database technology meet needs; does more than one participant need to update data; does data need to be private; will the database be attacked or censored; do users need to trust each other; is a trusted third-party needed; do changes need to be controlled?

If there is a need for transparency, security and the elimination of intermediaries, blockchain is a solution that allows real-time visibility of freight assets across the supply chain.

Blockchain benefits

1. Monitors performance history

Allows parties to see evidence of participants' past performance, including on-time deliveries, on-time pickups, etc.

2. Maintains high-value assets history

A trusted/accurate record of asset history is imperative to ensure it complies with standards from the factory floor to delivery.

3. Improves quality assurance

Every authorised member of a transaction can access data to validate milestones and reduce unsubstantiated disputes.

4. Monitors real-time freight capacity

Available truck capacity changes constantly. Through blockchain transparency, capacity is visible.

5. Improves payments and pricing processes

Payment processing/settlement is secure in a blockchain and transaction information is accessible.

6. Deters fraud

Every transaction is visible to those on the network. Nothing can be removed without detection; transparency deters fraud. Through notarization/non-repudiation, shippers can securely track the creation and modification time of a document or transaction, thereby confirming authenticity.

7. Prevents theft

A blockchain can contain detailed information and rules, such as requiring photo IDs for freight pick-up/delivery. Added precautions improve security and reduce freight theft. A blockchain also enables the secure transfer of titles for smart properties.

8. Proves provenance

Blockchain ensures that every shipped good includes a digital "passport" proving its authenticity/provenance. Passports include data, such as where/when the product was manufactured and what steps it took throughout its journey.

9. Issuance of smart contracts

Smart contracts are considered by many to be the most important blockchain feature. Entrepreneur magazine states: "With smart contracts, agreements can be automatically validated, signed and enforced through a blockchain construct – eliminating the need for mediators and therefore saving the company time and money."

Barriers to widespread blockchain adoption (risks/difficulties)

Despite blockchain benefits, there are concerns which are slowing the technology's widespread adoption. Among them are:

Lack of standards: For blockchain to succeed, all constituents must agree to data characterisations (i.e., what details will every bill of lading carry, what will the proof of delivery or invoice contain? What actions should trigger if data is missing or not validated?).

Cost: Developing/maintaining the software/hardware required to run blockchain is expensive. Additionally,

companies need qualified people to run blockchain, which can be expensive.

Legacy system integration: Companies must integrate blockchain into legacy systems. According to nasdaq.com, "Many organisations are reluctant to make a move to blockchain solutions because of the meticulous planning, time and money that would be required to achieve successful company-wide implementation."

Maturity: Blockchain is an emerging technology. While many anticipate its impact, blockchain is still uncertain. Also, blockchain has few standards or industry specifications for its adoption and use (which is the reason for BiTA's existence).

Why the industry needs common standards

When businesses cannot agree on a common framework, the government steps in and regulates the activity. This slows down processes and creates bureaucracy that increases cost. There is no example of government intervention in which costs were reduced. If the industry does not define the framework within which blockchain resides, the result may render blockchain moot.

The potential blockchain has in the logistics industry

Quite simply, it has the potential to revolutionise the \$8 trillion global logistics/transportation/freight industry. Blockchain may be the solution to transparency, security and reducing or eliminating third parties. There are many use cases – payments, provenance and visibility of commercial assets, driver ID, smart contracts, instantaneous settlement of transactions – virtually every challenge with freight tracking and delivery may be solved with blockchain. ■

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Distributed business networks can enhance public-private collaboration

Markus Hautala, Head of Blockchain solutions at Tieto argues that blockchain technology allows us to create more democratically governed distributed platforms and avoid vendor lock-in

The social media and e-commerce platforms of today have changed the landscape of business and social interactions for good. Platforms such as Facebook, Amazon, Alibaba and eBay are delivering immense value by enabling practically anyone to connect and trade on a global scale.

And whilst these platforms have gained global reach, we still lack the ubiquitous means to digitally conduct common interactions, such as signing a business contract, opening a bank account, founding a company and more. As our personal and business lives are becoming increasingly digital and global, we need to invent next-generation platforms that can be efficiently scaled across national borders whilst avoiding the risk for monopolies to emerge.

“During the company founding process, a digital identity is created for the company. This enables the company to be reliably identified and allows it to operate at full extent by sharing online verifiable information about itself.”

Creating a public-private business network for founding companies fully digitally

During the past couple of years, distributed platforms based on distributed ledger technology have become more common providing the opportunity to establish new types of

business and trust networks across multiple actors. Instead of relying on centralised platforms, we now have the means to establish new types of distributed business networks whilst avoiding vendor lock-in.

One example of such is the DLT-based business network created in Project Mercury earlier during 2018 in cooperation with Finnish authorities and businesses. Asiakastieto Group, Nordea Bank, OP Group and Tieto jointly with advisors from Finnish Tax Administration and the Finnish Patent and Registration Office, developed the world's first DLT-based business network that enables the founding of limited liability companies on an entirely digital basis. The newly-developed based business network is a proof-of-concept project, but further development is planned for an even wider-ranging collaboration between a number of Finnish organisations.

The mission to reduce the administrative burden on entrepreneurs

The current end-to-end process for forming a limited company is very manual and time consuming for company stakeholders and involved entities. Typically founding a company can take several weeks as the company founders need to create and sign the founding documents manually, the documents have to be delivered through regular mail to public author-

ities and the company founders need to visit a bank branch to open a bank account for the company and so on.

Furthermore, there is no means to digitally identify foreign citizens nor to perform Know-Your-Customer (KYC) checks which further complicate the process. This is because current isolated systems do not cater for exchanging verifiable identity information concerning the individuals or organisations. There is neither a system that will manage the entire process and which can update company information to authorities and financial service providers both simultaneously and in real time.

In the future, Finns will increasingly be self-employed as entrepreneurs and as such, the mission of this pioneering development is to reduce the burden of administrative procedures and encourage more people to become entrepreneurs and create new jobs.

An additional key objective of this initiative is to attract foreign talent by making it easier for foreign entrepreneurs to found start-ups in Finland and therefore, to improve the country's economic performance.

Creating a frictionless user experience for founding a company Thanks to distributed ledger technology, the business network orchestrates the end-to-end process across different

actors and enables information about the company and its stakeholders to be updated and made available to every party in the network simultaneously.

During the company founding process, a digital identity is created for the company. This enables the company to be reliably identified and allows it to operate at full extent by sharing online verifiable information about itself. For example, the company can authorise its employees to represent the company digitally. Accounts can be opened for the company, it can be registered for VAT and Tax Administration prepayment register, the Finnish Patent and Registration Office can register the company and the company can manage its shareholder register – all this entirely digitally.

While the business network is developed in cooperation with Finnish organisations, it could also be used globally. The technology solution is not geographically limited as it combines the decentralised transaction network (Corda) and global identity network (Sovrin). By integrating these, we now have also created a model for other highly scalable global business networks that can serve the vast number of various industry use cases involving record keeping, asset trading, multiparty process management and decentralised contract signing.

A perfect marriage between Hyperledger Indy and Corda

This project combined for the first time the two major decentralised platforms in a practical implementation. Corda's process and contract-centric architecture formed the backbone of the network between the different actors, while Hyperledger Indy – the basis for the Sovrin network – provides a decentralised platform for exchanging

verifiable data. Sovrin is a global decentralised identity network that allows people, organisations and things to have their own digital identity which they control.

“An additional key objective of this initiative is to attract foreign talent by making it easier for foreign entrepreneurs to found start-ups in Finland and therefore, to improve the country's economic performance.”

In Sovrin, the identity holder forms secure digital connections with entities (organisations, individuals or things) that can provide information about the identity holder. This information can literally be anything such as a personal identification number, home address, power of attorney or – in the context of Project Mercury – a right to represent a company. This information can then be shared by the identity holder to a party that requires these proofs. This provides for all kinds of rich digital interactions: Know-Your-Customer (KYC), contract and transaction signing (B2B, B2C, G2C), permits, asset ownership and so on.

Corda is an open source, blockchain-inspired distributed ledger technology (DLT) platform that removes costly friction in business processes by enabling organisations to transact directly using smart contracts while ensuring the highest levels of privacy and security. It is the outcome of over two years of intense research and development by R3 and its 100+ members. Corda's unique approach to privacy makes it well placed to support identity management on the distributed ledger as the platform combines privacy and confidentiality of business transactions with an ability to reuse business processes and data in the network.

Conclusion

During the past couple of years, DLT-based platforms have started to emerge, providing us with the means to establish new types of distributed business networks without vendor lock-in. The required technologies have matured at a rapid pace and during 2019, we will have reached a stage when they can be taken into use in large-scale production.

The public sector has a central role in digitalising today's society, as it provides core services – such as base registries – required for societies to function. The European public sector should follow the example of their Finnish counterparts and actively drive the adoption of new distributed business networks in collaboration with the private sector to ensure a wide market take-up. Private and public sector participants should jointly and iteratively prototype, pilot and develop such collaborative solutions to ensure that Europe will be at the forefront in adopting this technology and that the European economy remains globally competitive.



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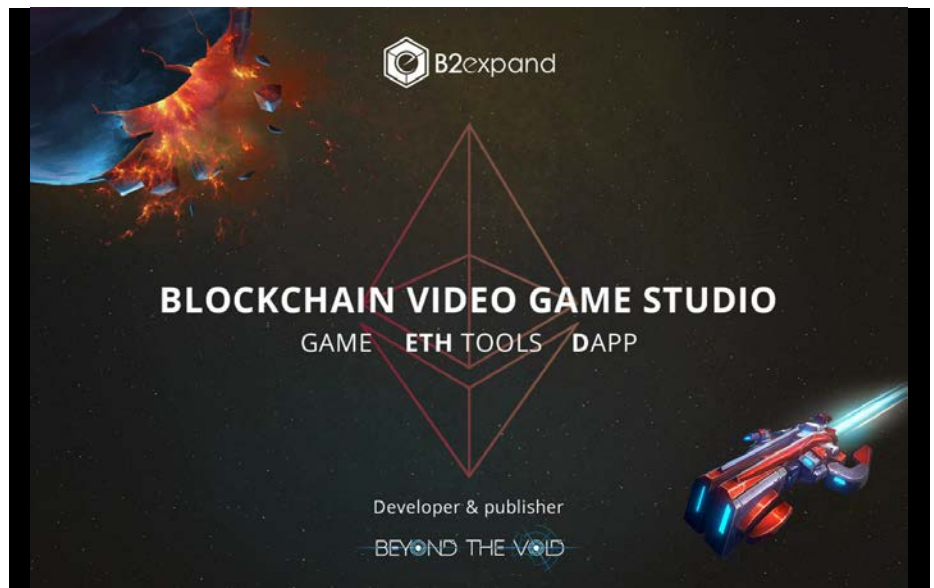
Advancing the video game industry with blockchain technology

B2Expand, headed up by CEO Manon Burgel, is making an important contribution to advancing the video game industry with blockchain technology, as this profile details

B2Expand was launched as the brainchild of the Burgel family. Stemming from a video game project, Beyond the Void (BTV), was the first French team to utilize an ICO model to develop and launch a video game with blockchain technology in mind. Upon the ICO's success in Nov 2016, the family formalized their vision under the name B2Expand in January 2017 to support continued development. The team is led by Eric Burgel as Chairman with his daughter, Manon Burgel, overseeing daily operations as CEO. Her brother, Rémi Burgel, is their Smart Contract Developer, working alongside Maxence Burgel, their uncle and Lead Concept Artist.

The company vision is a simple idea with a grand design: "Bringing back true ownership to the players." Advancement of the video game industry with blockchain technology empowers game developers and players by creating a transparent relationship between them. B2Expand pushes the boundaries of blockchain implementation by building DApps (decentralized applications) and Ethereum Tools to be used inside of video games. Game design, programming, production, and distribution is all possible because of the blockchain.

Their first project, Beyond the Void, is available on Steam in Early Access with the full launch anticipated on October 24 this year. Players can interact with the game's stand-alone BTV web shop,



the Nexarium, to buy, sell, and trade in-game assets on the blockchain with other players. A beta test for the decentralized mobile app will be introduced in September, leading to a final update in October to improve player experiences by replacing the former web shop.

With its melding of blockchain and games, B2Expand is committed to building the future of gaming, having participated in Ubisoft's start-up program from September 2017 to February 2018. Convinced of the blockchain community's interest in video games, B2Expand brought together leaders in these fields at their Blockchain Game Summit in late September 2018. Their goal is to push for the creation and implementation of common industry practices in favour of players and thus build a collaborative market to make video games more democratic.

A blockchain company that's also a successful game studio, they offer consulting and development services for companies looking to craft their dream DApp project. By providing blockchain tools for game developers, contributing technology articles, and leading the industry through educational events, B2Expand looks to inspire a unified approach for using blockchain to build the games of the future, today.



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Blockchain supports nurses in the continuity of health and social care

Secretary General of the European Federation of Nurses Associations (EFN), Paul De Raeve explains how blockchain technology supports nurses in Europe where the continuity of health and care is concerned

Blockchain has the potential to modify the way health and social data are traditionally collected, interpreted and connected, shifting from different bits of information held by a single 'owner', to the lifetime history, supporting the efficient and effective continuity of care, by offering a whole and secure way to capture, track and share a citizen's/patient's entire health and social experience.

The innovation of blockchain-inspired technologies has been acknowledged at EU level¹, with the EU investing in blockchain related projects and launching the EU Blockchain Observatory and Forum² to map existing initiatives on blockchain and informing policy debates and inspiring common actions, based on specific use-cases. Parallely, several EU member states have joined the European Blockchain Partnership³, with which the Commission aims to consolidate expertise across borders and address challenges such as disintermediation, trust, security and traceability by design. But where is the end-user in the co-design of policies impacting citizens?

To unlock the potential of blockchain in the health and social care sector, a common, systematic and end-user approach is needed, creating supporting tools for the frontline in their daily practice, ensuring high-quality continuity of care outcomes. However, only co-designed, fit for purpose digital solutions will smooth the deployment of the digitalisation of health and social care⁴, and if not, the investment in innovation will not have a return on investment. In this sense, nurses and SMEs designing blockchain solutions can be joint leaders in reforming health and social ecosystems, leading to a triple win for citizens, industry and the service provider.

The nursing approach to blockchain in health and social care

The right of citizens to timely access, affordable, pre-



Paul De Raeve, Secretary General of the European Federation of Nurses Associations (EFN)

ventive and curative health care of good quality constitutes a crucial societal challenge in the EU. 'Moving care back to the community'⁵ can address this issue, by design, in partnership with frontline nurses and a more holistic approach to value-based health and social care, placing the patient/citizen (prevention) at the centre of the process.

Blockchain can support citizen/patients' empowerment in the management of their own health and social data, by guaranteeing citizens in the chain know how and where their data is being used. So, blockchain has the potential to address key health and societal challenges, such as vaccination hesitancy, by facilitating the keeping of a record of vaccination, with increased control by the citizen/patient of his or her own information. This is just one example where the EU implementation gap can be closed through innovation.

Nurses added-value in blockchain relates to boosting the continuity of care, facilitating the communication between the different actors involved to deliver the

best outcomes for patients and citizens. In particular, nurses are key to improving access and outcomes in a people-centred approach, ensuring the continuity of care across the primary and secondary health and social care sectors.

With co-designed blockchain technology, nurses responsible for accessing, recording and processing health and social care data are more secure in the knowledge that such data will be accurate and consistent, leading to improved patient care pathways and as such, the measurable outcomes. By having a distributed database for health and social care-related information, providers can benefit from improved accessibility, accuracy and safety, resulting in better outcomes for all. Therefore, blockchain becomes a technology supporting the frontline by recording the history of data.

Moreover, through the blockchain network, patients/citizens have access to synchronised databases, giving unprecedented benefits for frontline care provision. The regular and updated exchange of a patient's health and social history will allow nurses to advance the process of discharging patients and data sharing in the continuity of care, the consequence of which is reduced bureaucratic red-tape and an improved quality of nursing interventions, which are crucial in terms of decreasing the unmet needs of patients and citizens'.

A co-designed blockchain can become a solution in the value-based health and social care ecosystems, as the gatekeeper now becomes the patient/citizen, that will directly access his/her continuity of care pathway. In this sense, blockchain needs to show the evidence of its potential to decrease the burden of data collection pending on nurses, allowing them to spend more time in direct patient care.

Blockchain and value-based reimbursements

Value-based reimbursement models, such as capitation (a fixed payment per beneficiary across a defined population) and bundled (pay for an episode of care or condition during a defined period of time) payments should link the continuity of care and blockchain.

Matching personal data on chronic conditions with primary care and public health data simplifies the transition

from fee-for-service payments towards value-based reimbursement models, that prioritise quality outcomes of the continuity of care. The promise of blockchain is redesigning the payments process from one that is system-centric, to one where patients' needs determine the services delivered across a condition or an episode. In this sense, blockchain aims to provide a new supporting infrastructure to address these issues, by creating a common platform to administer payments and adjudicate claims. Reflecting on financial models, including prevention, could make our ecosystems more sustainable, with the support of blockchain technology.

Conclusions

Blockchain can greatly contribute to enabling nurses to deliver on access to care, through the digitalisation of health and social care. To this end, blockchain needs to foster the integrated and the continuity of care policies, supporting nurses to deliver a safe and high-quality level of care. Engaging end-users, local frontline nurses, in co-designing 'fit for purpose' health and social care tools can make the systems more integrated, coordinated and sustainable. ■

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Blockchain: Success in government procurement requires more than just investment

Paul Parker from SolarWinds argues that where blockchain is concerned, success in government procurement requires more than just investment

Despite its relative infancy, blockchain is already one of the top five most important technologies in the IT strategy of 12% of public sector employees, with 15% (of those surveyed) stating that this will be the case in the next three to five years. This is according to the recent [IT Trends Report](#) from SolarWinds. The U.K. government is heavily encouraging blockchain-based technologies, with a [£19 million investment](#) in an innovative product or service delivery projects, including ones with distributed ledger technology announced in January of this year.

The promise of blockchain lies in how it can accelerate the verification processes using many connected computers (known as “nodes”) to store blocks of information. Blockchain is transparent by design and that transparency allows data to be shared more easily between parties. In the procurement process, for example, blockchain creates added layers of trust by using its ledger of historical data to validate the authenticity of buyers, sellers and the product.

In addition, blockchain connects multiple systems and allows them to interact with each other. This means it creates a mechanism for more effective communication between different points of the procurement process.

Blockchain has the potential to revolutionise the way government agencies acquire services and solutions, just as it has impacted the way the world’s banks handle the exchange of currency. But, as the financial world has discovered, network monitoring and management strategies play a critical role in blockchain’s success within public sector organisations.

Distributed network monitoring and visibility

One of the design challenges that can arise from the distributed nature of blockchain is that comprehensive visibility is not easy. The success of blockchain in procurement is dependent on a high throughput of transactions and low latency. Unfortunately, those goals can be difficult to achieve over a disparate network, where each node is under pressure to process every transaction. In addition, according to the SolarWinds [IT Trends Report](#), 58% of public sector IT professionals surveyed felt their network was not working at optimum levels. This increases the potential for roadblocks or point failures further down the line.

At the same time, much like the peer-to-peer system that makes blockchain function, many department networks are highly distributed. On-premises hosted, and hybrid network infrastructures are the norm. Teams need to be able to monitor data as it passes between all of these services to help ensure that their networks are operating efficiently and dependable. The best way to get this insight is by monitoring strategies that are designed to provide access and visibility into the entirety of the network, wherever it may exist.

Resilient, but not impervious

Better visibility can lead to better security. Indeed, following recent highly publicised breaches, blockchain technology has been suggested as potentially more secure, if used correctly. This is due to its decentralised nature, which can make it a harder target for hackers to hit. But nothing in this world is truly hacker-proof. Agencies must still make sure that they are maintaining the same high level of security practices they would do otherwise.



Implementing a security and information management system that patrols the network and scans for malicious activity is still extremely important. Continuous, proactive monitoring and encrypting data in transit and at rest must remain a fundamental part of an agency's security posture.

It is also important to remember that blockchain is a relatively new technology. As such, there may be vulnerabilities that have not yet been exposed – after all, during WWII, the Enigma Code was considered impossible to crack, until Alan Turing and his team at Bletchley Park came along. At this very moment, it is likely that many hackers are attempting to identify and exploit blockchain vulnerabilities. Maintaining a sound security position can help agencies fortify themselves against those efforts while taking strides to improve their procurement processes.

Innovation beyond the procurement process

Blockchain has considerable potential for the public sector in the U.K: it has been shown to be innovative and powerful in other industries and could very possibly revolutionise government procurement processes in the near future. However, this is only the start of the

potential blockchain revolution – as a [previous U.K. government report](#) suggested. The same technology could work to track government loans and spending, protect critical infrastructure, or even help to deliver on the government's foreign aid commitments in a more secure and transparent way.

Success with blockchain, though, is contingent on supporting the technology with comprehensive network management. Clear visibility across all nodes and management of performance levels will be integral to helping maintain security and preventing blockages in the network. Only then can blockchain and distributed ledger technology, successfully transform government digital services. ■

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Blockchain in manufacturing: The perfect match

The expertise of a thought leader on blockchain in the enterprise, Sadiq Quasim, Director from Loyakk Ltd is profiled here, as well as the important role of blockchain in manufacturing today

Sadiq, a thought leader on blockchain in the enterprise, runs Loyakk Ltd and is a frequent speaker on blockchain and its impact on Enterprises. Sadiq has been instrumental in defining the Loyakk's blockchain-anchored Value Web framework and the resulting solution portfolio. Sadiq has been a critical part of the team defining the blockchain-enabled Vega Business Relationship platform.

Prior to Loyakk, Sadiq's innovative efforts to bridge technology to business requirements have been applied in initiatives across major central government organisations like the Cabinet Office and the Department for Work and Pensions (DWP), as well as blue chip companies HP, EDS, CSC and Bupa. Sadiq's vision for Loyakk is to empower enterprises to reinvent the way they drive business and value across their fast-growing ecosystem of customers, channel, partners, distributors and suppliers.

Blockchain in manufacturing

Manufacturing is a key driver of the global economy. The sector alone accounts for nearly 17% of global GDP, according to the World Bank.

Unfortunately, manufacturing has always been rife with inefficiency and quality-control problems. Fake products can make their way to market because the current system lacks a way to track what's real and what's not.

In fact, the counterfeit goods market adds up to half trillion per year, based on data from the International Trademark Association.

Supply chains are unnecessarily complex and disconnected, so it isn't as easy to monitor as it should be. Meanwhile, customer expectations are increasing, which places even more pressure on manufacturers to deliver products at the price consumers want.

The many problems we see today in manufacturing – from counterfeiting and poor quality to inefficient processes and a lack of trust in production – are all due to the fact that manufacturers still operate as if we were all living in the 20th century.

Thankfully, blockchain technology can provide a solution to all the problems the manufacturing industry faces and helps to usher it into the 21st century.

The blockchain can improve verifiability and transparency in manufacturing

Do you remember the Chipotle E. Coli outbreak of 2015? To this day, no one knows what ingredient or meat caused the outbreak. That's due to issues with tracing the source of the bacteria. Chipotle's supply chain was just too complex and disconnected.

Had Chipotle's supply chain been on a blockchain, the company could have easily pinpointed where the contami-

nation originated from. That's because the blockchain is an immutable distributed ledger that enables real-time tracking of parts and supplies from origin to manufacturer to retailer.

By unifying the supply chain on a decentralised blockchain platform, suppliers, manufacturers and retailers can record at any time something changes hands or is bought and sold.

So, whether you're a corporation or a small business, putting the supply chain on the blockchain can and will have enormously beneficial consequences. Not only does it increase overall transparency, it also makes recognising (and solving or stopping) supply chain issues a whole lot easier.

What's an immutable, distributed ledger, again?

An easy way to understand how blockchain technology could completely revolutionise both manufacturing and supply chains is by comparing it to a living dossier of activity logs. These digital logs – which are automatically updated every time a meaningful transaction occurs – allow anyone to easily observe and trace the flow of parts and goods between companies.

This 24/7 eagle's eye view provides manufacturers with a never-before-seen level of control and compliance. They'll be able to see and address problems in real time, as well as eliminate the ability for copying or theft.

For instance, in a computer manufacturer's supply chain, various components are sourced from suppliers all over the world. Running the supply chain on a blockchain-based platform would enable the entire network to identify a faulty part immediately or prevent an unscrupulous player from pushing the part through to the next step in the supply chain.

In short, a blockchain-based solution like the [Loyakk Vega blockchain-powered enterprise relationship platform](#), built for companies operating on a large scale within a global network of suppliers and partners, can ease the burden of trust manufacturers face.

With the right blockchain platform, manufacturers and shippers can ensure quality products at the right price that are protected from tampering and unfair competition.

Helping manufacturers meet the demands of the modern customer

In today's Amazon and Alibaba-led world, the modern consumer demands choice, quality and affordability. They also want whatever they order to arrive as quickly as possible. Blockchain technologies have the potential to deliver on all of those demanding expectations.

In addition to improving security, a blockchain-based platform removes the need for middlemen, like lawyers and banks, by enabling a direct connection between manufacturers and suppliers. This is largely thanks to [smart contracts](#), which rely on an immutable code, ensuring certain terms and conditions are met in an agreement between two or more parties. The smart contract will only send a payment or asset to a party once they meet those terms and conditions.

This [ensures that all parties adhere to the agreement](#), in turn, guaranteeing the highest level of accountability.

A blockchain-based solution can also streamline processes by simplifying data management and reducing the time it takes to complete certain tasks. For example, as experts note, this enables the creation of a thorough [end-to-end audit trail](#). Traditional audits are not only very expensive, they're also very time-consuming and inefficient. Streamlining quality assurance checks will go a long way towards improving accountability and trust along the supply chain.

Everyone will benefit when the supply chain is put on the blockchain, from maker to consumer, as higher quality products can be produced at a lower price.

Blockchain and the future of manufacturing

Many industry experts claim that [3D printing is the future](#) of manufacturing. And they're absolutely right. The mass printing of rapid prototypes and customisable products is a game-changer for manufacturing as a whole.

But manufacturers have serious concerns about security. In a manufacturing marketplace of fail-fast prototypes and constantly re-optimised products, how do you protect your intellectual property and prevent someone from simply stealing a great idea?

The blockchain puts an end to this concern by using [smart contracts](#), which automatically negotiate terms and conditions, protect the design by giving creators full control over important files and guarantee that the additive manufacturing process meets requirements for design quality and materials.

Innovators won't have to worry about factory personnel stealing an idea or production quality not being up to snuff. By encrypting and maintaining digital product memories on the blockchain and overseeing product production through smart contracts, 3D printing and additive manufacturing can be carried out efficiently and securely.

Bright days are ahead for manufacturers

There are a lot of new technologies redefining [the way companies do business](#). But the blockchain is the one that can bring trust, quality, security, provenance and governance to the manufacturing process.

As blockchain technology continues to advance and becomes more defined, the supply chain and service supply chain, in particular, could begin seeing truer forms of transparency, accountability and efficiency.

The sooner manufacturers adopt blockchain technologies, like [Loyakk's Vega platform](#), the sooner they can benefit from a much better way of doing business.



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Blockchain: How a treasury system will foster better collaborative intelligence for cryptocurrencies

Bingsheng Zhang from Lancaster University reveals how a treasury system will enable a better collaborative intelligence for cryptocurrencies

Blockchain technology has pioneered a new consensus approach to build a distributed public ledger globally. One of the key features expected from cryptocurrencies and blockchain systems is the absence of a centralised control over the operation process. That is, blockchain solutions should neither rely on “trusted parties or powerful minority” for their operations nor introduce such centralisation tendencies into blockchain systems.

On the other hand, real-world blockchain systems require steady funding for the continuous development and maintenance. Given that blockchain systems are decentralised, their maintenance and developmental funding should also be void of centralisation risks. Therefore, secure and “community-inclusive” long-term sustainability of funding is critical for the health of blockchain platforms.

During the early years, the development of cryptocurrencies, such as Bitcoin, mainly relies on patron organisations and donations. Recently, an increasing number of cryptocurrencies are funded through initial coin offering (ICO) – a popular crowd-funding mechanism to raise money for the corresponding start-ups or companies. A major drawback of donations and ICOs is that they

lack sustainable funding supply. Consequently, they are not suitable as long-term funding sources for cryptocurrency development due to the difficulty of predicting the amount of funds needed (or that will be available) for future development and maintenance.

Alternatively, some cryptocurrency companies, such as Zcash Electric Coin Company, take a certain percentage of hair-cut/tax (a.k.a. founders reward) from the miners’ reward. This approach would provide the companies with a more sustainable funding source for long-term planning of the cryptocurrency development.

Nevertheless, all the aforementioned development funding approaches have risks of centralisation in terms of the decision-making on the development steering. Only a few people participate in the decision-making process on how the available funds will be used. However, the decentralised architecture of blockchain technologies makes it inappropriate to have a centralised control of the funding for secure development processes. Sometimes disagreement among the organisation members may lead to catastrophic consequences.

Ideally, all the cryptocurrency stakeholders are entitled to participate in

the decision-making process on funding allocation. This democratic type of community-inclusive decentralised decision-making enables a better collaborative intelligence. The concept of the treasury system has been raised to address the highlighted issue. A treasury system is a community controlled and decentralised collaborative decision-making mechanism for sustainable funding of the underlying blockchain development and maintenance.

At Lancaster University, the research team led by Dr Bingsheng Zhang has been actively developing a novel treasury system for blockchain in collaboration with IOHK. This project aims to resolve the funding sustainability issue for long-term cryptocurrency development and maintenance. Figure 1 illustrates an overview of the treasury system and it consists of iterative treasury periods.

During each treasury period, project proposals are submitted, discussed and voted for; top-ranked projects are then funded. In particular, Lancaster research team has developed the world’s first universally composable provably secure distributed decision-making system that supports liquid democracy with privacy assurance – to achieve better collaborative intelligence.

Blockchain: Potential to help the music industry

We spoke to singer, songwriter, record producer and audio engineer, Imogen Heap about the potential blockchain has to help musicians and the wider industry

Singer, songwriter, record producer and audio engineer, Imogen Heap speaks to us about the potential that blockchain has to help musicians and the industry more generally. She founded the company Mycelia, the mission of which is to “empower a fair, sustainable and vibrant music industry ecosystem involving all online music interaction services.”

Imogen believes that blockchain has the potential to ease the collaboration in business for music-makers and services and also to help those in the industry to be acknowledged for their creative work. This fits in with one aspect of the firm’s mission, which is to ensure that commercial, ethical and technical standards are set to exponentially increase innovation for the music services of the future.

“Our aim now is to start now with our Creative Passport, which together with music-makers enables us to put a foot forward and create our home for the future so that we can integrate with blockchain and are not left behind.”

Imogen explains more on these areas plus the extent to which blockchain has the potential to provide a quicker and more seamless experience for anyone involved in creating or interacting with music. Imogen also strongly believe in connecting the dots with all those involved in the shift from our current outdated music industry models to exploring new technological solutions to enliven and positively impact the music ecosystem.

“The real magic is The Internet of Agreements® is how do we integrate them into our daily lifestyle? Anything has to be easier than it is right now, indeed, today there is no shared database for songs, and as a result, there is no ecosystem there. We need to build that, and



Imogen Heap, Founder of Mycelia

we will be able to do this thanks to blockchain technology where lots of people are now thinking in the same way, which means we are not dealing with the current issues all by ourselves. This means that for the first time, the plight of musicians is suddenly interesting to people because there are technological solutions that work towards a better place for the future of the industry. Also, there is essentially money to be made in terms of innovation in music services.”

In terms of how blockchain could store a musician’s online profile, such as tour dates and press images,

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Imogen believes that while we talk about such technology, it is really an empowering tool that will augment the internet as we know it. She explains the notion behind [the Creative Passport](#), a digital container that holds verified profile information and uses blockchain technology. Featuring a 'smart contracts' template, it aims to facilitate direct payments, simplify and democratise collaboration from meaningful commercial partnerships that encourage creativity in the music industry.

"We do not understand everything about how the internet works, so it is the same with blockchain in that we don't need to understand it. We can simply use it in the future and it should enable us to create easier collaboration, so when something becomes so useful and easy to use then it will be adopted.

"Our aim now is to start now with our Creative Passport, which together with music-makers, enables us to put a foot forward and create our home for the future so that we can integrate with blockchain and are not left behind."

Also, Imogen remembers three years ago, meeting Vinay Gupta the then project launch manager for Ethereum, an open-source, public, blockchain-based distributed computing platform as she was introduced to their smart contract functionalities. "This really changed the game for me. It was so clear the huge positive impacts these could have on our current music ecosystem, I just had to get stuck in.

A conversation last year with RChain's president Greg Meredith had Heap take another step in realising the Creative Passport. "We discussed RChain and its open governance, how Greg looks to nature and viable systems for inspiration and problem-solving. I felt they were the right blockchain to run with for Mycelia. It's vitally important for music makers that we don't recreate century old problems of the past and take this technological leap of an opportunity to solve tired old issues such as lack of transparency, acknowledgement and flow of payment."

In closing, Imogen explains why now is the time for the music industry to take the long-view look and explore blockchain together with its creatives for the sake of its sanity and future.

"Other industries are talking about possibilities and innovation, so that is a very different story from what it was. The music industry can look at other sectors, such as banking and health, to move blockchain forward in terms of helping musicians and the industry." ■

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The role of blockchain in the world of investments

Olga Feldmeier, CEO of Smart Valor and described as the 'Bitcoin Queen of Crypto Valley' speaks to us about the role of blockchain in investments

Olga Feldmeier, CEO of Smart Valor and described as the 'Bitcoin Queen of Crypto Valley', is one of the world's foremost blockchain and cryptocurrency experts. Olga regularly delivers keynotes and presentations at industry events and on global broadcast slots.

Previously a UBS banker, Olga is now CEO of Smart Valor, a new blockchain-powered platform that concerns making alternative investments accessible for everyone. We were fortunate to speak with her at 2018's MoneyConf in Dublin to learn more about her seasoned views on blockchain and cryptocurrency.

Assuming that you have little or no knowledge of blockchain, how would you explain the concept of blockchain? Olga makes it simple, by taking us on a journey in our imaginations to imagine a network of computers all over the world on the intranet run from the same programme. Olga is keen to explain this point further to us in her own words. "This programme enables us to validate transactions and to prove that data is real."

The conversation then moves to Olga's thoughts on fractional ownership, by that, she explains that this concept is a very powerful one because where investment opportunities are present, the average person cannot afford them. One can become involved in exciting investment opportunities by the creation of intermediaries, such as large financial institutions and funds for real estate, for example. Olga then explains this fascinating point to us in more detail, as well as the role that blockchain in investments.

"With blockchain, you don't need central bodies to take part in investment opportunities. Any asset itself can be fractionalised, using a number of tools and can then be sold. Fractional ownership can also achieve digital shares in a company, but the really great thing about this is how ownership can be exchanged by participating. With blockchain, the transfer of ownership happens on a peer to peer global network and is instant and cost-effective.

"Any physical investment, such as real estate, makes you think about digital ownership, for example, in a



Olga Feldmeier
Founder and CEO
Smart Valor

“This is the case because Switzerland is one of the leading nations in terms of innovation and the banking sector. If you combine these two things together, you can see that when it comes to innovation, FinTech and blockchain, it is very natural for Switzerland to embrace these technologies. Switzerland has the chance to become home to the next generation of financial infrastructure. Crypto banks are the future – and smart countries such as Switzerland, Luxembourg, Singapore need to accumulate expertise to reach this point.”

Finally, Olga explains her thoughts on what is really exciting about blockchain, in that the technology has arrived to challenge the balance of power between people and state. But how? With decentralised money – taking the example of the country Ukraine – where the government says money can be printed money and wealth distributed. Today, as a citizen, you have the right to buy Bitcoin, which distances you from the local currency.

“At the end of the day, we can influence monetary policy to some extent which means the government no longer has the power over their people, so this means that there will be radical changes ahead to the social contract in terms of the relationship between people and state.

“Also, if people can move their wealth completely out of the banking system, then they become independent of the will of their government. Isn't it my right to decide what I do with my money? If I am excited about Apple or Google, for example, then why can I not invest in them? At the end of the day, if there is freedom of speech then should there not also be the freedom of money? This is not the case today.” ■

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company share. It takes a few days for the settlement clearing process to take place, which will involve going to the bank, for example. The bank will send the information into the centralised registry where the ownership of a share is recorded. Imagine instead, a centralised and distributed network of computers writing the same ledger in real time, so that method can be used for just about anything when it comes to owning things.”

Looking at Switzerland, we know that this country has surged ahead as the world's leading hub for blockchain and cryptocurrencies. Olga is well-positioned to explain her thoughts on this to us, including the fact that in Switzerland, Ethereum was introduced there in 2014 and gained much attention in the country. A Bitcoin company where Olga used to work gained a license from the financial regulator in Switzerland to operate as a financial intermediary as opposed to a bank, she reveals. Olga also explains the ambition from a political standpoint for Switzerland to become a global blockchain hub.

“That was a great signal to the rest of the world that Switzerland is open to Bitcoin and during the last year, there was a huge wave of Initial Coin Offerings (ICO's) in the country. Around 1 billion was raised through swiss entities and approximately 400 companies were created in Switzerland. The President of Switzerland likes to talk about Crypto Nation Switzerland, rather than Crypto Valley Switzerland. This shows that the ambition to established Switzerland as a global blockchain hub, so this comes from a very high political level.

eHarvestHub gives small farmers centre stage on the global market

Our global economy is leaving our small farmers behind, yet they produce more than 60% of the fresh food we consume. eHarvestHub gives farmers direct access to the global market making our food more affordable and accessible, as this analysis from Alvaro Ramirez at eHarvestHub reveals

We produce enough fresh food to feed the world, however, affordability and accessibility are a big problem. Fresh food is a global business, yet consumers pay high prices, while the farmers who feed us are financially being left behind. This can all be attributed to the complexity of our food chain. To make fresh food more affordable and accessible, we must radically change the food supply chain; from seed to the grocery store to the lending institutions who finance our small farmers each year.

To make this happen, “true decentralisation is needed and blockchain technology is perfect for it”, notes Alvaro Ramirez, CEO and Founder of eHarvestHub. The company’s approach to solving the affordability and accessibility of fresh food not only uses blockchain technology to achieve it, eHarvestHub’s business model removes the layers of middlemen leaving only key market participants: the grower, the trucker, the grocer and the consumer. The company brings the small farmer to the global stage, giving grocers direct access to their inventories that today can only be accessed through the existing layers. Let’s take a closer look.

According to World Bank agricultural data, more than 60% of our global fresh food production comes from the more than 480 million small farmers.

The eHarvestHub marketplace gives these small farmers a global stage. Regardless of the geographical location, eHarvestHub has found that small farmers face the same core problems: 1) not enough volume; 2) dependent on middlemen to market their product and arrange transportation and; 3) high-interest loans.

Developed countries with high population and economic power drive food imports today. Twenty-five countries import more than \$1 trillion of the world’s food production and 66 countries also rely on imported food. For example, last year the United States imported more than \$136 billion in fresh food, most of which came from the over 19 million farmers in Latin America. One of the main reasons why the United States imports fresh food from Latin America is because of food safety. Many farmers in Latin America follow Good Agricultural Practices (GAP) and similar food safety practices as American growers.

Small farmers don’t produce enough volume to meet supermarkets’ demand on their own, forcing them to sell to the multiple middlemen who clutter our food supply chain giving grocers little visibility to small farmers’ available inventories. This leaves farmers making pennies on the dollar for their product, while consumers pay high prices and the middlemen profit the most in this ecosystem. The product



moves through the value chain – sometimes exchanging hands seven to 10 times – increasing the risk of contamination, food fraud, lowering shelf life and increasing costs each time a product exchanges hand.

Technology alone is not the answer. To solve the accessibility and affordability problem, eHarvestHub goes to the root of the problem: increase the farmer’s margin using blockchain technology with its business model to give the small farmer a stage on the global market. eHarvestHub’s CEO says that technology providers fall short because while they may have sound technology, they end up taking percentages from the farmers’ profits, only becoming the new middleman. For technology to be effective, the business model must enable growers to have access to the technology without fear of losing their hard-earned money. With eHarvestHub’s flat trans-



action fees and no middlemen, these two factors increase margins for the farmer and enable growers to gain the maximum use of the company's technology. This not only creates true transparency for grocers and consumers, but it gives farmers access to consumer-driven lending.

eHarvestHub's full enterprise technology solution provides its customers with traceability, a real-time inventory, order management, direct access to truckers a marketplace where grower, grocer and trucker can interact directly, and it is intuitive and built with not so tech-savvy customers in mind. eHarvestHub's use of blockchain, smart contracts and cryptocurrencies not only to help farmers give full transparency on their products, but to be paid soon after the product has been delivered. Farmers currently must wait up to 90 days after the product has been delivered to be paid. The marketplace smart contract places the funds for a transaction in an escrow account, which gives the buyer a peace of mind as funds only get released if the seller and carrier fulfil all their contracted obligations. Once

all parties have fulfilled their obligations, the smart contract releases the funds to the seller and carrier.

Ed Treacy, Sr. Vice President of the Product Marketing Association, describes fresh produce logistics as a web because of the multiple times that fresh produce exchanges hands and locations. eHarvestHub simplifies that web by removing the middlemen. With the goal of making fresh food more affordable and accessible, lowering cost includes "not only removing the need for the supply chain middlemen but also the agricultural lender", explains Alvaro Ramirez. At the start of their planting season each year, farmers borrow from banks often paying up to 17% in interest.

Other financial institutions, unregulated in most countries, can charge up to 60% in interest. Since blockchain can truly connect farmer and consumer – regardless of their geolocation – consumers can see where the food they purchase comes from and where their money is going then they are most likely to support grocers who pay farmers higher. This transparency

that eHarvestHub provides, coupled with its cryptocurrency, allows consumers to crowdfund loans for farmers at much lower interest rates than farmers currently pay. This truly gives the power back to consumers and putting the value where it belongs, with our farmers.

eHarvestHub's approach to solving fresh food affordability and accessibility through blockchain technology and its social-economic business model truly disrupt and rewrite how our food reaches consumers. Helping farmers make more money will allow farmers to become more sustainable, as they will possess the funds to do so. Food waste can dramatically be decreased as farmers could plant fresh food based on market needs. The company's approach to consumer lending for farmers has the potential to uplift many farmers from poverty while helping consumers make an extra income.

For more information on how to get involved with eHarvestHub, you can contact Alvaro Ramirez at Alvaro@eHarvestHub.com or visit their website at www.eHarvestHub.com



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Gibraltar: The development of blockchain

Philip Young, Director of Marketing and Business Development at Gibraltar Stock Exchange Group explains his thoughts on the development of blockchain in Gibraltar

The Gibraltar Blockchain Exchange (GBX), is part of the Gibraltar Stock Exchange Group. In an interview with the firm's Philip Young, Director of Marketing and Business Development, we learn more about how he perceives blockchain in Gibraltar. He explains that it is important to start by being aware that the country is a jurisdiction, in terms of being a self-governing British territory with its own government and regulator. He is keen to explain this vital point to us further.

"We are pretty much self-governed in all aspects, but when it comes to defence we rely on the UK. It is important to say that two and a half years ago, the government and the regulator started engaging in a conversation as to how they could provide regulations in the area of blockchain capacity, for example. That was a three-way engagement between the government, private sector and regulators that really culminated over a period of two and a half years before 1st January 2018.

"This date marked one of the first countries in the world to have a distributed ledger technology legislative framework. That said, as a jurisdiction, Gibraltar can provide three things. Regulatory certainty – that comes with blockchain, as well as the legal and financial certainty – due to the ecosystem that the country had created with the private, banking and legal sectors.

"All these sectors are working together to support the development of the global blockchain community within one of the first regulatory frameworks in the world. As a result of that, during 2017 and this year, Gibraltar has been one of the global hubs now for the blockchain movement. With the launch of the new regulations this year, we are seeing global companies looking to come to Gibraltar and be regulated."

Philip adds that this really replicates what Gibraltar did 25 years ago when all the online games community was based in the country. Over the years, 25-30 of the franchisees in Gibraltar control 30 to 40% of the global gaming business, we discover. Looking back at this example, we can see that the country created a legislative framework and encouraged quality businesses to come to Gibraltar. What Gibraltar Stock Exchange Group wanted to do was to take that model and replace it with the blockchain industry.

"Gibraltar Stock Exchange Group began applying for its own licence in 2012/2013 because we recognised that the country was the last EU jurisdiction without a stock exchange. We wanted to use the stock exchange itself to be the catalyst for Gibraltar in terms of financial services and also very importantly, our association with the UK. We wanted to look at fundamental issues with small to medium-sized enterprises (SMEs) which cannot tap the capital market or come to a stock exchange because it is too expensive and takes too long.

"The capital market for SME's has always been broken, so we wanted to open up the market and raise money through equities or bonds, for example, through a regulatory framework to get SMEs to the market faster and by being economic. That has always been the fundamental cornerstone of what the Gibraltar Stock Exchange Group is doing."

Philip says the Gibraltar Stock Exchange Group ordered their license in 2015, but this was before they even became aware of the blockchain movement, but then they looked at it closer to see how they could take global leadership in terms of how to embrace the technology and use it to make things faster and cheaper.

"It could help to bring together buyers of regulated



Philip Young, Director of Marketing and Business Development at Gibraltar Stock Exchange Group

Finally, Philip leaves us with a profound thought. If you go back just one year ago, would you have been able to forecast where blockchain is at today? Although Gibraltar only has a population of 32,000 people, they remain a global centre and people come through their door from all over the world, Philip explains before offering his final thoughts.

“From schools up to senior management, they need to get their heads around a technology that is quite simple as a distributed ledger, but its application is yet to come following the current experimental phase. There will be clear winners coming out in ways that we cannot see.” ■

products with the issuers that are wanting the capital across the regulated platform. We began to work with the regulator and did our own assessment to get comfortable with what is a fast-moving space, indeed, every week feels like a year in terms of what is happening with blockchain technology. This is a challenge for policymakers, regulators and the private sector. Keeping up is a tough job.”

In addition, Philip says that one of the world’s first asset-backed securities was the first asset class that was linked to the Bitcoin. Gibraltar Stock Exchange Group also wanted to see how they could open up cryptocurrencies to see how they could be opened up to institutional investors. The industry today is very small and main retail-driven, but how do we get institutional players into the market? The answer, he says, lies in regulated exchanges and to start applying them to blockchain, cryptocurrencies and tokens.

Philip Young
Director of Marketing and Business Development

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Blockchain from a compliance perspective

Michelle McGuire, Head of Risk and Compliance at GECKO Governance shares her views on blockchain from a compliance perspective

When it comes to blockchain, Michelle McGuire, Head of Risk and Compliance at GECKO Governance argues that financial compliance is key, however many regulators are not moving as fast as the industry itself is moving, she observes. Jurisdictions such as Singapore, Malta, Gibraltar and the Isle of Man are leading the way. Having said that, jurisdictions such as the U.S. are lagging behind, something that GECKO Governance is hearing a lot about, Michelle adds.

"In the U.S., there are investors who are quite concerned about how the blockchain space could be regulated, so they are holding back in fear of what is to come. It is the view of our firm that the blockchain industry needs regulation and compliance and must to be brought in line with traditional markets, to bring institutional players in.

"Transparency is very important where a system is built on blockchain, which integrated with Hyperledger fabric, allows you to permission access into the system. That way, you are giving transparency to your investors, regulator or partner. You are giving accountability this way."

Michelle then explains that her firm does not feel that cryptocurrencies should be wedged into an asset class and that requires some thought leadership and some insight from the industry in collaboration with the regulators to bring it forward. This is because you do not want to stamp out innovation and the creativity of individual people, Michelle stresses. Michelle also offers her thoughts on how she would define blockchain itself from the risk compliance perspective.

"It is a form of software that secures data safely and blockchain helps businesses to manage data and not have to repeatedly ask their employees information such as date of birth, in terms of risk compliance."

"Transparency is very important where a system is built on blockchain, which integrated with Hyperledger fabric, allows you to permission access into the system. That way, you are giving transparency to your investors, regulator or partner. You are giving accountability this way."

The conversation then turns to Initial Coin Offerings (ICO) token sales, including the fact that from the perspective of GECKO Governance, the system they know is all on the blockchain with Hyperledger fabric. Michelle elaborates on this point further to us, from the perspective of managing cryptocurrencies and ICO investment needs.

"It can provide a level of comfort and assurance that you are doing what you need to and you can prove it. By bringing this into the blockchain space, you are really bringing in a high level of compliance, but when we are faced with the competition, this challenges us to expand our platform and therefore, to manage cryptocurrencies and ICO investment needs.

"It is important for any project to prove that they are as compliant as they can be in the world of blockchain. In this vein, we need to learn the process of token sales, find out where the pitfalls are and where the key obligations should lie and therefore, develop a platform from there."



Isle of Man

“It is important for any project to prove that they are as compliant as they can be in the world of blockchain. In this vein, we need to learn the process of token sales, find out where the pitfalls are and where the key obligations should lie and therefore, develop a platform from there.”

Following on from this, Michelle adds that software can be developed to manage the end to end process when it comes to token sales, so a number of projects need to be managed in terms of developing a white paper through to security wallets and smart contracts. A centralised platform can be used to manage this and GECKO Governance is an example of a firm working from a number of jurisdictions to meet the requirements of smart cards, digital wallets and custodial.

Finally, in terms of being regulated by the Isle of Man, GECKO Governance sees this as a positive move

when it comes to hefty regulation. This is something that any company to take comfort from, Michelle concludes, in terms of taking the most compliant approach they can. ■

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Financial services: The explosion of cryptocurrencies

Erik Voorhees, CEO of ShapeShift speaks to us about the explosion of cryptocurrencies from a financial services perspective. In this interview, he shares his thoughts on swapping digital currencies and the role of innovation in the field

ShapeShift is a part of today's cryptocurrency ecosystem, which enables one to quickly swap between assets. As an expert in the field of cryptocurrencies, we enjoyed a conversation with the firm's CEO, Erik Voorhees to find out more about cryptocurrencies, as well as swapping digital currencies and the role of innovation in this space.

Firstly, assuming that the reader has little or no knowledge of cryptocurrencies, Erik is eager to reveal that cryptocurrencies, such as bitcoin and Ethereum are defined as decentralised currencies. This means that they are not

controlled by any government and rely on technology, cryptology to be redistributed and are transferable from peer-to-peer (P2P) around the globe, very quickly.

"Cryptocurrencies value generally comes from people who are buying and selling them in markets where there is a limited supply, so as people buy and sell them their value goes up and down. They run on a blockchain, which is a distributed digital ledger. This allows them to settle without having to trust anybody else in the world. As long as we trust mathematics, we can trust that these things are going to work."

The conversation then moves to Erik's thoughts on swapping digital currencies and just exactly how safe and secure he thinks they are. He tells us that in terms of swapping from one digital currency to another, there are a couple of things to consider. Firstly, Erik says that when it comes to sending a digital currency on a blockchain, is extremely secure and is backed by the power of those networks.

"The main point of cryptocurrencies is to make it easier to transfer value securely, across borders, without having to trust any third party.

"Cryptocurrencies value generally comes from people who are buying and selling them in markets where there is a limited supply, so as people buy and sell their value goes up and down. They run on a blockchain, which is a distributed digital ledger. This allows them to settle without having to trust anybody else in the world. As long as we trust mathematics, we can trust that these things are going to work."

"There are a few different ways to swap from one digital currency to another. There are centralised exchanges where you can do this. You need to set up an account, deposit your funds and then set up orders to quickly exchange from one digital currency to another. Those have varying levels of security. You are essentially trusting that the exchange, which is holding your funds is not going to run off with their money or be shut down.

"There are other exchanges, such as ShapeShift, which are non-custodial and far safer than a centralised exchange. We never actually hold customer funds. It is like a vending machine – you pop one asset in and another one comes out, and therefore you always remain in control of your assets."

Erik then shares his views on the extent to which the cryptocurrency ecosystem is changing today and where he sees it heading in the future. He explains that the cryptocurrencies industry has grown by leaps and bounds, especially during the last year and a half. Erik goes on to explain this interesting point to us in further

detail and also his thoughts on what financial services could look like in the future.

"Cryptocurrencies have exploded in value in terms of global interest, but in the long-term, they will become the backbone of a new financial system. This will disrupt and disintermediate many banks and middlemen who have traditionally provided such services.

"Eventually, it will go far beyond financial services and it will disintermediate everything that requires trust. We will move to a system where we will not have to trust third-parties. Instead, we'll be trusting mathematics, which is much better than trusting governments and people."

When it comes to the role of innovation in the field, Erik explains that the entire field of cryptocurrency concerns this. Cryptocurrencies, he believes, are one of the most important innovations to happen to humanity since the internet and even before that, when the idea of paper currencies was invented. In closing, he elaborates on this fascinating point.

"These platforms essentially allow for permissionless innovation. Right now, if you are trying to innovate in the FinTech space, you tend to be held back by the fact that all of these traditional financial systems require permission. Cryptocurrencies and blockchain technology are permissionless. This allows innovation to take a much faster pace than we've seen in the financial space in centuries." ■

Erik Voorhees
CEO

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Building wealth through cryptocurrencies

Director of Investor Relations at Atlas Quantum, Bruno Peroni shares his expert views on building wealth through cryptocurrencies

Director of Investor Relations at Atlas Quantum, Bruno Peroni is an expert on building wealth through cryptocurrencies. As a start-up and venture capital enthusiast, he believes that anyone should be able to invest in any business. The firm's mission is to make institutional investment techniques accessible for everyone - through cryptocurrencies. We were fortunate to speak with him to learn more about the exciting world of building wealth through cryptocurrencies.

By way of an introduction, we know that Bitcoin is one way of exchanging value without a third-party, which is the main value proposition of cryptocurrencies. As such, everything in this vein is based on codes and algorithms, so you do not need to trust another party to exchange money, Bruno explains.

Where cryptocurrencies are concerned, this is the first time that value has been transferred over the internet, so in this respect, a unique piece of software represents value and cannot be copied. Bruno says that cryptocurrencies are borderless and can be transferred to

anybody in the world, a point he goes on to develop, in addition to his thoughts on the distinctive nature of tokens.

"It cannot be copied because it is transferred through a distributor network that cannot be attacked. The exchanges are where these transfers take place which are negotiation platforms for those who want to trade between currencies such as the Euro and the Pound and cryptocurrencies, or between different cryptocurrencies. The various cryptocurrencies are in competition to be the main cryptocurrency.

"There has been much confusion between cryptocurrencies and tokens. The fact that there are than 3,000 cryptocurrencies is simply not true. There are actually around 40-50 cryptocurrencies, all of which have very similar features and are distinct, for example, in terms of more privacy. For example, in Bitcoin blockchain, which is the registry of all transactions, companies are doing analytics on that, so it is easy to track where you have other forms of cryptocurrency. It is impossible to track the origin of that transaction and the owner of it.



Bruno Peroni
Director of Investor
Relations

“Tokens are a more difficult concept to track, but it helps to think in the form of a digital asset which you can transfer over the internet and it is unique and cannot be copied. That can be applied to a specific use case on the blockchain, for example, where identities are concerned, instead of having your identity held by a centralised institution such as Facebook, you have your identity held on a blockchain. A token represents your identity to trade between these.”

The conversation then moves to Bruno’s reflections on regulation and cryptocurrencies and the extent to which we are making progress in these areas. Regulations do change very quickly, but most regulators are open to cryptocurrencies, even though it is not an easy concept to understand. This is because some of these tokens are securities and at the same time, some are used as a payment method so as a new asset class blockchain has to fit in with the existing laws, Bruno tells us.

“I think we are still figuring out how that will go, but I think that regulations are admirable and will happen in various jurisdictions. Having said that, this is a borderless platform by definition, but this is also a hard concept to grasp because you can trade anywhere with a Bitcoin as regulations do not apply to it. I do think that cryptocurrencies will be regulated when they interact with the current financial system, for example, within exchanges.”

Concerning the continued volatility of virtual currencies, Bruno reveals why he thinks they will prevent cryptocurrencies from going mainstream. He explains that virtual currencies remain volatile for a number of

reasons, one of which is that there are more professional companies and institutions who are having fewer incidents that will make people scared.

“You will also get more mature investors because there are a lot of panic buyers and sellers in this market due to news, so it is a real infinite market in terms of trading where you have a lot of new people in financial market trading. So, it is definitely important that ways of using cryptocurrencies are managed well but at the same time, you can see other solutions such as Stable Coins. These are coded cryptocurrencies to have a stable price.

“Stable Coins are basically cryptocurrencies, so when money comes into the market they produce a supply, so there are always mechanisms to maintain a price, so it can be used by merchants, for example. These assets have to be managed in order to lose money with volatility, which is a great way to trade currencies instantly and accept payments.”

In closing, Bruno tells us that when it comes to the future of cryptocurrencies, he sees a few of them being used in the future for daily activities, such as business-to-business operations and remittances.

“At the same time, we will have tokens in the future, which can be used as digital assets for other reasons such as tokenizing existing assets. I think we will have millions of these for different purposes, for example, we might be able to tokenize the production of soy and it will be the cheapest way to ensure the securitization of assets and there will be millions of tokens for different purposes.” ■

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The EU: The undisputed global leader in open and fair trade

David Martin MEP, Group of the Progressive Alliance of Socialists and Democrats in the European Parliament argues that the EU is now the undisputed global leader in open and fair trade

In the last year and a half since Trump became President of the U.S., the international trade scenario has changed quite a lot and not for the better.

The European Union (EU) used to rely on the U.S., not only as a key political partner but also as a strong defender of the multilateral trading system and of open, fair and rules-based trade.

As the limited inputs provided to the Buenos Aires ministerial conference in December last year clearly demonstrated, the U.S. has not only disengaged from the World Trade Organization (WTO) but is also undermining its authority by blocking the appointment of the WTO Appellate Body's judges.

It might be argued that Trump is simply keeping his ill-judged electoral promises. The steel and aluminium tariffs illegally imposed against the EU and other trading partners are the result of his "America first" slogan. The EU's response to this protectionist measure has been prompt and firm. The EU Member States are often divided when it comes to trade but on this issue, they managed to speak with one voice. As for the Juncker-Trump statement made over the summer about a possible agreement to remove tariffs on all industrial goods except for cars, I must admit I am quite sceptical. The EU shouldn't accept to negotiate such a deal under a permanent threat of imposition of new tariffs (for instance on cars).

Against this background, it is fundamental that the EU continues strengthening its trade relations with the rest of the world. The Singapore, Japan and Vietnam trade agreements are concluded and ready for Parliament's ratification following approval by the Council. I am confident that the Singapore and Japan deals can be ratified by this Parliament, although I am far less



David Martin MEP

Image: © European Union 2011 PE-EP

optimistic towards Vietnam as the text still needs to be translated in all EU official languages. In April, the EU also finalised negotiations for a new trade agreement with Mexico. But this will certainly be for the next parliamentary mandate.

Besides their significant economic benefits, such agreements are also of geostrategic importance. These four countries are part of the Trans-Pacific Partnership Agreement (TPP) involving other seven Pacific-rim states like Canada, Australia, Philippines and Thailand. It is crucial that the EU does not lag behind while our trading partners are moving forward by intensifying their trade flows. Especially given that the U.S. has withdrawn from TPP and is more generally favouring protectionism over fair and open trade.



More importantly, these agreements reflect EU values. They all include provisions on labour and environmental standards, as well as mechanisms to allow civil society to monitor their implementation. The agreement with Mexico also features for the first time provisions on anti-corruption and a stand-alone chapter on animal welfare.

“It is fundamental that the EU continues strengthening its trade relations with the rest of the world. The Singapore, Japan and Vietnam trade agreements are concluded and ready for Parliament’s ratification following approval by the Council.”

But there is still much work to be done. Trade negotiations with Mercosur, Indonesia and Chile are progressing while those with Australia and New Zealand have just kicked off. The EU can be pleased with what it has achieved in terms of trade-related legislation. We now have in place binding rules on due diligence on conflict minerals, a new anti-dumping methodology for non-market economies like China, modernised trade defence rules that, for the first time, take social and environmental standards into account and work is being finalised for the adoption of a framework for the

screening of foreign direct investments. This shows that while the EU is in favour of an open and rules and values-based trade, we are not naïve, and we have equipped ourselves with instruments to defend our strategic interests and our companies and workers from unfair competition.

In its bilateral agreements and through its actions at the WTO, the EU demonstrated that it is prepared to stand up for a global trading system that is both open and fair. The UK should be a key contributor to this agenda. What a pity we have chosen to walk away. ■

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Understanding your citizens: The Universal Credit challenge

Local authorities and social housing providers must use data to provide a faster and more efficient service for the citizens they serve says Gary Bell, Civica's Executive Director, Managed Services

Universal Credit, the flagship reform of the benefits system was introduced to make welfare payments easier for local authorities and social housing providers. It was hoped that combining the likes of unemployment benefit, housing benefit and tax credits into one monthly payment would ultimately simplify the process.

While good in theory, problems with the roll-out, including many system design flaws and administrative glitches, are having a negative impact, not just on local authorities but the citizens that they serve.

[An analysis released by the Labour Party](#) the end of last year revealed that some councils across England are having to divert their own financial resources to deal with problems caused by the rollout of Universal Credit.

In addition, the six-week waiting time for payments is having a knock-on effect in areas such as council tax and homelessness as people are struggling to pay their rent and bills on time due to a longer wait to receive benefits.

With approximately 6.5 million households still to move onto Universal Credit due to a phased roll-out, the pressure is set to grow. While there are clearly challenges for local authorities in terms of the transition to the Universal Credit system, technology offers the means to overcome them.

Know your citizens

By understanding a citizen's credit history you can better judge and determine how people can pay debts and stay out of arrears. By identifying those that might

have payment issues, councils will be better placed to work with those residents likely to be impacted by Universal Credit early on in order to anticipate small issues before they become major problems. For example, a council could provide tailored help and advice when it comes to budgeting, or if a resident clearly has funds but is paid at an inconvenient time of the month then payment deadlines could be shifted.

This is a strategy being employed by Cartrefi Conwy council in North Wales. In terms of getting to know their customers, Tony Deakin, Financial Director of the organisation, says: "We've undertaken work with Experian to understand the credit history of our tenants, and their propensity to pay online or by direct debit. We are also utilising basic nudge principles in order to better understand how we can influence our tenant's payment methods. All of this was influential in our work to develop and promote our online payment portal."

Use data to build the bigger picture

While local authorities and housing associations already hold a large amount of data on citizens, the challenge for all public-sector organisations is in making sense of this data, in keeping with data consent regulations, to provide tangible benefits for the end user. These insights can also help better manage council resources and workloads by highlighting when they may need more employees or focused project teams.

An organisation doing just that is Prospect Housing. Speaking about how it is using technology to adapt its arrears modules, Director, Brendan Fowler says: "Predictive analytics are allowing us to see who is regularly missing payments or paying late. This in turn leading the housing association to work with citizens to identify



new payment dates and methods to ensure they don't fall into debt."

Map the customer journey

Local authorities will also benefit from looking at the multiple service points where citizens make contact and payments with a council. For example, having a 360-degree view of a citizen's payment journey may allow them to notice that a resident is behind with their rent or council tax and could map that back and see if they have or have not been paid their Universal Credit. Through greater understanding, councils will be able to operate much more effectively – and provide a better service to citizens.

While the issues surrounding Universal Credit are well documented, one key point to consider is that many councils are taking positive action to not only lessen the negative impact but also move forward and create a better service for citizens. This sentiment was perfectly encapsulated by Manjeet Gill, Interim Chief Executive, Wokingham Borough Council and Deputy Policy Spokesperson on Housing at SOLACE: "The key thing we

have discovered is the need to be positive – there's been an element of learning. We need to find the digital champions and the community development advocates to get people online."

With much work still to be done, local authorities and social housing providers need to turn to data to offer their citizens a faster, more efficient service to enable Universal Credit to become the positive reform it was intended to be. ■

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Prepaid cards: At the frontline in the fight against homelessness in the UK

Jennifer Duncan, Director of Government and Public Sector at Mastercard details why prepaid cards are at the frontline in the fight against homelessness in the UK

The Observer reported last year, following a Freedom of Information request, that half of all council tenants across 105 local authorities who received the housing element of Universal Credit were at least a month behind on their rent, with 30% two months behind. When comparing this to council tenants on housing benefit, 10% were a month behind on their rent, with under 5% running more than two months behind.

This pattern has also been reported by housing federations. Across the United Kingdom, 73% of housing federation tenants on Universal Credit were found to be in debt, compared with 29% of all other tenants. In the private sector, the Residential Landlords Association found that only 13% of landlords were willing to let properties to tenants on Universal Credit – claimants are being turned away at the door.

While there are many factors likely to be driving up this trend, individuals struggling with financial management is a key contributor. Claimants are expected, where possible, to arrange their own rent payments as they would if they were in full-time work. However, 20% of claimants are believed not to have a bank account, with many more thought to have had no prior experience of managing their own housing costs.

For those claimants who do not have a bank account, they are typically

offered a Post Office Card Account. This account does not enable payments or budgeting, instead, it simply allows an individual to withdraw funds in cash from the Post Office. For welfare claimants managing housing payments, potentially for the first time, this approach protects neither tenant nor landlord. It is also an expensive way of transacting for individuals and families who already have extremely limited resources.

“It puts the tenant in control and gives the landlord peace of mind. With many welfare recipients, in-work and receiving irregular income this flexibility to budget and manage funds is critical. Other budgeting features can be added including time locks on payments which can help to protect the finances of those with chaotic lives.”

If the only financial product you have access to restricts you to withdrawing cash, then you have little choice about the services and goods you buy and the price you pay for them. A number of studies have shown that it is expensive to be poor. This is driven by a lack of access to utility bill discounts by paying by direct debit, the inability to buy coach or train tickets online at discounted prices or the other deals that the majority take for granted.

The financial cost associated with this is known as the ‘poverty premium’, depending on where someone lives and their circumstances, it can cost a

family anywhere from £500 to £1,500 a year. To put this in perspective, Ofgem estimated that the average annual energy tariff in 2018 was £1,185 (dual fuel direct debit). Demonstrating that by having access to digital payments, in some cases, people can literally earn the ability to heat their home.

Universal Credit claimants should be offered the opportunity to access digital products to help maximise budgets in every way they can and have access to tools that enable money management. Encouragingly, the analysis of a pilot programme in Kent concluded that: “Prepaid cards have the potential to promote financial inclusion and independence, helping people manage their money and debts and widening options for financial management”.

A variety of prepaid types, including transaction accounts are well established with public sector organisations and the citizens they serve. Mastercard and its customers already work with over 200 public sector organisations to deliver prepaid programmes to support a range of services and government policy. These offer a real alternative to existing welfare disbursements. For public sector partners, this gives them the ability to save financially, cut out inefficiencies in processes and improve visibility over transactions, whilst at the same time increasing the level of care provided to each individual being supported, something that is key.



So, what is a prepaid transaction account? At a minimum, it has all the functionality of a basic bank account and does not require a credit check. Prepaid transaction accounts have no overdraft or cheque facility, reducing the likelihood of unmanageable debt which can lead, in the worst cases, to homelessness.

Account users can also set-up direct debits and standing orders, make card purchases in-store and online, check balances and expenditure online and withdraw cash using the ATM network. Providers such as The Change Account also offer financial education and budgeting tools and loyalty discounts at major retailers. Whereas, a Pockit account operates in a similar way, but has an added credit builder feature to help those with a bad, thin or no credit history to build a good one. The Post Office is expected to launch its own service in the coming months, which has the potential to bring the benefits of prepaid to even more people.

These features all aid the account holder's ability to avoid the poverty premium and to inform their spending decisions. However, budgeting tools, in particular, can support welfare claimants to successfully navigate their new financial responsibilities including managing housing payments. This tool enables account holders to protect and separate vital funds such as rental payments from everyday spending in a simple way.

It puts the tenant in control and gives the landlord peace of mind. With many welfare recipients, in-work and receiving irregular income this flexibility to budget and manage funds is critical. Other budgeting features can be added including time locks on payments which can help to protect the finances of those with chaotic lives.

We should be moving beyond the successful prepaid pilots and into full roll-out without delay. Prepaid transactional accounts should be offered to

all welfare claimants with budgeting needs as standard. By taking this step, the Department for Work and Pensions and local authorities, who are on the front line of welfare delivery, can simultaneously improve the financial health of welfare claimants and set them up for success.



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Deploying technology to bridge the public spending gap

Adrian Fieldhouse, Managing Director for Government at Sopra Steria explores how the deployment of technology can help to bridge the public spending gap

Day in, day out, the news headlines tell us that public services are under ever greater strain. While the government recognises the need to modernise and transform services, it does so against the constraints of a tightly constrained public purse. Add to this the increasing demands of citizens, who expect premium service delivered at the mere click of a finger and you realise the true challenge facing government.

A recent report by the National Institute of Economic and Social Research (NIESR), commissioned by Sopra Steria, warns that the pressure on the public finances could be greater than the government realises. The report predicts the emergence of a public spending gap of £300 billion over the next seven years. A hard Brexit and the threat of deteriorating economic conditions would only add to the gap, potentially contributing a further £50 billion by 2025.

Analysing the gap

NIESR's analysis looks at so-called "warranted" spending – the amount of funding needed to deliver public services that satisfy public and political demand. It suggests a shortfall will open up between warranted spending and the government's plans for funding key public services.

One explanation for this is the increasing proportion of people aged over 65, which is projected to rise from 18% in 2017 to 26% by 2067. This will create the need for extra resources to cover rising health and social care costs and to serve a larger number of pensioners.

A second explanation is that low levels of public spending might be affecting the quality of public services. There has been a marked deterioration in key government targets, including for health, where NHS operation waiting lists have reached a 10 year high. Even with the birthday funding settlement of an additional £20 billion



a year, the NHS will continue to grapple with rising and more complex demands.

So, the government seems to face a stark choice – tax increases or even more cuts to public spending – if it is to avoid government borrowing rising to unsustainable levels.

Changing the outcome

Another alternative and one more likely to be accepted by the public, is reshaping the way in which public services are delivered through business process improvements and greater innovation.

The last decade has seen significant improvements in the way information is delivered and public services are made accessible. The next wave of digital transformation will meet public needs at less cost through enhanced insights (using data and analytics to influence decisions), effectiveness (applying platform approaches to achieve better and more consistent outcomes), people (leveraging data and mobile technologies to build the workforce of the future), engagement (real-time, interactive feedback to engage and co-create services) and risk management (managing cybersecurity and building government resilience).

It also means adopting new ways for the government to operate, using agile principles and putting user

experience at the forefront. This includes adopting new commercial models, such as handing choice back to the customer via a Netflix model of government, with service upgrades, options and enhancements being made available as convenient 'bolt-ons'.

Clearly, there are multiple uses for such technology, which we have only just started to explore – the possibilities and benefits for government and citizens are endless. The answer lies in transforming and uplifting services through new technologies. This approach will enhance the services provided by government beyond what it would and could normally afford to offer.

Unless our government continues to embrace these innovations, the UK's public services may face an untenable situation, where they cannot deliver services in the way they have always done. ■

Adrian Fieldhouse **Managing Director for Government**

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Spend Analysis and Recovery Services II (SARS II) – Framework Agreement RM3820

Could this framework facilitate significant financial benefits to you....

The SARS framework was designed to help Customers procure Spend Analysis and Recovery Services from a range of suppliers who provide retrospective 'audit' and analysis of core spend and supplier transactions (invoices and payments), to identify and recover any supplier overpayments, overcharges or missed opportunities (discounts, rebates etc.) from a customer's suppliers on a 'gainshare' basis.

This means that the customer only pays a percentage fee of any amounts actually recovered, not simply identified i.e. An effective NO financial cost to the Organisation.

Unlike many sequels SARS II represents in our view a significant improvement on the first.

SARS II now allows Public Sector organisations to procure a more specific range of services by splitting the Framework into a number of lots. This enables more focus on the provision of different 'specialist' services whilst still providing the flexibility to request all required services from a single Supplier.

Advantage of SARS II to the Public Sector

Public Sector organisations can save significant time, resource and cost because virtually all the procurement issues have been addressed by the framework eliminating the need to conduct their own full procurement exercise.

Suppliers on the framework have already been carefully evaluated during the tender process against set criteria:

- Quality
- Technical Merit including capacity to supply, performance, reporting, references, Insurances etc.
- Security Considerations
- Environmental/Social considerations
- Financial Assessments
- Price

Reviews are a 'partnership'

What needs to be understood with the procurement of these services is that whilst you are procuring technological and specialist expertise, these reviews are truly about working in 'partnership' to identify and recover previously unidentified opportunities for financial recoveries and savings.

Maximising these recoveries is therefore also about relationships, understanding individual practices and flexibility.

Historical Private and Public Sector approaches to procurement of Spend Analysis and Recovery Services.

Private Sector

The Private Sector has more often than not required physical presentations (meetings in person) from the 'finalists' (following a previous filtering or elimination process).

Focus is on:

- Who they believe will generate the greatest returns from the review (often NOT those charging the lowest fee)
- The approach to be used by the Supplier
- Which Supplier they believe provides the best fit within their organisation

In this way, they are choosing who they feel they can best work with and who they believe will generate them the most returns from the review. This is a subjective judgement call as likely recoveries are notoriously difficult to predict.

Public Sector

Public Sector organisations in most cases selected a Supplier to provide Spend recovery services based solely on the evaluation of tender responses with no presentations taking place.

This can lead to the organisation not realising the full potential benefits of a Spend Analysis and recovery review.

The Cost v Benefit conundrum...



This is the hardest part of the tender evaluation but is generally the ultimate decision maker.

The cost of a review is dependant on the amounts recovered, as fees are based on a 'share' of recoveries only, across various recovery ranges. Will more be recovered by those charging the lowest fee?

At present, most tenders try to look objectively by awarding simply all the marks to the lowest bidder, but who is the lowest bidder when Suppliers are asked to provide fees based on a range of recoveries?

How do you guess the recovery and therefore the fee? and which Supplier do you believe will ultimately recover you more?

| Supplier | Fee% | Recovery | Review Benefit |
|------------|------|----------|----------------|
| Supplier A | 5% | £100,000 | £95,000 |
| Supplier B | 20% | £250,000 | £200,000 |

Spend Analysis and Recovery Services II - Procurement made easier...

Please do not hesitate to contact us to discuss any questions you may have. We would be delighted to help.

**Crown
Commercial
Service
Supplier**



How much could our review be worth to you and your services?

Simple as...

1 Contract Award

- Identify scope of review
- Understanding cost/benefit factors
- Award contract

2 Data Extraction & Analytics

- Identify and obtain data required for review
- Opportunities for recoveries identified using advanced analytics
- Results verified on behalf of the Client

3 Money Recovered

- Suppliers contacted for confirmation of overpayments
- Monies returned direct to Client
- Suite of reports provided to Client



£10m
recovered
from HMRC



£10m
recovered
from Contract
Compliance
Reviews



£20m
recovered
from Statement
Credits



£100m
recovered in
Overpayments



twice2much.com

SPEND ANALYSIS AND RECOVERY SERVICES II (SARS II) –
FRAMEWORK AGREEMENT RM3820

Crown
Commercial
Service
Supplier

Ensuring optimum estate security management

Justin Freeman, the Technical Manager of the Master Locksmiths Association (MLA), offers some useful advice in order to keep your estate security at its peak

With the news that the number of crime incidents recorded in Britain has gone up by 6% over the course of the last year,¹ the Master Locksmith's Association has issued new advice to help estate managers prepare and protect against an increasingly threatening crime landscape.

The most important step in ensuring the safety of your estate is to establish an effective strategy from the outset – one that ensures that any issues relating to security and safety management are identified and addressed promptly and in a systematic manner. An effective security policy should begin at the very top and permeate itself throughout your organisation. Clear and well-defined roles and responsibilities are vital, and all staff should be aware of this strategy and understand their role within it, including any key personnel within tenant businesses.

When establishing your security strategy, consider the areas that could be prone to security threats and be sure to amend your plans accordingly. Dependent on the nature of the estate, you will typically be dealing with a large and often complex site with numerous access and entry points, and multiple purposes and users. Determining security needs can be a complicated and time-consuming matter and it's important that those with responsibility receive relevant and frequent training. However, it's all too easy for another member of the team to inadvertently take on security and safeguarding responsibilities without realising.

This unplanned assumption of security roles can be highly dangerous – an example we see all too frequently is staff members placing padlocks on emergency doors to prevent people from opening it and causing a nuisance, without realising it could invalidate insurance and make them legally responsible if people

are unable to exit a building or an area in the event of an emergency.

When it comes to security itself, technology can be a significant help, especially in areas with high footfall. Investing in high-quality CCTV cameras can help provide undisputable evidence should an incident occur, whether it be a burglary or a false injury claim. Electronic door openers and closers are another great way of enhancing the security of your facility as they ensure that doors close properly. Meanwhile, investing in electronic access control may also be something you wish to consider. Not only can it help you monitor and regulate access to various areas, but it also allows access rights to be changed relatively quickly and cheaply.

However, within your security strategy, be careful to distinguish between access control and primary security measures. Put simply, the role of an access control system is to limit access to certain parts of a building or site to specific individuals. They can range from a very simplistic form of digital code lock (mechanically operated push button locksets) operated by a simple code, right the way through to complex smart security systems that enable managers to add or delete users from a central location. While people using a facility without the level of knowledge of facility management will assume any door with a lock on it is secure, access control products are not tested to security or attack standards and should not be relied upon as primary security products.

Whether operated by fingerprint, swipe card, smartphone or facial recognition, many facilities managers we speak to have already introduced smart security and it's easy to see the appeal. With ever-more sophisticated operating systems, smart security can increasingly be integrated with existing CCTV and

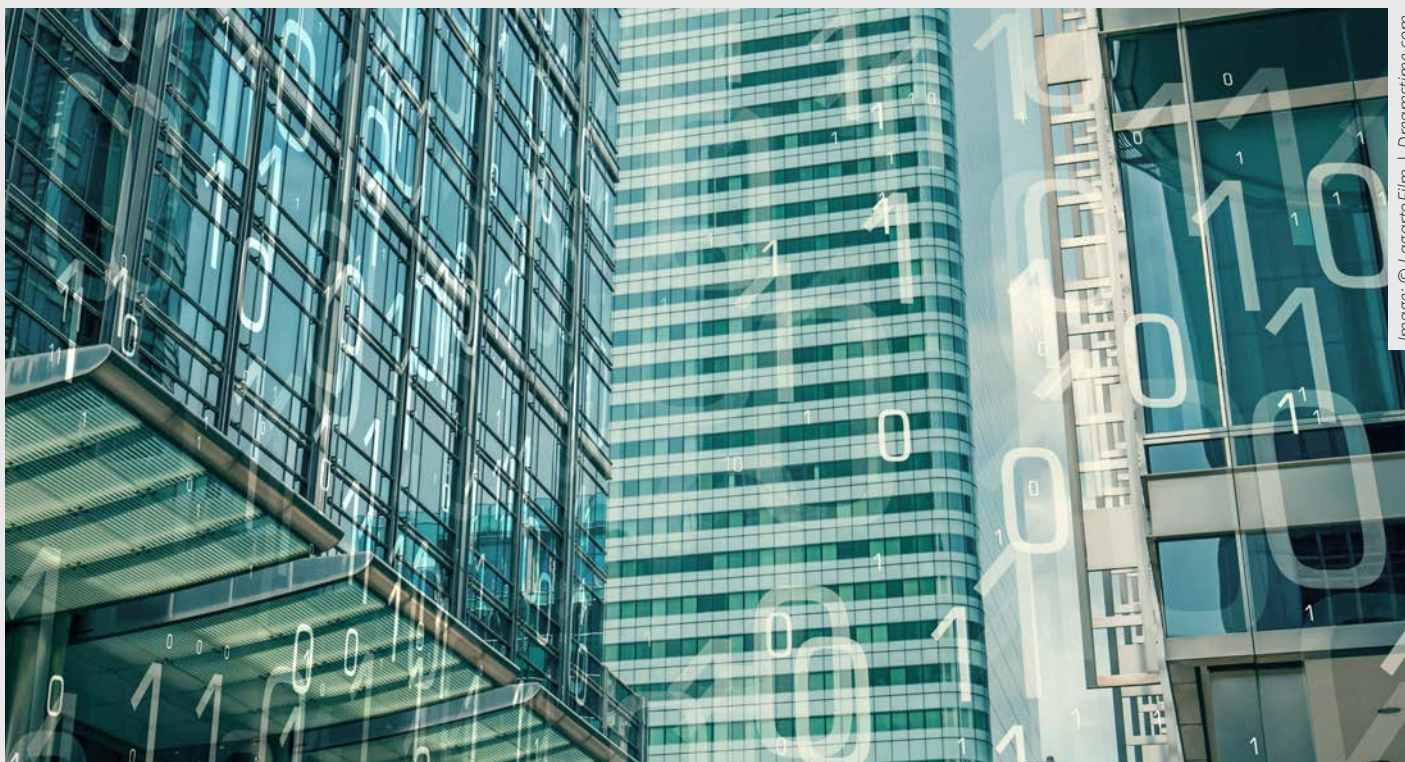


Image: © LagartoFilm | Dreamstime.com

alarm systems and can also be integrated with Time and Attendance systems.

Perhaps the most useful of all, smart locks are highly configurable. Digital locks can be changed in an instant and records stored of when a lock has been activated and by who. In short, smart security is promising optimum convenience, enhanced security and access to valuable, real-time information.

“The most important step in ensuring the safety of your estate is to establish an effective strategy from the outset – one that ensures that any issues relating to security and safety management are identified and addressed promptly and in a systematic manner. An effective security policy should begin at the very top and permeate itself throughout your organisation.”

The security of smart systems remains, however, far from secure. In the case of smart security, it's the 'key' element of a smart lock that is particularly problematic. This is because whether it's voice, card, tag, smartphone or biometric data that is used to activate the lock, this data is difficult to safeguard. Not least as it is usually stored within web-based storage, such as the cloud, which presents its own risks.

Whilst the UK has for a long time had excellent security standards for mechanical security - including BS 3621, 8621, 10621, BS EN 1303, BS EN 12209 and PAS 24 for complete windows and doors – the first security standards for smart locks have only just been published. As a result, the smart security industry as it is today has developed without this guidance. None of the smart locks currently on the market have yet been tested against the new security standards and these are yet to be recognised by insurers and police forces.

The Master Locksmiths Association has to date considered smart security to be a secondary security measure or the equivalent of access control. Whilst the newly developed security standards come into effect, we would continue to recommend caution and advise against using smart security as a primary security measure.

If you are thinking of using smart security for access control, it is vital that as with any access control equipment you ensure this is used in a manner that complies with the fire safety regulations. In 2006, the Regulatory Reform (Fire Safety) Order 2005 (RRO) came into force, stating that a facility's responsible person, rather than a fire officer, was in charge of ensuring a facility complies with the Fire Safety Order.



Image: © Ahavelaar | Dreamstime.com

For most facilities or estate managers, this meant they were responsible for ensuring the facility complies with the Fire Safety Order and operates good practice in all aspects of safety and security. It is a requirement in this role to ensure that a risk assessment is carried out to check access control has the correct fail safe/fail secure operations in place. This includes determining a failsafe should the power to the smart security system be cut. It's also important to have a good understanding of health and safety requirements including checking escape routes and fire doors, to ensure that in an emergency there are no complications.

Evacuation points and security can be a confusing prospect – occupants need to be able to escape the facility easily, whilst mitigating the risk of perpetrators access. Understanding who uses a site or building is also key as regulations relating to emergency exit hardware (often termed panic hardware) will differ depending on whether it will only be members of staff, who will be

familiar with the layout of the building, or whether it may be members of the public who are in the building for the first time. If in doubt, a trained locksmith can give you tailored advice on this and specify products that meet the requirements of the risk assessment.

If not already in place, a security training plan covering the training, drills and security actions of people at the facility should be implemented too, as well as being included in induction training. Selected security personnel should monitor the safety of the building. Not only must these individuals be trained in the operation of security equipment and systems, but they should also be able to test security and safety equipment and should do so regularly.

Once security is established, maintenance is mandatory. Equipment will inevitably suffer from general wear and tear, as well as the effects of ageing, therefore, conducting regular safety reviews is paramount. As well as



checking for necessary repairs, be careful not to help criminals gain access in any way. Any greenery on your estate will require regular and systematic checking, too. As nice as trees and shrubbery look, they can provide areas of cover for intruders and lead to blind spots on CCTV footage as they grow. Ensure that trees, plants and CCTV are all placed correctly so that there are no blind spots. Also, be wary of placing them too close to fencing. As trees grow, their branches could eventually offer a ready-made access ladder over your perimeter fencing. Similarly, industrial wheelie bins and other large items should be kept well away from the perimeter.

However, perhaps the greatest single influence on the success of your security is to ensure that the strategy and equipment you use is correct from the outset. When replacing equipment, be careful not to skimp on poor replacements. Cheaper may not always be better – and we often see insurance policies invalidated by poor quality or badly maintained equipment. If you're

in doubt, ask. Taking advice from a qualified and competent individual – such as an MLA approved locksmith – helps to provide the peace of mind you need. ■

1 Crime in England and Wales: Year ending March 2018, Office of National Statistics, 19th July 2018.

Justin Freeman
Technical Manager

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Is your vacant property being secured the best way?

Stuart Woolgar, CEO, Global Guardians Management explains the rudiments of property guardianship and asks us to consider if a vacant property is being secured the best way possible

Property guardianship is about so much more than issues of security, it is about social responsibility and about income generation, so much in tandem with topics high up on both the public and media agenda. The housing crisis and shortage of affordable accommodation, especially in our inner cities, will regrettably continue for a good number of years until a way is found to rationalise the property sector to the satisfaction of all the various stakeholders.

The benefits of guardianship

At Global Guardians, apart from our reputation as one of the best, most ethical and responsible companies in the industry, we have implemented several additional beneficial offerings to complement our mainstream property guardian services and these include:

Voids into profit client income generation scheme

By realising the full potential of our property owners' assets, Global Guardians are able to generate a revenue stream through exciting and innovative projects, which include, but are not limited to, filming, photo shoots, corporate events, art exhibitions, car park monetisation and advertising hoardings.

How it works

Our location team will assess the property's potential for VIP activity and will provide a complete breakdown of

what we expect to achieve from the site. We will then advertise and market your property to our well-connected group of location specialists.

Once the client is happy with what has been proposed, we will manage the projects from start to finish, ensuring everything runs smoothly and the property is returned to us in the same state as before.

“Becoming a property guardian really can be a life-changing opportunity for a lot of people. Licence fees can be significantly lower than normal market rent in the UK.”

Life-enhancing chances community projects

We encourage both our guardians and our staff to help those in the communities around our properties, particularly the elderly or disabled. This can be anything related to the care of their properties, especially small maintenance jobs or a bit of gardening.

Improve your void long-term empty building maintenance service

We take a headache away from our property owners. No stress or worry about their property being looked after and kept clean, safe and in good repair.

Preserving heritage property service for empty listed buildings

This is all about keeping our precious

historic buildings from deterioration and we understand how to pay particular care to those in our portfolio.

Asset reactivation through our London based architectural partners

This is ideal for property owners who are stuck with a property that appears otherwise unsaleable and unwanted and may need a fresh pair of eyes. It also assists those owners who may be located overseas and need independent, professional advice.

Vacant property insurance advice

Anything other than the very basic cover is often difficult to obtain by the asset owner and this is commonly known as 'FLEA', which are the perils of fire, lightning, explosion, and aircraft. Freeholders should check to see if the cover extends to include Property Owners Liability, as not all FLEA policies are the same and it is worth remembering that even if individuals trespass into a vacant building illegally or unofficially, the property owner may still be liable for any mishap which might occur.

Property owners often, and quite naturally, want more than the basic to ensure there is a greater degree of cover in place for their asset and if a lender has a charge on the property concerned, then they will insist on a wider scope of cover.

Surprisingly, many insurance providers do not take into consideration the



presence of guardians in an otherwise vacant property. Because of this, Global Guardians have arranged for one of their preferred partners to assist clients with getting the appropriate cover.

Each of these bolt-on services provides added value to our core guardianship operation and demonstrates both our innovation and why we are market leaders. As well as the above, there are other obvious benefits:

Business rates

Due to the temporary nature of the security service provided by Global Guardians, a 'change of use' is not generally necessary to reduce costly empty building rates. It is due to the fact that our property guardians are living in the property under a weekly licence agreement, that can be terminated at any time with just four weeks' notice, which means the building is occupied but only temporarily so. Therefore, council tax and not business rates apply and there is a huge difference in cost between the two. From the moment the property guardians are living in the vacant property until the time the

owner requires the building back for its intended use, the empty building/business rates reduction will be upheld. We have become experts in this temporary conversion and save money for our clients in virtually every situation.

Security savings

If there are people in situ, living in a property 24/7, so it neither appears empty nor abandoned and is obviously being looked after, trespassers and troublemakers will invariably go elsewhere. Barricades, metal screening, boarding and all the rest of the usual security hardware will always have a weak point, and determined trespassers will find a way in.

Likewise, with technology – CCTV, sensors and alarms; it's not feasible or affordable to put them in every room, especially if it is a large building. The alternative of security guards and dogs can't be there 24 hours a day, the budget for that is also simply impractical unless there is a very good reason; if a team of guards is rostered 24/7 at current rates, costs can run into tens of thousands of pounds a month.

Property guardians

Becoming a property guardian really can be a life-changing opportunity for a lot of people. Licence fees can be significantly lower than normal market rent in the UK.

This can make an enormously positive impact on anyone's life, enabling many to save for a deposit to get a mortgage on their own home or allowing them to live so much nearer to their place of work. No more long and expensive commutes which can be such a boon in so many ways.

In the Chancellor's Budget statement at the end of 2017, it was suggested that the country needed some 300,000

new homes to be built annually to meet demand and stabilise the remorseless rise in property prices seen over the past two decades and there is still an ongoing debate as to how achievable this is.

Virtually any building, residential or commercial, can be used for living accommodation and there are only four key criteria to be met:

- The property must be windproof and watertight;
- There has to be an electricity supply;
- There has to be running water and drainage;
- The building will be empty for a minimum of three months.

There are an enormous number of long-term empty properties around the country that meet these conditions, c. 250,000 according to UK government estimates and Global Guardians are experts in temporary conversions of commercial buildings to provide living quarters. Why not call and see how we can assist you?



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Addressing the issue of late payments in government contracts

The efforts of Cabinet Office Minister Oliver Dowden concerning new measures designed to address the issue of late payments in government contracts and to “level the playing field” for small firms looking to bid for work are discussed here by Open Access Government

The UK government has announced new measures designed to tackle late payments and create a more level playing field for smaller firms bidding to win contracts.

Poor payment practices can cost small businesses dearly, causing cashflow problems, building up debt and hindering growth – and can even result in otherwise viable companies going under.

The issue was put in the spotlight earlier this year when construction giant Carillion, a major government contractor, collapsed into administration, leaving many subcontractors high and dry.

“Companies who pay late should not be rewarded with public sector contracts. We need a robust public procurement process that holds larger companies to account for their payment practices.”

Despite being a signatory of the government’s Prompt Payment Code, a report by two committees of MPs found the company was a “notorious” late payer that forced standard payment terms of 120 days on its suppliers.

Publishing the findings in May, Frank Field MP, Chair of the Work & Pensions Select Committee, says: “Carillion displayed utter contempt for its suppliers, many of them the small businesses that are the lifeblood of the UK’s economy.”

Rachel Reeves MP, Chair of the Business, Energy & Industrial Strategy Committee, adds: “The collapse of Carillion left small businesses and sub-contractors out-of-pocket, with many left unpaid for months and facing ruin.”

Carillion’s poor payment practices may be an extreme case, but the problem is by no means an isolated issue.

Figures from the Federation of Small Businesses (FSB) show small firms are owed an average of £6,142, mostly from larger organisations not paying them for goods and services on time.

According to its research, 37% of small firms have run into cashflow problems because of late payments, while almost one in three has had to turn to an overdraft and 20% have seen a slowdown in profit growth.

The FSB estimates that if all payments were made on time then 50,000 more businesses would stay open and the wider UK economy would receive a £2.5 billion boost.

According to the most recent figures from 2015-16, the government spends £5.6 billion directly with small businesses. When subcontracts for small businesses from larger suppliers are taken into account, total spending hits £12.2 billion.

In April this year, Cabinet Office Minister Oliver Dowden announced a new package of measures designed to address the issue of late payments in government contracts and “level the playing field” for small firms looking to bid for work.

Under the proposals, large suppliers could be excluded from major government procurement opportunities if they cannot demonstrate fair and effective payment practices for subcontractors. In addition, subcontractors would be given greater access to buying authorities to report poor payment performance.

Furthermore, suppliers would have to advertise subcon-

tracting opportunities with the Contracts Finder website and provide the government with data showing how businesses within their supply chains, including small firms, benefit from supplying to central government.

Prime Minister Theresa May has also written to Cabinet members asking them to nominate a minister to act as a “Small Business Champion” in each department to ensure SMEs are given a fair opportunity.

The plans were discussed at a roundtable event in March hosted by the Cabinet Office and attended by the FSB, the Confederation of British Industry and bodies representing social enterprises, entrepreneurs and chambers of commerce. In all, these organisations represent an estimated two million-plus small businesses.

Announcing the package of proposals, Dowden explains: “We have set a challenging aspiration that 33% of procurement spend should be with small businesses by 2022 - and are doing more than ever to break down barriers for small firms.

“Small businesses are the backbone of the UK economy and play a key role in helping us to build a strong, viable private sector that delivers value for taxpayers and jobs for millions all over the UK.”

The FSB welcomed the government’s plan to clamp down on poor payment practices in its own supply chains - but called for more to be done.

“Each year, the UK public sector spends over £200 billion on goods and services from third parties. As such a large and prominent customer in the economy, the government has a pivotal role to play in demonstrating what it is to be a good client,” says Mike Cherry, the federation’s national chairman.

“Companies who pay late should not be rewarded with public sector contracts. We need a robust public procurement process that holds larger companies to account for their payment practices.

“Episodes like the Carillion collapse bring into stark relief the need for stronger action that excludes businesses [that] cannot demonstrate a fair and responsible approach to payments from bidding for these contracts.”

The FSB is calling for further measures to build on the package announced by the government, including requiring all large companies to appoint a non-executive director with specific responsibility to report to the board on behalf of suppliers, including overseeing the statutory duty to report on payment practices.

Coupled with this, it wants to see the use of Project Bank Accounts to become the default option for all appropriate public sector contracts, not just those in the construction sector.

Project Bank Accounts are ringfenced accounts that act solely as a payment channel to ensure contractors, key subcontractors and suppliers are paid on contractually agreed dates. Employers are required to maintain adequate funds in the account to cover work in progress and other project commitments.

“Project Bank Accounts would help stop the unfair and irresponsible payment practices deployed by too many big businesses and ensure that small suppliers are paid promptly once a job is done,” says Cherry.

“This is not only good for small businesses but the whole of the UK economy.”

According to the FSB, there were a record 5.7 million private sector businesses in the UK at the start of 2017.

Small businesses accounted for 99.3% of all private sector companies and 99.9% were small or medium-sized. Total employment among SMEs was 16.1 million – 60% of all private sector employment in the UK – and combined turnover topped £1.9 trillion, 51% of the private sector total. ■

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The public sector can set the example on supplier payments

In the wake of the Carillion bankruptcy, there is an opportunity for the public sector to set a new global standard for supplier payments, argues David Brown, CPO and co-founder of Previser

The ripple effects of the Carillion bankruptcy are still being felt across both public and private sector procurement. With the construction giant owing £800 million to suppliers up and down the UK when it went under, it is no surprise that the affair has evoked strong emotions and calls for action. In October, a bill with the backing of over 200 MPs will be debated which would put construction companies' retentions into a safety deposit scheme. This may well be the latest of a number of interventions into payment practices.

The scrutiny is good news. Carillion is the canary in the coal-mine for the problems caused by companies treating supplier payments as 'lines of credit', as the MPs report put it. We should fix the problems now.

It is brilliant to see that, as well as looking at how the private sector manages its supplier payments, the government is focused on ensuring that public sector procurement is leading the way when it comes to paying suppliers quickly. As a powerful economic force, the public sector can make a critical difference for small suppliers and set a new standard for the commercial world.

Slow payments: bad for buyers, fatal for suppliers

Slow payments, caused by lengthy payment terms, are one of the leading

causes of small business bankruptcy in the UK. They are also extremely wasteful, for both suppliers and buyers. While waiting for their invoices to be paid, suppliers are often forced to turn to expensive credit to cover their cash-flow. At the same time, their productivity is crippled by the need to constantly chase up invoices and the lack of cash to invest in the business. This pushes up the costs of doing business substantially and, ultimately, feeds through into higher prices for buyers if those suppliers are to stay in business.

Speeding up payments, then, is not only a question of ethics but a sound financial decision. It means, not just saving the jobs of hundreds of thousands of people across the UK, but helping reduce the cost of purchasing and stretching budgets further.

That said, it is all very well pointing out the benefits of speeding up payments. Achieving it is another matter.

With 63% of organisations reporting that they have received duplicate invoices, invoices cannot simply be paid without proper checks and balances. However, given that most invoices are still managed on paper, checking invoices is a time consuming and inefficient process. A study from Concur has found that the average invoice ties up 15 employees.

Unfulfilled promises

To help speed up payments, many public sector purchasers have been encouraged to take up supply chain finance (SCF). These schemes allow suppliers to be paid by an SCF provider on the buyer's behalf once an invoice is approved, speeding up payment without impacting the buyer's cash-flow. However, as you will no doubt have found out if you have implemented SCF, it is far from a silver bullet.

SCF schemes require huge on-boarding costs for suppliers, in terms of technology and compliance procedures. In practice, this means that they are completely impractical for smaller suppliers. Our analysis shows that the best in class SCF programme is able to service just the largest 15% of a buyer's suppliers, with the average for a bank-led scheme closer to 1% penetration. Those very large suppliers involved are not the ones who struggle to access finance or who have acute cashflow constraints.

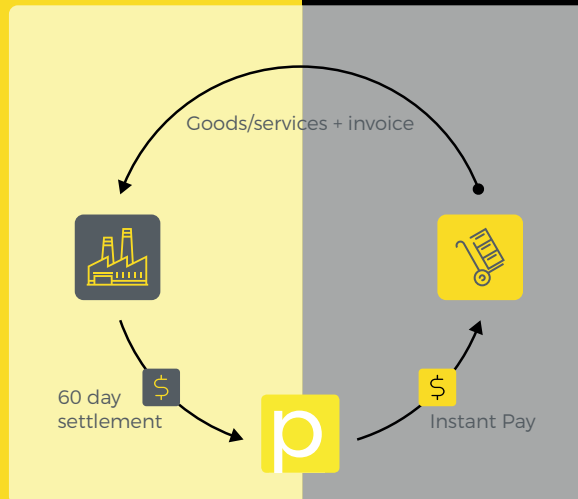
Not only is SCF unworkable for smaller suppliers, the introduction of SCF can often lead to a buyer extending their payment terms. This has no impact on the businesses covered by the scheme, but the 99% of companies not covered by SCF actually end up in a worse position than they were before the scheme was introduced because they are waiting even longer to be paid.

No process changes for buyers

- Manage orders, invoices, and approvals the same way
- Pay by the due date, as today
- Just provision Previs with data access, we do the rest

Instant payment for suppliers

- No changes to invoice delivery (email is fine)
- No waiting: instantly paid when the invoice is received
- No tracking, admin, chasing of outstanding invoices



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getting businesses paid instantly

While SCF provides a useful tool to finance teams to optimise working capital, another solution is required to speed up payments for small suppliers.

Setting a world standard for supplier payments

There is good news, however. With slow payments high on the political agenda and the emergence of new technologies, we can have instant invoice payments for all suppliers, without requiring major process changes.

Powered by machine learning technology, Previs's InstantPay takes a purchaser's ERP data and accurately predicts the few invoices that are unlikely to get paid so that the rest can be paid instantly by a funder – typically a bank or other large financial institution. The buyer then pays the funder back on its normal payment terms.

Suppliers which opt-in to have instant payment pay a small fee, typically 1%

of invoice value per month, which makes it extremely economical for smaller companies.

Previs's programme doesn't require buyers to make process changes to get suppliers paid faster. Buyers can maintain their existing processes, or work more incrementally to improve them, without worrying about slow payment times for suppliers.

UK Public sector procurement was worth £223 billion in 2017. Imagine the transformative effect that enabling that money to be paid to suppliers instantly would have. Moving that money into the economy could create hundreds of thousands of new jobs, boost innovation and significantly reduce purchasing costs.

This is an opportunity for our public services to be at the cutting edge of a complete transformation in commerce and set a new standard for the world to follow.

If you'd like to find out more about introducing instant invoice payments, please get in touch. Search Previs InstantPay or email us at info@Previ.se.

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Speech, language and communication: Forgotten skills?

Mary Hartshorne asks if speech, language and communication are forgotten skills and gives a compelling response to this intriguing thought

Having worked in the field of children’s speech, language and communication for nearly 40 years, it is perhaps not surprising that communication skills come top of my priority list when I think about what’s important for children. But that’s not the case for everyone; many people are unaware of just how critical these skills are.

Recently, Education Secretary Damian Hinds announced a new collation of companies and charities whose objective would be to promote the importance of the home learning environment in [supporting children’s early language](#). He considered it a “scandal” that some children start school unable to speak in full sentences. There was quite a bit of [media interest](#) in this and when asked why this was happening, I focused on the fact that while many people see the importance of reading, a healthy diet, physical exercise – learning to talk is not seen as part of this list. It’s interesting that in Damian Hinds’ speech, he very quickly moves onto the importance of learning to read.

And yet there is plenty of robust evidence that clearly shows the importance of early language *underpinning* reading:

- [Language at age two](#) predicts reading, maths and writing when children start school
- Early language is the [single most important factor](#) in influencing literacy levels at age 11, more important than behaviour, peer relationships, emotional well-being, positive interaction and attention.

Even more importantly, the role adults play in helping children to read, eat properly and exercise is well understood, but frequently there is a belief that children just learn to talk by themselves. ‘It just happens.’ In



Mary Hartshorne, Head of Evidence

actual fact, the adults’ role in supporting language development is critical, so Damian Hind’s speech is welcomed.

Fortunately, the tide may be turning, certainly in schools. A couple of major reports show just how aware teachers are of the importance of good spoken language skills in children; in one survey, over two-thirds of teachers across primary and secondary schools felt it was very important that communication skills were taught in schools. [Another survey](#) saw

language as opening doors, unlocking the world of reading, writing, learning and releasing children's potential to grow.

If anything, with a move towards a service-driven economy, employers see communication skills as even more critical. Time and again employer surveys rate young people's communication skills as the most important skill needed for their first job. Although, they also report that they are the skills most lacking in new recruits and there's been a call for the gap between what's taught in schools and what's needed in the workplace to be addressed.

Added to this, young people themselves also recognise the importance of having good communication skills:

“Good communication is one of the most important skills anyone could have..”

“Oh my God, it just affects everything.”

People knowing about children's speech, language and communication matters. Without an understanding of the importance of these skills, it's easy for them to get left off the 'most important' list and critically, it is easy for children who have difficulty learning to communicate – children with speech, language and communication needs (SLCN) to get missed. This was one of the key findings of Bercow: Ten Years On, a national review of provision for children and young people with SLCN.

It found a lack of awareness of the importance of children's communication, especially in decision-makers. The report of the review, led by I CAN and the Royal College of Speech and Language Therapists (RCSLT) was published in March this year. It found that children's communication wasn't prioritised in national and local strategy. Because of this, the report found a lack of focus on spoken language in the way children learn and, in the systems, which ensure parents and carers have the information and services they need to support early language. It found a postcode lottery of services for children with SLCN; the support children

get depends on where they live and often, on which school or setting they go to.

More optimistically, the report also draws on the many examples of effective practice which were presented in oral evidence sessions. From these, powerful recommendations, strategic solutions are presented.

It is encouraging that children's early language is so prominent in the government's Social Mobility Action Plan, with widespread recognition of the 'word gap' between young children in disadvantaged areas and their peers. This isn't enough; speech, language and communication continue to be important beyond age five. Children need language to learn, understand what they read, solve problems and manage their emotions right through adolescence and into adulthood. Likewise, many children with SLCN have long-term difficulties for which they need on-going support. More needs to be done.

The report and recommendations are complemented by a website www.bercow10yearson.com. It hosts a wealth of calls to action and practical steps to change for everyone: school staff, practitioners working early years, parents, young people and commissioners. Take a look, take action, sign the petition asking for a full government response and keep up-to-date with progress by following #Bercow10. ■

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Maternal education and Specific Language Impairment in children: Not a robust relationship

It has long been held that a mother's education is a key factor in the development of their child's language. However, the link may not be as strong as previously thought, writes Mabel L Rice

Children develop language as they interact with parents, siblings, and people in the neighbourhood. For decades, the extent of mother's education has been recognised as an important indicator of the resources of the home related to children's social, cognitive and vocabulary development¹.

Recently, the New York Times featured an [article on its front page](#) that tied higher levels of maternal education to maternal age, due to the additional years of schooling, which in turn delays the start of families but adds to the family financial resources. The age that women become mothers also varies by geography and in the U.S., these factors are also linked to socioeconomic status and urban versus rural residency. In turn, these differences are linked to political decisions and public health policies.

Given the current spotlight on maternal education, it is time to revisit what is known about the relationship of maternal education with children's language acquisition and whether it plays a role in risk for [Specific Language Impairment \(SLI\)](#), defined as a language disorder that delays the mastery of language skills in children who have no hearing loss or other developmental delays.

It would be tempting to think that maternal education could play a large role in children's language acquisition, broadly across all dimensions of

language, or in accounting for SLI or providing ways for a child to overcome SLI. Such interpretations would not be consistent with available evidence, however, which shows a more complicated picture of the relationship between maternal education and children's language acquisition.

Effects of maternal education differ depending on the dimension of language studied. For example, relations between maternal education and children's language differ for words compared to grammar. Comparing the relationship of maternal education and language outcomes in children with and without SLI reveals surprising outcomes that work against simple models of causality or ways to overcome SLI.

Mothers' education and children's word learning

The best evidence comes from long-term longitudinal studies of children with and without SLI. In a study of 240 children with SLI and 279 unaffected children that included longitudinal measures from two-and-a-half to 21 years of age, across all participants children of mothers with higher education had higher performance on vocabulary tests over time²; however, the effect was weak, accounting for 1.3% of the variance on the vocabulary test.

A study of 1,255 twins at four and six years of age reported that children of mothers with higher levels of education had higher scores across multiple outcome measures (vocabulary and

grammar)³. On the other hand, an epidemiological study of 1,766 24-month children reported that risk for late appearance of words was not associated with particular strata of parental educational levels or socioeconomic resources⁴. Perhaps a longer span of word learning is more sensitive to influences of maternal education, or perhaps the effects are not as strong for predicting low levels of word acquisition.

Mother's education and grammar

An accumulating body of evidence suggests that maternal education does not predict grammar outcomes. In a study of 69 children at risk for delayed language acquisition, because they were treated in neonatal care units at birth, at four years of age, maternal age predicted vocabulary/semantic outcomes but did not predict grammar outcomes⁵.

Another programme of study focused on the finiteness requirement of verb conjugation in English and other languages⁶. This is the requirement for well-formed sentences to mark past tense, the third person singular -s, conjugated forms of *BE* copula and auxiliary, and insertion of *DO* auxiliary in questions such as "What do you want?"

These grammar markers appear in the speech of toddlers, although English-speaking children tend to omit them inconsistently throughout the toddler period and beyond.

In a detailed study of toddlers' utterances, mothers' education did not predict change in their toddlers' use of these markers⁷. In addition, a longitudinal study found that mothers' education levels do not predict growth in the production of finiteness markers for children with SLI or typically developing children ages 2;6-8;9⁸.

Using a similar task, a study of 130 SLI children, 100 non-specific language impairment (children with low nonverbal IQs), 73 low cognition children (passed language and hearing testing but had low nonverbal IQ) and 117 unaffected controls reported initial test levels in kindergarten for all four groups and longitudinal outcomes for the other three groups between six and 10 years. Mother's education did not predict accuracy on the grammar marker in kindergarten or growth in accuracy between six and 10 years in any of the groups⁹.

Another study used tasks requiring children between the ages four and eight to make judgments of sentences similar to sentences they produce with omitted finiteness markers and compared children with SLI, younger controls and same age controls. Mothers' education did not predict growth in children's judgments of errors for any of the groups¹⁰.

A further study documented ongoing acceptance of omitted *BE* and *DO* in questions, in children with SLI but not their unaffected peers aged six to 15. Mother's education did not predict performance for either group of children on this grammar task¹¹.

In a large sample of 16-year-old twins, the correlation of mothers' education with grammaticality judgments for the question finiteness task was .16, statistically significant but low, accounting for only .0256% of the variance¹².

Another measure of young children's early language is their mean length of utterances, measured in words and morphemes such as finiteness markers and others such as plurals and prepositions. In a longitudinal study of an SLI group and a younger MLU-matched group, mother's education did not predict growth for either group in vocabulary scores or MLU between three and 10 years¹³.

A study of MLU in 306 children ages three to nine with SLI (170) and without SLI (136) found no evidence of an advantage in MLU growth for the children of higher educated mothers at the initial times of assessment. Further, there were low correlations between siblings within the families of the target children¹⁴.

Revisiting the focus on mother's education

Although mother's education is surely an important factor in a family's social and economic resources and in many aspects of children's lives, it appears that the influence of this metric on children's language acquisition and the developmental trajectories of various linguistic manifestations of SLI is modest at best.

Children's acquisition of grammar, in the metrics of MLU in early childhood and in the likelihood of finiteness marking throughout childhood, appears to be unaffected by maternal education levels. This is consistent with the observation that young children around the world, across diverse levels of maternal education, acquire their native languages usually without explicit teaching. It also assures us that it is very unlikely that low levels of maternal education are the cause of SLI.

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Higher education: Preparing students to be work-ready

Alison Watson, Programme Leader for BA (Hons) Business at Arden University shares her views on how the higher education sector is helping to prepare students to be work-ready

There is great pressure on both organisations and higher education institutions to develop skilled workers. As many sectors face a skills gap, employers are struggling to recruit the right talent, while traditional students graduate with big debts and limited work experience. It is necessary for this gap between employee shortages and lack of experience to be filled. Higher educational institutions see this issue and attempt to resolve this through their curriculum development and embedding transferrable skills into degree programmes. The following provides an overview of how universities are attempting to rectify this issue.

The higher education sector is becoming increasingly aware of the demand from employers for the develop-

ment of required sector skills when designing undergraduate and postgraduate programmes.

Today, employers are not only looking for graduates to be equipped with the knowledge in their specialised fields but also to possess fundamental soft skills to enable them to operate effectively within an organisation, for example, communication, negotiation and time management skills.

In order for employees to function effectively, they need to be able to demonstrate they have these hidden skills and are able to put them into practice. More programmes are being designed with these skills in mind and are embedded through teaching and



EDUCATION & YOUNG PEOPLE

A number of universities have identified a priority to work with employers and professional, statutory and regulatory bodies to develop programmes suitable for students to complete, in order for them to support their career development.

Marketisation is forcing change within the academic environment. Today, there appears to be a decline in learning for its own sake and, as an alternative, higher educational institutions are opting to introduce more vocational courses focusing on teaching skills that can be transferred to the working environment. Presenting students with real-life problems will help them to develop the necessary experience.

Working with a range of stakeholders, including businesses, enables higher education institutions to identify the most sought-after skills. This collaborative approach supports the commitment to transform students into job-ready individuals who are able to quickly adjust to the business environment.

The increasing accessibility and development of higher apprenticeships are also contributing positively to this combined effort between stakeholders to develop students' potential.

It is, therefore, essential for higher education institutions to continue to build relationships with a range of external stakeholders who can influence the development of their courses. Equipping graduates with the practical skills to be ready to enter into the work environment is essential for our economy and society. ■

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learning strategies. Caution must be drawn, however, to providing graduates with a balanced competence set. Focusing too much on these skills could lead to more practical ones being ignored.

A lot of universities are committed to providing society with work-ready individuals. A part of this process is to support, develop and prepare students for the working environment, for the benefit of employees and employers alike.

The main driver for students when enrolling in university courses is career enhancement and to get a good job. With this motivation in mind, universities provide students with numerous support mechanisms to help them prepare for life after study. Not only do they equip graduates with the skills necessary to function in their sector, but also coach and mentor students to support them in their job search with guidance on writing a CV, interview advice and time management tips.

Many universities provide students with access to alumni, whereby students can actively network with peers to gain contacts in the world of work. Careers advice services are also often at hand to provide guidance to students and work placement opportunities.



Reconciliation

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 Eagle-Woman 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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Manufacturing and engineering education options in the UK

Mediaworks, on behalf of Omega Plastics, share their expert views on education options in the UK's manufacturing and engineering sector

In 2014, the engineering and manufacturing sector provided an estimated £455.6 billion to the UK gross domestic product (GDP), making up 27% of the total. It is one of the biggest economic sectors in Britain, with a job total of 5.7 million (19% of employment in the UK).

But for the sector to continue to grow, it needs to build a future in the younger generation. After all, it is this generation that will pick up the work when the current workforce begins to retire.

“The engineering and manufacturing technologies sector saw 74,000 apprenticeships starting out in the 2016/2017 period, which lifted them up as one of the five most popular apprenticeship sectors. In fact, they have remained in the fourth position since 2010.”

Luckily, the forecast is positive – in 2016, over half of 11-16 year olds stated they would think about a career in engineering, which is a much-improved figure compared to 41% in 2012. It's likely that this positive change is down to teachers and parents; 96% of teachers said they would encourage a career in engineering to their pupils and 75% of parents said they would be pleased with their children taking a career path in the sector.

To explore this rising trend further and to look into the future of manufacturing and engineering, [plastic injection moulding](#), we investigate on behalf of Omega Plastics.

A fall in higher education

Despite the industry's strengths, it is experiencing a downturn in the number of graduates. The future forecast predicts that we will need 265,000 skilled entrants per year to meet the demand for engineering enterprises

until 2024. However, currently, we are experiencing a shortage of 20,000 graduates.

But the downturn already seems to be bouncing back; there has been almost 5% growth in the number of engineering course applicants in the last 12 months, where other subjects have experienced only a 2.7% rise. Engineering courses have seen gains across all subjects except electrical and electronic. Likewise, 71% of those applicants entering a first degree in engineering and technology are from UK origin.

The degree completion rate for engineering students is also notable, with many graduates successfully gaining a job in the sector after finishing their course. 68% of UK first degree engineering graduates are in full-time work six months after graduation and 84% are in full-time work three years after graduation, with only 2% unemployed.

Apprenticeship popularity

The engineering and manufacturing technologies sector saw 74,000 apprenticeships starting out in the 2016/2017 period, which lifted them up as one of the five most popular apprenticeship sectors. In fact, they have remained in the fourth position since 2010.

Sadly, a bright beginning doesn't always last, as nearly a third of UK apprentices are not seen through to completion. The overall success rate for apprenticeships has taken a decline to around 68.9%, compared to 2010, when it was at 76.4%. So, what do the figures look like for engineering and manufacturing? Is the decline apparent here too?

58,000 engineering apprenticeships were achieved in England in 2014/15, with 42% of those achieved being



at or above Level 3. However, despite no official figures, we can assume that the 2016/17 success rate figures for engineering apprenticeships have continued to rise now that there are over a quarter of a million workplaces offering apprenticeship programmes, a 50% increase over the past five years. Furthermore, four out of five manufacturing employers are reported to be planning to recruit manufacturing and engineering apprentices in the next year.

The UK is home to 650,000 engineering firms and this number is only set to grow. It is safe to predict that the need for skilled workers will only increase in line with this. Improving the perception of the industry is vital to the continued success of the industry, as well as appropriate training. However, if the figures discussed here are anything to judge by, the engineering and manufacturing sectors do not have much to worry about in this department. ■

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What businesses must do to attract the best young talent

Manuelle Malot from EDHEC Business School explains what businesses must do to attract the best young talent

Research clearly shows that until 2030, the number of skilled jobs needed for the global economy will be greater than the number of available candidates. For businesses, across a wide variety of sectors, there is an ongoing battle for the best talent. The critical question facing firms is simple: what should they be doing to attract the best young talent?

Research from EDHEC's NewGenTalent centre reveals that the answer is multi-faceted. Firstly, firms should consider offering young talent an exciting, international, entrepreneurial and meaningful adventure; not a 'career'. It is vital that businesses consider and understand the aspirations and behaviours of young talent, even if they are sometimes paradoxical.

Not only are companies competing with each other to find and hire the best talent, they are also competing with the entrepreneurial drive of young people themselves. There is an increasing tendency among the young to join or create human-sized organisations and start-ups so that they can learn and grow faster.

One way to achieve this is by offering "fast track" or "rotational programmes" as early career development. This should allow and encourage young people to develop and take on challenges that have real impact and meaning. Businesses should also capitalise on what is unique to them. For example, collective dynamics and learning from other employees.

Our research also showed that young talent pay par-

ticular attention to a firm's social and environmental responsibility and expect these to be reflected in their missions.

When it comes to how young people approach looking for placements/first jobs, they mostly use their universities' career intranet platforms (48%), followed by a company's website (39%) and finally, their personal network (35%).

Transparency during the recruitment process is another important factor. The majority, 71%, highlighted it as being important. Young people are used to almost instant application responses and want considerable fluidity. Speed and simplicity when applying are crucial. In essence, they are looking for a personalised "candidate experience". Feeling "unique" can be very motivating. Similarly, they want documented job offers and transparency in salaries.

The idea of having to complete an application form when they have already sent the same information in their CV is a real turn-off. They would much prefer to write an email, rather than a long covering letter.

Receiving a personalised reply is also important, 74% said so. Young talent wants feedback from every step of the application process. When they are unsuccessful, they are particularly concerned with how they performed in interviews, so as to improve the next time.

Firms also need to be very mindful of what information is publicly available: the information that young people find about a company, before applying, is often decisive. 80% of young people conduct research on the company culture before applying and 78% believe that the company culture influences their application.

The firms that succeed in the battle for young talent will be the ones that use recruitment communication in a specific and sincere manner: less stereotyped corporate discourse, with offers that are detailed and reflect the company's culture and values.

Finally, firms must understand and make the most of

social networks. Professional social networks are hugely important to young people: 87% of students and recent graduates are already registered on at least one. Among them, 78% will check their account at least weekly and three out of four will read their news feed.

It is imperative that companies communicate on professional networks and have content that is adapted to young, qualified and demanding talent.

Social networks also have an impact on the decisions that young people make, before they apply. They make it simple and easy to check that a company's promises match the realities experienced by other young graduates already employed in the company. For young talent, their ex-peers, are the trusted experts.

However, a strong digital presence should not come at the expense of establishing direct contacts with students: job and career fairs, campus presence, educational partnerships, business games etc, are all still important. This generation also needs human relations, mentoring and coaching.

In a globalised, fluid and graduate-friendly job market, employers who want to engage, attract and retain the best young talents, must be proactive and sincere. ■

Manuelle Malot from is a specialist in graduate recruitment and career management. She is an author and recognised expert on new generation career and workplace trends. She has more than 25 years of experience advising both executive professionals and organisations on the changing world of work.

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How apprentices contribute to the UK's construction industry

Amy Hodgetts, Copywriter for Niftylift Ltd explores just how apprentices contribute to the UK's construction industry

City & Guilds has revealed that 87% of employers within the construction industry are facing a dire problem. There is a notable shortage of skilled workers in the industry and that is leading to problems when it comes to recruitment. Construction News supported this finding, with data showing that 12.6% of the UK's construction workforce originates from overseas, with 5.7% coming from the EU. Within London, this total comes to 60%.

Additionally, of the current British-born workforce in construction, 30% are over the age of 50. This raises the issue of retirement and what companies will need to do to plan for those who will be leaving soon.

Experts seem to think that apprentices could solve the problem. Apprenticeships could be more crucial than ever before, especially following Brexit. Nation Apprenticeship Week was at the beginning of March and with an influx of publicity circulating, it has encouraged employers to think about the future of their workforces – could apprentices fill the employee shortage?

The top five sectors for apprenticeship starts includes engineering and manufacturing courses and construction, planning and the built environment courses. In the 2016/17 academic year, the engineering and manufacturing sector witnessed 74,000 starts, while the construction sector had 21,000. Leading UK house-builder, Redrow, released its second annual research report which revealed that thanks to a positive shift in attitudes and the perception of construction, the apprenticeship pathway has improved, with a 14% increase in young people considering a career in the sector.

Regarding the report, Karen Jones, Group HR Director at Redrow, comments that: "This year's results illustrate

that apprenticeships and careers in construction are being viewed in a more positive light.

"Apprenticeships are a way of futureproofing the UK workforce, particularly in sectors where there is a skills shortage, such as construction, so it is pleasing to see that progress is being made."

A new levy was introduced for apprenticeships last year, so the success of apprenticeship programmes is predicted to continue due to the new funding methods the levy will support. Whilst some employers have snubbed the new levy as just being 'another tax', both large and small employers can benefit from the fund, meaning that 90% of apprenticeship training costs are funded by the government.

Furthermore, employers within the construction sector can use up to 10% of the funding to train employees across the full supply chain – something not to be snubbed with the current shortage of skilled workers.

UK Construction Media says that apprenticeships are certainly showing results: 86% of employers say that apprenticeships are helping them develop relevant skills and 78% think the schemes help improve productivity.

Chris Wood, CEO of Develop Training, voiced his confidence in apprenticeship programmes by saying: "Working with some of the UK's largest utility firms, our success rates have been very high. We and our customers have no doubt that, managed well, apprenticeships do work."

He also says: "New initiatives such as Trailblazer Apprenticeships and the Apprenticeship Levy have raised awareness across the UK. Even so and despite huge skills shortages, many employers are still only



scratching the surface of what they could be doing to use apprenticeships to attract new people to join the industry and improve the skills of existing employees.”

There’s a lot of evidence to suggest that apprenticeships could be the way forward for a sector struggling to deal with a lack of skilled workers. Downing Street has committed itself to create three million new apprenticeships by 2020. The construction industry could be on the receiving end of a large chunk of those programmes, which will be an opportunity to deliver a new generation of highly skilled workers – something that the industry is experiencing a lack of right now. In fact, the Director of the National Apprentice Service, Sue Husband, predicts that 2018 will be crucial for programmes. As more opportunities become available, now could be the time to cut yourself a slice of the apprenticeship programme success – and secure your future workforce now. ■

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Face to face vs. online training: What's your pick?

Kamy Anderson, an expert in learning management system and e-learning authoring tools, currently associated with ProProfs, explores the differences between face to face and online training

Online training has developed immensely compared to its humble beginnings. A long time ago, it was considered to have poor outcomes when it comes to acquiring knowledge and skills and the learning materials weren't actually embraced by participants. Luckily, the situation has now changed.

Nowadays, online training uses a set of carefully designed courses to cater to each learner's different learning styles and there are many software tools such as Learning Management System (LMS) software or e-learning software which contribute to the satisfaction of both learners and their trainers.

However, traditional face to face training shouldn't be overlooked just yet. Not all students are fans of the online learning environment and some subjects are just not so practical for self-guided learning. So, what to choose? Read on to discover the benefits of both of these approaches and determine what suits you most.

The benefits of online training

Great flexibility – Learners can choose the time and place where they want to take their lessons and are not strictly bound to a schedule. This type of training offers a number of various teaching methods which include audio, text-based or visual examples and explanations. Students can study and review their materials as many times as they wish, which is impossible in a regular face to face environment.

Affordability – Online courses are, in most cases, less expensive than face to face. Once the materials are paid for, they can be used over and over again without a requirement for paying a trainer. It is no longer needed to spend ridiculous amounts of time on organising classes or forcing employees to attend them at times inappropriate for them.

Platforms such as cloud-based LMS or e-learning software are completely automated and self-directed so that the time spent on administering learning activities can be decreased significantly.

Effectiveness – Large businesses can benefit from the scalability of online training to a large base of employees across multiple locations. This type of training is especially useful for compliance training as it reduces the time spent on identifying and addressing gaps as soon as they are detected.

Modular online courses allow your employees to access the materials quickly whenever they need to advance their skills in a certain area, which provides your company with more capacity to focus on new opportunities.

Consistency – Online learning ensures that all materials of a course have been covered by each and every learner. Traditional methods most often fail to do so since different trainers use different teaching styles which are not appropriate for everyone and that can lead to inconsistent outcomes.

Analytics – Exercises in online materials allow for a quick gathering of students' data so that trainers can use them effectively to track their progress and to make any changes in the design of the course, if necessary. Moreover, they allow for detailed feedback to be provided in order to reveal which areas need to be developed further.

Benefits of face to face training

Direct responsiveness – One of the greatest benefits of face to face training is that it enables the instructor to evaluate their students in real time. Instructors can see how attentive a student is, how engaged he or she

is with the studying materials and how well they understand it. With this in mind, teachers can easily adjust the pace of the lesson so as to help their students learn more effectively.

“Online learning is a great tool for someone who has a strong sense of self-discipline and is able to study without the assistance of others, but for someone without these skills, it is mostly useless as they might find it hard to motivate themselves to actually sit down and study.”

Collaborative environment – Besides strengthening interpersonal relationships between individuals, team learning provides an engaging environment for people which provides a much wider studying outcome as team members can approach the material they are studying from different perspectives. This method of learning also gives way to discussion and debate among learners which promotes the effective acquisition of new skills and knowledge.

What’s the ideal pick?

Clearly, both methods of teaching have their individual benefits and flaws and neither is perfect. When it comes to learning, a combination of different approaches and methods work best, but neither of these alone can promise to provide optimal results.

Online learning is a great tool for someone who has a strong sense of self-discipline and is able to study without the assistance of others, but for someone without these skills, it is mostly useless as they might find it hard to motivate themselves to actually sit down and study.

Other than being affected by the skills and preferences of learners, teaching methods also get affected by the area being studied. For example, certain soft-skills like business storytelling or conflict management would do much better in a collaborative environment since non-verbal communication can often be a very important element of the subject at hand.

The bottom line

As we have already stated above, a combination of both methods has the best chances of achieving good results, as both of these methods alone can perform poorly if utilised alone. As for how much of each should be used, that depends on the subject being studied and the comfort level of the people you need to be trained.

When it comes to policies, standards and any other form of regulatory compliance training, online teaching has shown to have great results while face to face teaching provides great results for studying abstract topics and soft skills. Because of this, the so-called “hybrid” teaching methods are considered to have the best results in universities, workplaces and schools alike.

All of this gave way to the development of platforms for learning management that take the best out of both methods to enable scheduling, administration and analysis of this hybrid learning campaigns’ effectiveness. These platforms can help bridge the gap between face to face and online learning, which enables people to make better decisions about which and how much of each method they should utilise.

Kamy Anderson is an ed-tech enthusiast with a passion for writing on emerging technologies in the areas of corporate training and education. He is an expert in learning management system & e-learning authoring tools - currently associated with ProProfs. ■

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Research into working conditions: Most employees can work smarter

Open Access Government lifts the lid on a recent survey about working conditions today which reveals that most employees can work smarter, given the chance

In a new survey concerning working conditions today in the UK, we learn that over half (58%) of employees can identify changes at work which would make them more productive. Most employees can work smarter, given the opportunity.

These are the findings of a study published in July 2018 by The Skills and Employment Survey 2017 (SES), along with researchers from Cardiff University, UCL Institute of Education and Nuffield College, Oxford.

A staggering 3,300 workers from across the UK, between the ages of 20 to 65, were interviewed in research, funded by the Economic and Social Research Council (ESRC), the Department for Education and Cardiff University.

“The big message coming out of our findings is that workers have great ideas about how productivity could be improved. Growth is unlikely to come from simply increasing the supply of skills; employers need to harness the views of their workforce and treat them fairly. This will give us a better chance of closing the productivity gap.”

The study reveals that efficiency-enhancing ideas are more frequently offered and acted upon in organisations where employee involvement is high. Such employers give their employees more autonomy to decide how to carry out their jobs and are more supportive of those they manage. We discover that 28% of those whose line manager is highly supportive are in jobs which also provide workers with the chance to express efficiency-enhancing ideas, in comparison to just 13% of those who said that their managers are less supportive.

We also learn that many employees long for the chance to tell employers what should be done with 18% of

them saying that their suggestions could well increase their own productivity greatly. These changes include:

- “Being allowed to put more ideas forward rather than being told what to do by people who can’t do it” (a machine operator working for a chemicals company).
- “The skills of the team need to be up-to-date; this would make me more productive. So, I wouldn’t have to check their work all the time like now” (a foundry technician working for a bronze sculpting company) and;
- “Better connectivity internationally, such as video conferencing between Singapore, Denver and London offices” (a business analyst working in banking).

The survey also shows that one in eight (13%) employees had put forward ideas the past year to management and/or their colleagues which had contributed greatly to increasing efficiency. No less than 70% had taken more direct action by creating efficiency-enhancing initiatives themselves or with their colleagues.

‘Productivity at Work: the Workers’ Perspective’, one of three reports published in July, says: “More needs to be done – and can be done – to raise productivity...Greater involvement of workers is the key, but this is where management practices have taken a backward step in recent times with sluggish productivity (being) one of its unwelcome consequences.”

The findings also show that only a quarter (25%) of those surveyed strongly agreed that their employer treated employees in the business fairly. Researchers say this could have a knock-on effect on job performance, given that those with a high sense of organisational fairness are more willing to go the extra mile.



While women have not only caught up but have overtaken men in occupying jobs that require higher education qualifications over the last two decades, the researchers note: “Much still needs to be done to translate greater gender equity in jobs skills into equal pay as evidenced by the persistence of the gender pay gap.”

Alan Felstead, Research Professor at Cardiff University’s School of Social Sciences, says: “Britain has a longstanding labour productivity gap with international competitors, despite British employees working more intensively than many other nations. Our research seeks to understand the role of employees in sparking a much-needed reversal in this state of affairs.

“The big message coming out of our findings is that workers have great ideas about how productivity could be improved. Growth is unlikely to come from simply increasing the supply of skills; employers need to harness the views of their workforce and treat them fairly. This will give us a better chance of closing the productivity gap.”

Finally, the researchers explain that the incidence of technical change at work has fallen sharply across all occupational groups since 2012 and that these changes have become less demanding in terms of skills.

“Not so long ago, computers were only used by the most educated, but nowadays they have become a general

purpose technology found in virtually all organisations and industries, and used by most workers”, comments Professor Francis Green of the Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES), UCL Institute of Education.

“While this technology was being rolled out it meant that everyone had to become more skilled, but in the last decade the incidence of technical change at work has been falling, and since 2012 the required level of literacy and numeracy skills at work has fallen for the first time.” ■

Links for further information:

The Skills and Employment Survey 2017: www.cardiff.ac.uk/ses2017

Cardiff University: www.cardiff.ac.uk

The Economic and Social Research Council (ESRC): www.esrc.ac.uk

Department for Education: <https://www.gov.uk/government/organisations/department-for-education>

Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES): www.llakes.ac.uk

Job quality quiz: www.howgoodismyjob.com

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What will smart working look like 10 years from now?

Alison White of PLACEmaking and Barney Smith of Perform Green take a look at exciting future technology solutions and what 'going to work' will look like 10 years from now

The way we work has been changing steadily since the introduction of the personal computer in the 1970s. By the turn of the millennium, laptop users were able to work from multiple locations, but it was the game-changing iPhone – combining cloud computing with communication – which revolutionised the ability to work remotely and on the move. Since then, smart organisations have fully embraced mobile working and enabled staff to balance their external obligations with business needs, so gone are the days of the 9 to 5 working week in traditional offices.

Whilst working from home on a Friday is common for some, our clogged roads and peak time congestion do suggest that traditional working patterns still exist for many. Employers offering minimal 'flexibility' around the perceived core requirement to be physically "in the office" will find themselves left behind smarter employers who are busy preparing for the future.

Our way of working will continue to evolve and become increasingly smarter. Having continuous access to quicker, more reliable and personally profiled and filtered information with continuous communication connectivity will limit the need to physically travel to places of work, enabling us to choose places that suit our needs: when we want to work alone we will choose places that are comfortable



and convenient including, if we so wish, our living/working home base.

Will we all be working from home?

We are social creatures at heart and working from home only suits us for part of the time. When we want the benefit of stimulating company, the buzz of social interaction and/or the advantage of exceptional technology connectivity, we will walk or cycle to our nearby 'village hub': a drop-in space not owned or provided by a single employer but a highly serviced independently operated place, accessed on a pay-as-you-go basis. Not a concrete, glass and steel office, but a far more relaxed, informal and social atmosphere – high street coffee shop meets library, meets workshop/techno lab, meets home kitchen. In the 'village hub', we will hap-

pily 'work' alongside other specialists from different sectors, industries and backgrounds, organically partnering with a selection and contracting with them on common enterprises for one or multiple customers.

We will have continuous real-time connectivity with colleagues and partners who are themselves in their local 'village hub'. We don't own anything, but as consumers we have access to a range of different work settings that enable us to focus on our tasks, handing them back for others to use when we're done. The providers host the environment, offering technical support plus a range of add-on services (childcare, dog walking, etc), theming the 'village hubs' to attract different interest groups on different days. Larger towns will have multiple hubs,

mixing specialists in response to opportunities or demands.

What is the purpose of the office?

The HQ has a purpose, but perhaps we should think of it as the ‘mothership’, with the aim of driving the business enterprise, focusing on customer demands and ensuring that remote specialist outputs are aligned to those needs. The purpose of the mothership is to be the brand flagship, driving business development and hosting continuous virtual engagement with its remote and contracted specialist resource base. In place of traditional management structures, managers are now specialist ‘navigators’, continually analysing real-time data predicting trends in customer needs and orchestrating specialists to develop new products and deliver customer solutions. The value of the ‘mothership’ – unlike the HQ – is not about how big it is or how prominent its address, but in its connectivity to communications networks and highways.

When we visit the mothership, it will be for specific events. We may well do that physically, but we can now also do so virtually, represented by our own avatar which, as an extension of ourselves, will occupy space as if we were actually there: moving around, mixing and interacting with colleagues, partners or customers. The internal environment needed to host these events will be different: no longer offices filled with desks and sterile meeting rooms, but informal, social and communal spaces and creative multi-functional communication-rich visually transforming ‘project areas’ that foster innovation and reflect the importance of interactive team-based problem-solving. The platforms that

we use will also change – so out will go typed email and messaging, in its place will be voice-activated collaboration and conversation platforms.

What impact will this have on our lifestyles?

Avatars have no need to commute by car or train, so peak time mass transport in and out of city centres is no longer needed. As a result, the dynamics of where to live change, no longer dictated by commuter distance from an employer’s office, but instead influenced by proximity to the local ‘village hub’, the type of interest groups or co-workers it attracts, who we want to engage with and the community in which we want to live.

Well-located ‘village hubs’ add to already established community facilities and to places previously blighted by commuter travel patterns. Positioned on the high street, rather than in now-defunct business districts, the ‘village hub’ contributes to the creation of new forms of social cohesion as retail patterns change. Staying local means, we adopt healthier modes of transport, whilst technology enables us to seek new opportunities on a national and global stage from the comfort of our local community. Improved technology connectivity and an emphasis on preventive healthcare both ensure that we enrich community-based services with real-time access to remote specialists directing our care.

Meanwhile, virtual access to global institutions remodels the higher education sector, enabling young adults to stay within their community during intense learning periods and affordably delivering life-long learning across the community: re-establishing multi-

generational, close proximity living and addressing many mental health issues associated with loneliness and isolation.

As a result, the intensity of demand for affordable living in concentrated places is balanced with opportunities to remain and invest in local but highly connected communities. Curiously, the technology advancements of the future that we feared would harm our way of life could indeed offer us the opportunity to reconnect with what we value most – our friends, our families and our communities.

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Understanding and managing lone worker risk

Javier Colado, SVP of International Sales at Everbridge shares his views on understanding and managing lone worker risk, with a focus on helping to keep people safe and businesses running

There are 53 million lone workers across Europe, America and Canada, accounting for around 15% of the overall workforce, according to [Berg Insight](#). With advances in technology continuing to facilitate and improve mobile and remote working capabilities, this is a trend that we can expect to grow.

Lone workers are defined by [The Health and Safety Executive](#) as 'individuals who work by themselves without close or direct supervision' and are often exposed to and more vulnerable to risks that many office-based workers may not be. Examples of these types of jobs include security staff, maintenance and healthcare workers, taxi drivers and even some shop workers.

For employers, migration towards lone working in today's evolving workforce brings with it a new and complex set of challenges in terms of ensuring the health, safety and welfare of all lone workers that they employ. It is, therefore, imperative that organisations develop a robust strategy for assessing and controlling lone worker risk and are equipped to do so with an arsenal of appropriate and advanced policies, procedures and systems.

Assessing lone worker risk

In the UK, The Health and Safety Executive broadly outlines that [lone workers should not be put at more risk than other employees](#). However, as lone working

and the risks affecting lone workers vary for every business, it is vital that organisations first define their own set of core standards and values. These could include permitting lone working for only low-risk activities, ensuring that lone workers are sufficiently trained and experienced and having clearly defined channels of communication with a tested and trusted emergency response procedure.

“For employers, migration towards lone working in today’s evolving workforce brings with it a new and complex set of challenges in terms of ensuring the health, safety and welfare of all lone workers that they employ. It is, therefore, imperative that organisations develop a robust strategy for assessing and controlling lone worker risk and are equipped to do so with an arsenal of appropriate and advanced policies, procedures and systems.”

Once standards have been defined, a thorough risk assessment can be developed and implemented to provide a complete view of a company’s working environment according to job role and responsibility. This will enable specific risks affecting lone workers to be identified.

A popular framework used for this type of analysis is the PET2[®] risk-assessment tool, which outlines three key areas for consideration:

- **Person and people** – is there anything about the lone worker or the people they come into contact with that could pose a risk to their safety?
- **Environment and equipment** – is there anything about the environment or equipment, or lack of, which could pose a potential risk?
- **Task and triggers** – what is it about the activity being carried out that might lead to a problem or create risk for the lone worker?

Implementing control measures: Policies and procedures

Once steps have been taken to identify the risks affecting lone workers, organisations need to determine the most appropriate and effective control measures for their business and build these into a unique and robust set of policies and procedures. In practice, this should be an umbrella document with customised policies for each job role. It should also be subject to regular revisions from the individuals that it aims to safeguard as not only will this keep company policies up to date, it will help to ensure buy-in and cooperation is received across the organisation at every level.

Implementing control measures: Systems and communication

In the same way that significant advances in technology are facilitating a growing trend towards lone working, so too are they providing organisations with the capabilities to support and sustain a more mobile workforce. In this respect, it is fundamental that businesses have the right systems in place in order to effectively manage risk and ensure lone worker wellbeing when a critical incident occurs.

This should include being able to quickly locate and communicate with a lone worker in the event of a critical incident of any scale, for example, through utilising location-aware technology. This can be done with a platform that garners location data from multiple sources, including access control and badging systems, wired and wireless network access points, office labelling systems and corporate travel management systems. With access to all of this information, organisations can quickly locate any employees who may be in harm’s way and implement a response plan.

For critical communications systems such as this to be effective as a means of mitigating lone worker risk, it is important that they are proactive and two-way. Lone



Javier Colado, SVP of International Sales at Everbridge

workers should be able to reactively notify their employers of a potential risk or critical incident when it occurs and organisations should be able to reach and notify them of information that could allow potentially hazardous situations to be avoided completely.

“In the same way that significant advances in technology are facilitating a growing trend towards lone working, so too are they providing organisations with the capabilities to support and sustain a more mobile workforce. In this respect, it is fundamental that businesses have the right systems in place in order to effectively manage risk and ensure lone worker wellbeing when a critical incident occurs.”

With growing numbers of employees working remotely or without supervision, there has never been a better time for organisations to address the specific risks facing lone workers in their care. The ability to connect and unify a sometimes-disparate workforce through

effective communications not only holds the key to lone worker safety but also stands to positively affirm an organisation’s continued commitment and dedication to its workforce. ■

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