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SPACE STRATEGY PUSHES THE BOUNDARIES OF KNOWLEDGE IN EUROPE

MAROŠ ŠEFČOVIČ, VICE PRESIDENT OF THE
EUROPEAN COMMISSION EXPLAINS HOW THE
SPACE SECTOR MAKES LIVES BETTER, SAFER
AND HEALTHIER

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The City of Varberg has been awarded **Sweden's Best Place To Live** in both 2014 and 2015, and is nominated again this year. Our thriving city centre is nominated as third time finalist in **Sweden's City Centre of the Year** award. We welcome these awards and regard them as appreciative of our chosen path towards the future.

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FOREWORD

Martin Kern
Interim Director

European Institute of Innovation and Technology (EIT)

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Europe has excellent business, higher education and research organisations, but still lags behind its global competitors. Why? At the EIT, we believe that a big part of the answer is insufficient cooperation among key innovation players. That's exactly where the EIT Community comes in.

An electric flying car and an artificial tree that cleans the air with the power of 275 trees.

These are not science fiction but innovations created by the EIT Community. Earlier this year, 18 EIT Community innovators were featured by Forbes in their prestigious 30 under 30 list of the most promising young

entrepreneurs in Europe. EIT-supported ventures raise millions of euros in investment and are among Europe's innovation leaders.

How do we do this?

In short, we unite Europe's leading business, higher education and research institutions to create innovation hubs where the best ideas can grow and become products, services and jobs. We are Europe's largest innovation community – and, quite possibly, the world's – with almost 900 excellent partners spread over more than 30 innovation hubs across Europe. More than 800 entrepreneurs have graduated with EIT-labelled degrees, and almost 2,000 more are about to join them – these change-makers are gaining practical insights to help turn their ideas into action. Our Regional Innovation Scheme ensures that we reach every corner of Europe, remain open to new talent and continue to grow.

At the heart of every SME is an entrepreneur with bold ideas ready to make a change in Europe. We all know the challenges facing Europe today, from unemployment to climate change, to name only two. How do we face them?

Tado° had an idea for an intelligent heating control system that links to smartphones. After joining us at the EIT Climate-KIC Venture Competition, they then entered our accelerator programme, benefiting from EIT Climate-KIC's start-up advisors, its European network, funding and contact with other investors.

In the past 5 years, tado° has raised more than €50m to become one of the world's best-funded Internet of Things start-ups combating climate change.

What tado° shows – and what the stories of more than 200 start-ups created by the EIT Community within the areas of climate change, digitalisation, sustainable energy, healthy living and active ageing, raw materials and food show – is that there are thousands of entrepreneurs across Europe with bold ideas, ready to bring the change Europe needs. All they need is a spark to set them alight – through funding, mentorship, training or partnerships, through an environment connecting business, education and research, where innovation can grow and reach the market. The EIT Community is this spark.

Join us to make innovation happen! ■



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INTRODUCTION

As we head into summer, we launch the publication under the new name Open Access Government. The newly titled May issue sees a new look in a year that could also coincide with a new UK government. Following the triggering of Article 50 in March earlier this year, the government has recently announced a snap election to be held on June 8th.

The election could see a whole new change of direction for the government.

In this time of uncertainty, cooperation remains more important than ever. This edition of Open Access Government begins with a foreword from Martin Kern, Interim Director of the European Institute of Innovation and Technology (EIT), who highlights the importance of cooperation between key innovation players in Europe and the EIT community.

Also in this issue, we highlight European space policy, with key editorial from the Vice-President of the European Commission, Maroš Šefčovič. In his piece, Šefčovič outlines the EU Space Strategy and how the space industry is making lives better, safer and happier for Europeans. In the same focus, a feature from Peter Mandix Sehestedt of the Ministry of Higher Education and Science in Denmark, outlines why the Danish space sector is just as important for the economy.

One country we shine the spotlight onto in Open Access Government is Finland. In our special focus on the Nordic country we highlight the environment, energy and healthcare research.

The focus kicks off with an article from Riku Huttunen, Director General of the Energy Department at the Ministry of Economic Affairs and Employment. Huttunen shares Finland's ambition to achieve carbon neutrality by 2050.

Academy of Finland's Jarmo Wahlfors also shares how key players have developed a growth strategy to ensure a coherent approach to Finnish health research and innovation. Articles from Tekes Finland and the Finnish Environment Institute also feature.

Other areas we look into are gynaecological health research, Horizon 2020 in Switzerland, The European Disability Strategy, The European Capital of Culture 2017 and food resilience in the UK.

Furthermore, as technology use increases we examine the growing issue of cybersecurity. Sir Julian King, EU Commissioner for the Security Union, reveals how tackling cybercrime should be a consideration for everyone in Europe. Europol, who share similar thoughts on how to reduce cybercrime, also include their thoughts on the challenges facing Europeans.

As always, I hope you find Open Access Government informative and useful and I welcome any feedback you may have. ■

Laura Evans
Editor



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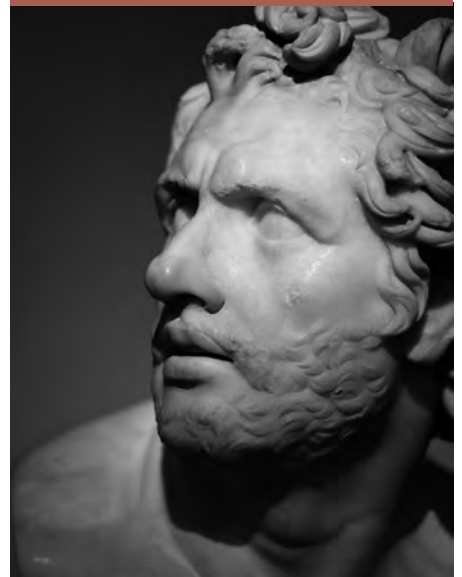
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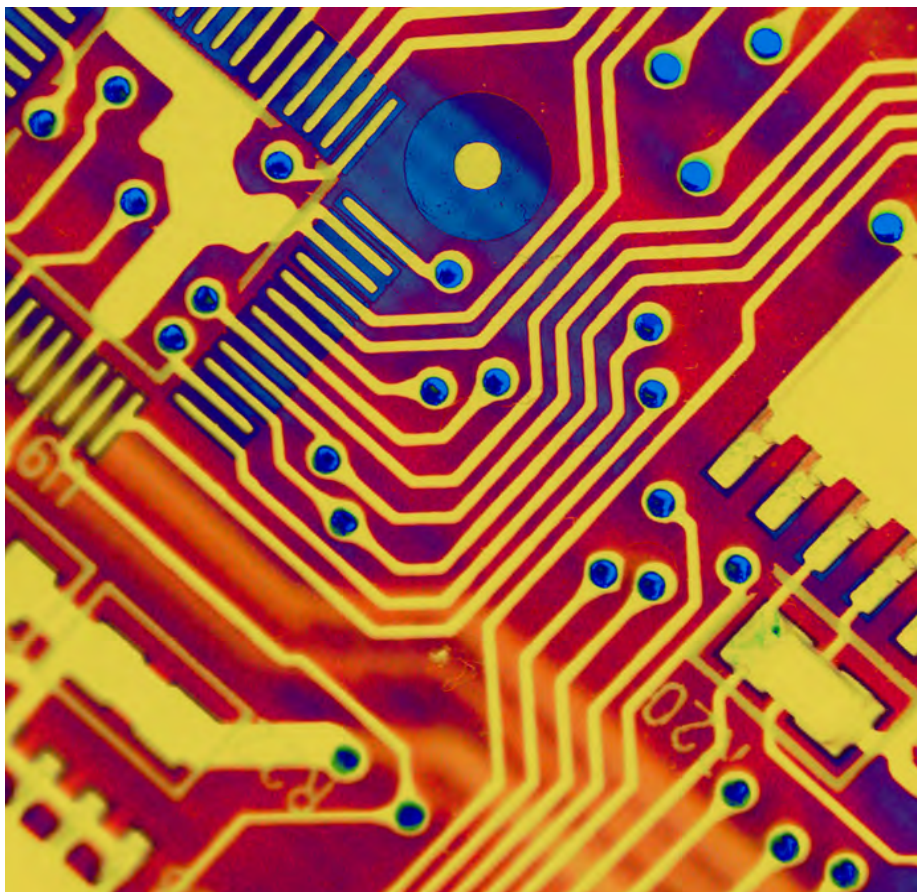
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Recognising dementia as a public health priority

The World Health Organization, says recognising dementia as a public health priority is key to addressing the condition globally

While improvements in health care and access have contributed to people living longer, this has resulted in an increase in the number of people with non-communicable diseases, including dementia. The numbers are daunting. Recent reviews estimate that globally, nearly 9.9 million people develop dementia annually, translating to one new case every 3 seconds¹. In 2015, dementia affected 47 million people (roughly 5% of the world's elderly population), a figure that is estimated to nearly triple to 132 million by 2050². The global cost of dementia care was estimated to be US\$818 billion, constituting 1.1% of global gross domestic product³. By 2030, the cost is estimated to increase to US\$2 trillion, a total that could undermine social and economic development globally.

Dementia is not an inevitable consequence of ageing

Crucial to interpreting these numbers is that dementia is not a normal part of ageing. Age is the strongest known risk factor for the onset of dementia, but it does not exclusively affect older people. Young onset dementia (onset of symptoms before age 65 years) accounts for up to 9% of cases⁴.

The gap is wide between the need for prevention, treatment and care for dementia and the actual provision of these services. Dementia is underdiagnosed worldwide, and, if a diagnosis is made, it is typically at a relatively late stage in the disease process. In high-income countries only one-fifth to one-half of cases of



dementia are routinely recognised and documented in primary care. Data from low- and middle-income countries is scarce; in one study from India, 90% of people with dementia had not received any diagnosis, treatment or care⁵. Care for people with dementia – from diagnosis until end-of-life, is frequently fragmented if not entirely lacking.

Dementia is a public health priority that touches multiple sectors

In 2012, WHO published *Dementia: A Public Health Priority*⁴ to provide the knowledge base for a global and national response and to facilitate governments and other stakeholders to address the impact of dementia as an increasing threat to global health. It identified that a lack of awareness and understanding of dementia often results in stigmatisation and barriers to diagnosis and care.

Indeed, the impact of dementia is far-reaching. For both the person with dementia and their carers, stigmatisation can contribute to social isolation, delays in seeking diagnosis and care, and a reluctance to ask for help^{4, 6}. Behavioural and psychological symptoms of dementia profoundly affect the quality of life of people with dementia and their carers. Providing care to people with dementia incurs a substantial emotional burden, including detrimental effects on carers' mental

and physical health⁷ as well as considerable indirect costs through loss of income.

Dementia, unlike other diseases, does not respect the boundaries of health alone, instead requiring a multi-sectoral response from other sectors such as social services, education, employment, justice and housing to improve the care and quality of life of people with dementia and their carers.

A shared global commitment is needed to raise the priority of dementia and reduce the burden

In 2013, a G8 Dementia Summit hosted by the UK, culminated in a communiqué and signed declaration of shared commitment from participating stakeholders and countries⁸. Ensuingly, WHO, supported by the UK Department of Health and The Organization for the Economic Cooperation and Development (OECD), organised the first *Ministerial Conference on the Global Action against Dementia* in March 2015 with over 450 participants from 89 Member States⁹. It fostered awareness of the public health and economic challenges posed by dementia and importantly, a better understanding of roles and responsibilities among countries and stakeholders, reflected in the 'Call to Action' adopted by participants.

In June 2016, the WHO Executive Board in decision EB139(1)¹⁰ requested the Secretariat to develop a draft Global Action Plan on the Public Health Response to Dementia, with clear goals and targets. Subsequently, in January 2017¹¹ the Executive Board considered the draft dementia global action plan and recommended to the 70th World Health Assembly to adopt the decision to endorse the plan during its review in May 2017.

WHO's vision, as described in the draft action plan, is a world in which dementia is prevented and people with dementia and their carers live well and receive the care and support they need to fulfil their potential with dignity, respect, autonomy and equality. To do so requires urgent solutions that adopt a multi-sectoral public health approach.

WHO is committed to supporting people with dementia and their families

WHO's *iSupport* is an evidence-based online support programme¹² for carers of people with dementia. It supports dementia carers to provide better care, with less detrimental consequences for their own health, while helping them to take better care of the person with dementia.

Dementia, along with depression and other priority mental disorders are included in the *Mental Health Gap Action Programme* (mhGAP) and its tools, the mhGAP-Intervention Guide¹³. This programme aims to scale up care and services by capacity building and health system strengthening approaches.

Likewise, a dementia friendly toolkit, currently in development, aims to provide countries, communities and partners with information to support them to be more dementia-friendly, considering aspects such as the community's built environment and infrastructure, social inclusion and engagement of people with dementia, dementia awareness and knowledge of the broader community.

Additionally, the *WHO Global Dementia Observatory* is an interactive web-based data and knowledge exchange platform¹⁴ that collates and disseminates data from countries on key dementia indicators to facilitate countries in strengthening their systems to support people with dementia and their carers. Development of the Observatory is currently underway.

This is a snapshot of WHO's strong commitment to address dementia through its many initiatives, working in collaboration with people with dementia, their carers, national and international partners. We must sustain collaborative global efforts to address this challenge for a better tomorrow for people with dementia and their carers, families and communities.■

¹ Prince M, Wimo A, Guerchet M, Ali GC, Wu Yutzu, Prina M. World Alzheimer Report 2015. The global impact of dementia: an analysis of prevalence, incidence, cost and trends. London: Alzheimer's Disease International, 2015.

² Ibid

³ Ibid

⁴ Alzheimer's Disease International and WHO. Dementia: a public health priority. Geneva: World Health Organization; 2012. (http://www.who.int/mental_health/publications/dementia_report_2012/en/).

⁵ Dias A, Patel V. Closing the treatment gap for dementia in India. *Indian Journal of Psychiatry*, 2009, 51 (5): 93–97.

⁶ Batsch NL, Mittelman MS. World Alzheimer Report 2012: Overcoming the stigma of dementia. London, UK; 2012. (https://www.alz.org/documents_custom/world_report_2012_final.pdf)

⁷ Prince M, Prina M, Guerchet M. World Alzheimer Report 2013 Journey of Caring: An Analysis of Long-Term Care for Dementia. Alzheimer's Disease International, London, UK; 2014 (<https://www.alz.co.uk/research/WorldAlzheimerReport2013.pdf>)

⁸ Department of Health Government of the United Kingdom. Policy paper RDD/10495: G8 Dementia Summit Communique. London, UK; 2013. (<https://www.gov.uk/government/publications/g8-dementia-summit-agreements/g8-dementia-summit-communique>)

⁹ First WHO Ministerial Conference on Global Action Against Dementia. Geneva: World Health Organization; 2015. (http://www.who.int/mental_health/neurology/dementia/ministerial_conference_2015_report/en/)

¹⁰ WHO Executive Board. 139th session decisions and list of resolutions; June 2016. (http://apps.who.int/gb/ebwha/pdf_files/EB139/B139_DIV2-en.pdf)

¹¹ WHO Executive Board. 140th session decisions and list of resolutions; Jan 2017. ([http://apps.who.int/gb/ebwha/pdf_files/EB140/B140\(7\)-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/EB140/B140(7)-en.pdf))

¹² Information on *iSupport* tool available at: http://www.who.int/mental_health/neurology/dementia/isupport/en/

¹³ Information on mhGAP available at: http://www.who.int/mental_health/mhgap/en/

¹⁴ Information on the Global Dementia Observatory available at: http://www.who.int/mental_health/neurology/dementia/GDO/en/

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Pharmacogenomics of polypharmacy in Alzheimer's disease

Ramón Cacabelos of EuroEspes Biomedical Research Center details how the incorporation of pharmacogenomics to treat Alzheimer's patients is crucial

Alzheimer's disease (AD) is a major problem of health in developed countries and the most prevalent form of dementia, representing the 6th cause of death in the U.S, with an age-adjusted death rate of 25.4 per 100,000. Genomic, epigenomic, cerebrovascular, metabolic and environmental factors are potentially involved in the pathogenesis of AD. The age and sex-related syndromic profile of Alzheimer's reflects, at least, a tetravalent phenotype: (i) a neuropathological component (classic hallmarks: senile plaques, neurofibrillary tangles, neuritic desartorization, neuronal loss); (ii) a neurobehavioral component: cognitive deterioration, behavioural changes, functional decline; (iii) an age-related biological component (direct-, indirect-, and unrelated biochemical, hematological and metabolic phenotypes); and (iv) gender-related phenotypes. According to this heterogeneous, complex clinical picture, the therapeutic intervention in dementia is polymodal in order to modify the expression of all these complex phenotypes. AD patients present concomitant disorders including hypertension (20-30%), overweight or obesity (20-40%), diabetes (20-25%), hypercholesterolemia (more than 40%), hypertriglyceridemia (20%); excess of urea (more than 80%), creatinine (6%) and uric acid (5%); alterations in transaminases (ASAT, ALAT, GGT)($>15\%$), alkaline phosphatase (14%), bilirubin (17%),

and ions (more than 10%); deficits of iron (5%), ferritin (3%), folate (5%), and vitamin B12 (4%); thyroid dysfunction (5-7%), and reduced levels of RBC (3%), HCT (33%), and Hb (35%).

Cardiovascular disorders (more than 40%), atherosclerosis (more than 60%), and different modalities of cerebrovascular damage (more than 60%) are also frequent among patients with AD. Most of these biochemical, haematological and metabolic anomalies exhibit gender differences and may contribute to accelerate the dementia process. The pharmacological treatment of these concomitant pathologies adds complexity and risks to the multifactorial therapeutic intervention in patients with dementia. Of major relevance is the treatment of diabetes, hypertension, dyslipidaemia, and cardiovascular, cerebrovascular and neuropsychiatric disorders. The chronic treatment of these illnesses increases the risk of drug interactions and toxicity, aggravating the clinical condition of the demented patient. In this context, the incorporation of pharmacogenetics protocols into clinical practice is fundamental to minimise drug-drug interactions and ADRs, and to optimise the global therapeutic outcome, avoiding deleterious effects on mental function and cognition.

Major determinants of therapeutic outcome in AD include age- and sex-related factors, pathogenic pheno-

type, concomitant disorders, treatment modality and polypharmacy, and pharmacogenetics. Different categories of genes are potentially involved in the pharmacogenetics network responsible for drug efficacy and safety. Pathogenic, mechanistic, metabolic, transporter, and pleiotropic genes represent the major genetic determinants of response to treatment in AD. By-products of these genes are integrated into transcriptomic, proteomic and metabolic networks which are disrupted in AD and represent potential targets for therapeutic intervention.

AD patients may take 6-12 different drugs/day for the treatment of dementia-related symptoms, including memory deterioration (conventional anti-dementia drugs (donepezil, rivastigmine, galantamine, memantine), neuroprotectants), behavioural changes (antidepressants, neuroleptics, sedatives, hypnotics), and functional decline, or for the treatment of concomitant pathologies (epilepsy, cardiovascular and cerebrovascular disorders, Parkinsonism, hypertension, dyslipidaemia, anaemia, arthritis, etc.). In over 20 to 30% of the patients, behavioural deterioration and psychomotor function can be severely altered by polypharmacy. The principal causes of these iatrogenic effects are the inappropriate combination of drugs, and the genomic background of the patient, responsible

for his/her pharmacogenomics outcome.

Pharmacogenomics profiles

Pharmacogenomics accounts for 60 to 90% variability in pharmacokinetics and pharmacodynamics. The modest effect (and toxicity) of current Alzheimer's disease drugs is in part due to their pharmacogenomics profile, since over 70% of AD patients are deficient metabolisers.

Tetragenic haplotypes integrating CYP2D6, CYP2C9, CYP2C19 and CYP3A4/5 variants in the Iberian population yield 156 genotypes. The most frequent haplotype is H3 (1/1-1/1-1/1-3/3) (20.87%), representing full extensive metabolisers, and only 17 haplotypes exhibit a frequency higher than 1%. In addition to H3, the most frequent haplotypes (more than 2%) are H55 (1/4-1/1-1/1-1/3)(8.41%), H26 (1/1-1/2-1/1-3/3)(8.07%), H4 (1/1-1/1-1/2-3/3)(8.07%), H58 (1/4-1/1-1/2-3/3)(3.99%), H72 (1/4-1/2-1/1-3/3)(3.82%), H2 (1/1-1/1-1/1-1/3)(3.74%), H9 (1/1-1/1-1/3-3/3)(3.57%), and H38 (1xN/1-1/1-1/1-3/3)(2.46%). This indicates that about 80% of the population is deficient for the biotransformation of current drugs which are metabolised via CYP2D6-2C9-2C19-3A4 enzymes. Most anti-dementia drugs are metabolised via CYP enzymes.

Alterations in cholesterol (CHO) metabolism are involved in AD pathogenesis and over 40% of AD patients are hypercholesterolemic. The pharmacogenetics of cholesterol response to the hypolipemic compounds shows a great variability with a high response rate (RR) (78.95% responders and 21.04% non-responders). APOE-related basal CHO levels are significantly different, with females showing higher CHO levels than males; how-

ever, females and males responded similarly to the hypolipemic treatment. The stratification of patients according to their APOE, APOB, APOC3, CETP and LPL genotypes shows no genotype-related differences at basal CHO levels, except in the case of APOE carriers where the highest baseline levels of CHO are found in APOE-4/4 carriers and the lowest levels in APOE-2/2 carriers, in addition to a clear age-related profile.

The construction of a pentagenic haplotype integrating all possible variants of the APOE+APOB+EPOC3+CETP+LPL genes identified 111 haplovariants with differential basal CHO levels. About 75% of these haplotypes in the AD population have a frequency below 1%, 10% have a frequency between 1% and 2%, 8% have a frequency between 2% and 5%, and only 4% of the haplotypes are present in more than 5% of AD patients. The haplotypes most frequently found are H55 (33-CT-CC-AG-CC) (8.79%), H58 (33-CT-CC-GG-CC) and H37 (33-CC-CC-AG-CC)(7.07%). Haplotypes H104 (44-CC-CC-AA-CC)(0.11%), H110 (44-TT-CC-AG-CG)(0.11%) and H98 (34-TT-CC-AA-CG)(0.11%) show the highest CHO levels, and the lowest levels correspond to haplotypes H26 (23-TT-CG-AG-CC) (0.11%), H8 (23-CC-CG-AG-CC)(0.21%), H50 (33-CC-GG-AG-CC)(0.21%), and H63 (33-CT-CG-AA-GG)(0.11%).

In AD patients, the CHO response to conventional lipid-lowering compounds is genotype-dependent and can, in part, be explained on a pharmacogenetics basis. It is obvious that a simple stratification of patients according to single genotypes is of poor value for a fine interpretation of pharmacogenetics results; however, the integration of gene clusters associated with specific phenotypes yields informative haplo-

types with potential utility in pharmacogenetics studies. It is likely that thousands of genes are involved in CHO metabolism, and probably not a single gene plays an absolute dominant role over the others; however, some genes exert a powerful effect on other congeners associated with a specific pathogenic cascade (e.g. APOE in AD) or a pharmacogenetics pathway (e.g. APOE vs CYPs in AD treatment with donepezil).

In over 80% of patients with AD, polypharmacy is imperative for the management of concomitant disorders; however, drug interactions may constitute a severe complication with deleterious effects on brain function and quality of life. In this regard, the implementation of pharmacogenetics procedures can be of great utility for minimising drug adverse events and for optimising multifactorial therapeutics in complex disorders such as AD.

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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

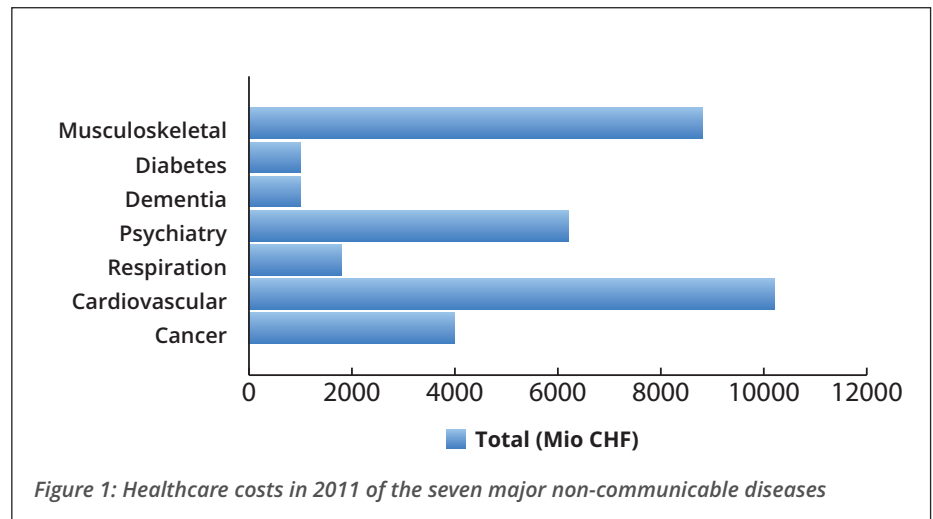
It is estimated that 10% of the cost of healthcare in Switzerland (or the equivalent of €500 billion per annum in the EU) being associated with lost work is related to injury or dysfunction of the musculoskeletal system (Fig. 1). Surgical and subsequent rehabilitative interventions are important part 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.

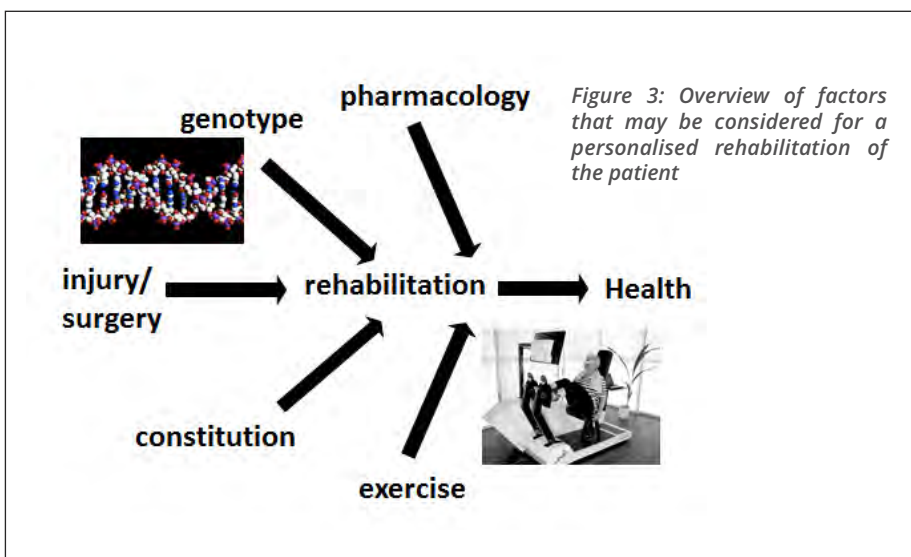
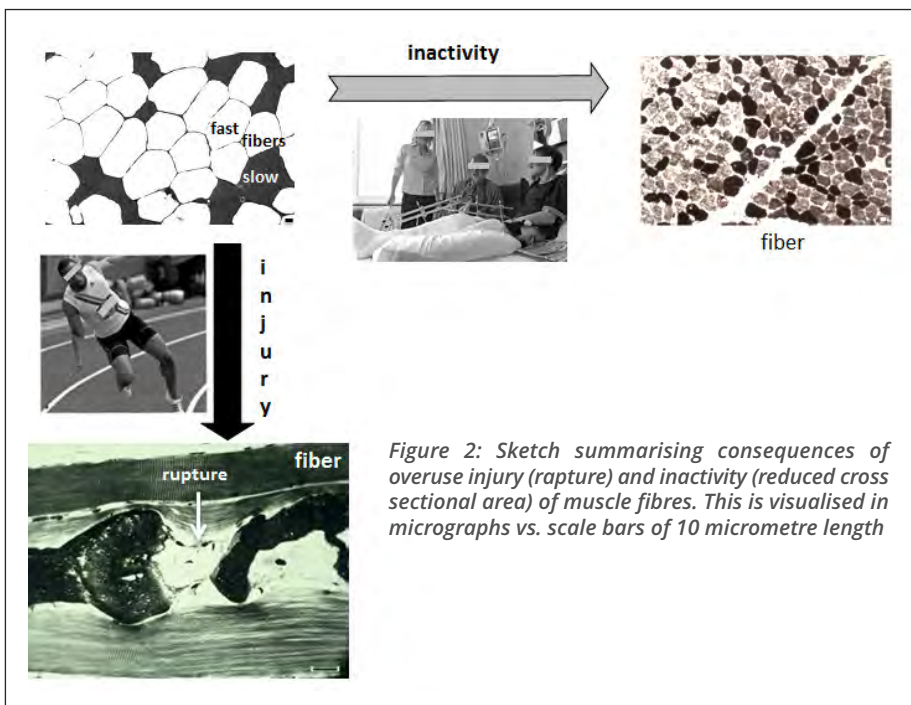
By contrast, a muscle's functional capacity is reduced in the absence of a physiological stimulus by a reduction in the size of muscle fibres and their content in mitochondria (Fig. 2).

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



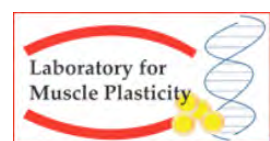
to inter-individual differences in the healing of muscle with re-attachment of the ruptured rotator cuff tendon, and the strengthening of skeletal muscle with rehabilitative exercise in patients.

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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Dementia research: Translating knowledge into new treatments

Chief Executive Hilary Evans highlights how Alzheimer's Research UK is helping advance dementia research, but warns there is still more to be done

Five years ago, then Prime Minister David Cameron made an announcement that was to trigger a real step-change in our nation's response to the growing dementia crisis. Launching the first Prime Minister's Dementia Challenge, Mr Cameron pledged to bring political attention to dementia, describing his ambition to tackle the condition as a 'personal priority'. For the first time in our country's history, we saw a real focus on dementia from government with a genuine determination to drive progress in research, change societal attitudes to the condition and improve care.

Much has changed since then, and it's no exaggeration to say that much of the progress that has been made has been thanks to the Dementia Challenge. In January this year, Mr Cameron became President of Alzheimer's Research UK. As our foremost ambassador, the role will see him continuing to be part of the fightback against dementia by championing our vision and helping to raise awareness, as well as driving forward progress in research.

Putting dementia on the global agenda

As a world leader, David Cameron put dementia on the global agenda. A year after launching the Dementia Challenge, we saw him harness the UK's presidency of the G8 to bring together world leaders for the first ever summit on dementia – setting in motion a worldwide push to tackle a condition which devastates lives worldwide. The summit culminated in a commitment to strive for a cure or disease-modifying treatment for dementia by 2025, and inspired the creation of the World Dementia Council to steer global action to achieve this ambition.

The commitments Mr Cameron made on dementia while in office have led to tangible changes in the dementia research landscape in the UK. Under the first



Hilary Evans, Chief Executive, Alzheimer's Research UK

Prime Minister's Dementia Challenge, government funding for dementia research doubled between 2012 and 2015. Today we see the impact that this had: in March, our analysis revealed that the number of UK dementia researchers had almost doubled over 6 years, as had the number of new breakthroughs being published from dementia studies. These numbers tell us we are gaining ground in the search for much-needed treatments and preventions.

Of course, the fight is by no means over – something that Mr Cameron himself highlighted on taking up his voluntary role as our President. Following years of under-investment, we started from a low base and despite increases in funding, dementia research still



lags behind other serious health conditions. There is still only one dementia researcher for every £2m of costs to the UK economy attributed to the condition, compared to 10 researchers working on cancer. We need even more ambitious investment if we are to achieve the breakthroughs people living with dementia so desperately need.

“Today we know more than ever before about the diseases that cause dementia – now we need to translate that knowledge into new treatments that can transform lives.”

Alzheimer’s Research UK

That’s why at Alzheimer’s Research UK, we’re focused on increasing our funding for research with a range of strategic initiatives designed to speed up progress – from our network of Drug Discovery Institutes, working to fast-track treatment development, to our £2m Prevention and Risk Reduction Fund, designed to support innovative new research projects to find new ways of reducing dementia risk. We are proud to be a founding charity partner of the UK Dementia Research Institute – the UK’s largest ever joint endeavour in dementia research – and to be working on some unique collaborations with the pharmaceutical sector, government

and academia aimed at accelerating the development of new dementia drugs. To match the immense scale of the challenge we face, we need charities, the government and industry working together to tackle it.

Today we know more than ever before about the diseases that cause dementia – now we need to translate that knowledge into new treatments that can transform lives. Dementia is the only leading cause of death in the UK for which numbers are still rising. But research has changed the outlook for other conditions that were once considered a certain death sentence, and we can do the same for dementia – if we lift our ambition and continue to increase our investment. Through a concerted and joined up effort, and with influential individuals like David Cameron helping to galvanise support for research, we know we will get there. ■

Hilary Evans Chief Executive

Alzheimer’s Research UK
www.alzheimersresearchuk.org
www.twitter.com/ARUKnews
www.facebook.com/alzheimersresearchuk

Time for a change of tack on drug development for neurodegenerative diseases?

UCB's Duncan McHale outlines why reclassification might be a good idea to boost drug development for neurodegenerative diseases like Alzheimer's and Parkinson's

Neurodegenerative diseases are a growing global challenge, as medical advances ensure more individuals live longer. By 2020 there will be more than 40 million people in the world with Alzheimer's disease (AD) and by 2040, without the development of disease modifying drugs, this will rise to more than 80 million. Discovering and developing disease modifying drugs is proving very challenging, with many programmes failing. November 2016 saw another phase 3 failure with Lilly's solanezumab failing at the final stages of development. Is this the end of the amyloid hypothesis or a case of too little, too late and too broad?

"AETIONOMY is an Innovative Medicine Initiative (IMI) funded consortium established to develop a mechanistic based classification of neurodegenerative diseases, with an initial focus on Alzheimer's and Parkinson's disease."

The amyloid hypothesis

Alzheimer's disease is a chronic neurodegenerative disease which usually presents in the seventh or eighth decade of life. However, earlier onset is not uncommon. The cause(s) of AD are not fully understood but the presence of amyloid (protein) plaques in the brain was demonstrated in 1911 and since this time the disease has

been thought of as a disease of amyloidosis. Multiple potential therapies targeting amyloid processing have been developed and studied, with several still in the development stages. These therapies have all demonstrated an ability to reduce amyloid load in preclinical models, but this has so far not been beneficial to humans.

Amyloid is undoubtedly associated with AD and its presence has been a core part of the diagnosis, either post mortem or, more recently, through imaging techniques. However, the amount of amyloid does not correlate with disease severity and many subjects have significant amyloid deposits

but no symptoms. Despite these anomalies, the majority of current potential therapies have been targeting this mechanism. The community eagerly awaits the results of a clinical trial using Biogen's aducanumab as the most promising agent so far, but given the failure of other admittedly less potent molecules targeting amyloid deposition, many are pessimistic about a good result.

Drug development for neurodegenerative diseases at a turning point

The failure of these therapies to date could be because the amyloid hypothesis is flawed and, despite the



association, amyloid is a downstream consequence of the disease process and not pathogenic in its own right. However, the presence of familial forms of the disease caused by genes involved in amyloid processing make this unlikely. For example, the presenilin 1 gene is part of a protein complex which degrades amyloid, creating the pathological 42 amino acid peptide.

“By 2020 there will be more than 40 million people in the world with Alzheimer’s disease (AD) and by 2040, without the development of disease modifying drugs, this will rise to more than 80 million.”

It is much more likely that, for most individuals, amyloid is not the sole cause and additional pathological mechanisms are involved. Indeed we now know that the Tau protein is one of these additional mechanisms. It is therefore time to start focussing on some of these other mechanisms to find the causes of AD, which we can then target with new therapies. We need to look for mechanisms that are important in later stages of the disease process and/or can still be successfully modified once the very early symptoms appear. AETIONOMY is a consortium with the sole purpose of identifying these other mechanisms involved in AD and reclassifying neurodegenerative disease using these discriminatory mechanisms, which will help us develop new treatments.

At AETIONOMY we have been taking the totality of research in AD and, using our knowledge base, integrating this information into a common framework to search for other potential mechanisms. By looking for these other mechanisms we hope to find sub-populations of patients who can be treated by targeting the cause in



them which is present with the amyloid plaques. Success will result in a new way to classify AD beyond just the presence of memory problems and plaques. Success will also result in new mechanisms for targeting and precision medicines for AD.

AETIONOMY

AETIONOMY is an Innovative Medicine Initiative (IMI) funded consortium established to develop a mechanistic based classification of neurodegenerative diseases, with an initial focus on Alzheimer’s and Parkinson’s disease. This public private partnership is co-led by myself and Martin Hofman-Apitius from SCAI Fraunhofer. The premise behind the project is that, although large sums have been invested in research in neurodegeneration and a lot of data generated, the co-ordination and integration of this data across the community has been less well addressed. The consortium has brought together experts in

informatics, computing, engineering, mathematical modelling of disease, neuroscience and clinical neurology from leading academic centres, as well as neuroscience, informatics and neurology drug development experts from the EFPIA Industry partners.

AETIO **N/O**
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Preventing Alzheimer's disease with neuroimaging methods

Ai-Ling Lin of the Lin Brain Lab details how neuroimaging research can be used to reduce brain aging and the impact of Alzheimer's disease

Alzheimer's disease (AD) is one of the most common forms of dementia, accounting for 60%-80% of all dementia. The neuropathological hallmarks of AD include extracellular β -amyloid (A β) senile plaques and intracellular neurofibrillary tangles (tau). Neuroimaging studies in humans show that decades before the aggregation of A β and tau tangles, cognitively normal individuals had developed metabolic and vascular deficits. In particular, significantly reduced cerebral metabolic rates of glucose (CMRglc) and cerebral blood flow (CBF) were found in people at high risk for AD several decades before the possible onset of dementia.

Brain metabolic and vascular integrity plays an important role in determining cognitive capability and mental health. Failure to maintain CMRglc has been shown to lead to cognitive impairment and brain volume atrophy. Similarly, studies have shown that neurovascular risk is highly associated with an accelerated decline in language ability, verbal memory, attention and visuospatial abilities. Reduced CBF is linked to anxiety and depression, and impaired blood-brain barrier is associated with neuroinflammation and synaptic dysfunction. These metabolic and vascular reductions precede brain structural alteration (grey matter and white matter atrophy) and cognitive impairment. Therefore, preserving brain metabolism and hemodynamics



are critical for optimising our lifespan, as well as our health span.

Caloric restriction (CR), without malnutrition, has been repeatedly shown to extend life expectancy, as well as enhance brain functions. On biochemical and molecular levels, CR shows to improve glucose homeostasis and insulin sensitivity, up-regulate brain-derived neuro-trophic factor, reduce oxidative stress, inflammation, and retention of A β and tau. CR also shows beneficial effects on vascular systems by decreasing blood pressure, atherogenic lipids, inflammatory cytokines and increased cellular stress resistance. In line with this, animals treated with CR had lower incidences of age-related neurodegenerative disorders and diabetes.

To study the functions in a living brain in real time, non-invasive neuroimag-

ing methods have been developed as powerful tools for identifying in vivo metabolic and vascular biomarkers. For example, CMRglc can be measured using positron emission tomography (PET), and CBF by magnetic resonance imaging (MRI). Our group also uses magnetic resonance spectroscopy (MRS) to measure levels of various brain metabolites, mitochondrial oxidative metabolism, and neuronal activity. We have used this state-of-the-art, multimodal imaging technology to identify CR effects in brain aging.

Recent neuroimaging studies with mice

In a recent animal study, we found an age-dependent decline in CBF, neuronal activity, mitochondrial oxidative metabolism, total creatine (TCr) level, and adenosine triphosphate (ATP) in mice fed with ad libitum (ad lib; mean-

ing “at one’s pleasure”). However, all these physiological functions preserve with age in mice fed with a 40% CR diet. Interestingly, we found CR also has significant effects in young mice (5-6 months of age). Within 2 months taking the diet, the young mice show significantly enhanced CBF, TCr, ATP, and taurine (related to neurotransmission), compared to age-matched mice fed ad lib. In addition, CR causes a metabolic shift in the mice at a very early age. Instead of using glucose as the predominant energy source for sustaining brain functions, young CR mice shifts to use ketone bodies as the fuel. In bodies with increased ketone, their metabolism suggests increased oxidative metabolism. Utilization of ketone bodies significantly elevates the oxygen utilisation in mitochondria through beta-oxidation of fatty acid. This is supported by evidence from isolated mitochondria and our imaging results that old animals with CR diet had preserved oxidative metabolism, mitochondrial functions, and neuronal activity compared to the age-matched ad lib animals.

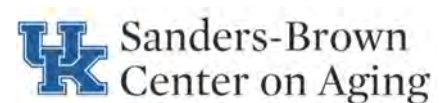
The increased oxidative metabolism also plays a critical role in preventing A β retention. Previous neuroimaging studies showed that cognition-associated brain regions have non-oxidative glycolysis exceeding the required needs of oxidative phosphorylation, a phenomenon known as aerobic glycolysis (AG). Excessive AG (or the “Warburg effect”) is a key process that sustains T cell activation and differentiation, and is involved in inflammatory-mediated conditions. In line with this, the distribution of AG in normal young adults is spatially correlated with A β deposition in AD patients and

cognitively normal individuals with elevated A β . Animal studies further demonstrated that A β plaque formation is an activity dependent process associated with AG. Therefore, increased oxidative metabolism in cognition-related regions may decrease AG and thus reduce the risk for AD, consistent with the literature that CR reduces AD-like symptoms in mice. Reduced AD risk was also found in rhesus monkeys, showing CR impedes age-related iron deposition in the brain, which consequently reduces the potential interaction between metal and A β , and thus decelerates the pathogenesis of AD.

CR has repeatedly shown to improve memory in aging, both for studies in humans and animals. We had similar observations in a recent study, showing CR had significantly protective effects on learning and spatial memory for old mice. The cognitive outcomes are correlated with CBF in hippocampus and frontal cortex, the brain areas regulating learning and memory. The findings indicate that the level of CBF in cognition-associated brain regions may play a critical role for determining performances on learning and spatial memory. We further identified that the anxiety level in the mice had significant and inverse correlations with CBF in hippocampus and in frontal cortex. These findings indicate that preservation of CBF with age is pivotal for sustaining memory and mental health. More importantly, this positive impact on cognitive functions may also be attributed to early-life changes in neurovascular and neurometabolic functions. A recent study suggested that neuroprotective mechanisms play a major role during early stages and compen-

satory mechanisms in later stages of neurological diseases. This is consistent with our imaging findings that CR induces early enhancements, and later preservation, on brain metabolic and vascular physiology.

In summary, CR has repeatedly shown to extend lifespan and health span in various animal models. Using neuroimaging methods, we demonstrated that CR induces early enhancements in brain metabolic and vascular functions, and preserves these functions with age; the preservation of brain functions is highly associated with cognition and mental health in aging mice fed with CR. As neuroimaging can be readily applied to humans, it has tremendous translational values to identify dietary effects to slow brain aging and prevent AD in humans.



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The role of physiotherapy for Parkinson's

Writing on behalf of the Chartered Society of Physiotherapy, Dr. Bhanu Ramaswamy highlights how physiotherapy can help manage the symptoms of Parkinson's

Parkinson's is a neurological condition that affects one in every 500 people across the United Kingdom.

Currently there is no known cure and as the function of the brain is known to gradually decline, the condition can be portrayed through a negative viewpoint. Anecdotal and published material from people diagnosed with the condition however stress that correctly timed education and available support networks enable them to live more normal lives, and improve the quality of their experience with Parkinson's.

This happens through interdependent relationships with differing groups of people (family, friends, peers through the voluntary sector, health professionals, social care providers and employers), from the time around the diagnosis, and ongoing through the course of the condition.

Progression of Parkinson's

The symptoms and progression of Parkinson's differ between individuals, sometimes making diagnosis difficult. It may take a few years before the atypical Parkinson's conditions are distinguishable from idiopathic Parkinson's, the most common form. There are certain symptoms however that are experienced more commonly, categorised according to their effect on movement (motor symptoms) or other issues (non-motor symptoms). Non-motor symptoms can include altered sleep, low mood, altered processing of thoughts, sometimes affecting how easily a person can do more than one task at a time, and memory, plus physiological changes, such as constipation or waxy skin.

The main motor symptoms are slower movement in all people (bradykinesia), involuntary shaking (tremor) in some, usually observed as a hand or foot tremor, and the experience of muscle stiffness (rigidity). The

combination of stiffness and slowness can cause movements to become smaller. People may experience these with altered swallowing and speech (quiet voice, less melodic speech pattern), changes to facial expression to become more mask-like, changes to writing (becomes smaller), as well as smaller, more shuffling steps when walking. The symptoms first appear on one side of the body and are thought to arise as a result of the loss of a chemical called dopamine in the brain, which helps regulate movement. It is important to note that not everyone will experience the vast array of motor or non-motor symptoms.

Physiotherapists work as part of a team of health and social care professionals to support individuals with Parkinson's in achieving their best possible lifestyle. This might involve providing information about Parkinson's, including a link to the vital social network provided through the voluntary sector. Here, peers have the experience to answer questions about Parkinson's and what the future may hold from one perspective, just as the professionals can offer their skills and knowledge from a different angle. People don't die directly because of Parkinson's, and therefore, they should be encouraged to take up opportunities to share ideas on how to manage living with the condition with others through a wide support network.

Managing Parkinson's through physiotherapy

The National Institute of Health and Care Excellence (NICE) advocate physiotherapy for people with Parkinson's. Physiotherapists help people affected by injury, illness or long-term conditions through movement and exercise, manual therapy, education and advice. Where people cannot 'recover' from a condition such as Parkinson's, a role of physiotherapy is to enable people to remain independent and well for as long as possible, regardless of age, manage discomfort or pain, and

prevent the complications from a less active lifestyle that occurs secondary to the main condition.

A thorough assessment and dialogue between the physiotherapist and person with Parkinson's will identify goals and life priorities to enable planning of areas that require intervention, especially focusing on the ability to carry out everyday tasks based on their unique needs.

In general, the benefits of physiotherapy for people with Parkinson's and the people most close to them include improving or maintaining fitness through exercise (especially for balance, strength and flexibility); helping with movement control to maintain independence and prevent or manage falls; help alleviating pain, and ensuring posture is optimised as this affects breathing, swallowing, tasks such as turning (in bed or when walking) and balance, including tasks such as walking or getting up out of a chair.

Whilst the medical management of Parkinson's is through the prescription of drugs, exercise and movement therapies are also necessary to help manage many Parkinson's symptoms.

When someone is newly diagnosed, the emphasis of physiotherapy is to support the individual to identify activities to take on or keep up with, to stay fit, active and healthy, thus minimising the impact of Parkinson's later in life. This includes the use of leisure and third sector programmes to promote general fitness and inclusion in community activity. For people with Parkinson's, it is vital to consider taking exercise daily as one would take medication. No exercise done correctly has been demonstrated as harmful, and when done properly, it can help recalibrate slow and small movement (motor symptoms) associated with Parkinson's. In addition to the physical benefits of training targeted to symptoms of Parkinson's, exercise has been shown to help in managing non-motor symptoms, and physiological (including brain) and mental health.

There may be a point as the individual ages, as the condition progresses, or when Parkinson's is only one of their medical conditions when some of the symptoms of Parkinson's may have a bigger impact on day-to-day

life. At this point a physiotherapist can problem-solve with the individual to consider their needs. They may then teach family and friends strategies to help with better movement that minimise injury to anyone, with an emphasis on everyone staying active and safe. Treatments focus on teaching strategies to overcome difficulty in generating automatic movement and thought that are affecting daily function (dual tasking). For example, external cueing, such as auditory, tactile, visual and sensory cues, or attentional strategy training (e.g. mental rehearsal and visualisation of movement). ■

For more information see below:

For a physiotherapist: the [European Physiotherapy Guidelines for Parkinson's disease](#). A free publication (contributed to by 17 European countries, including the UK representatives of the Chartered Society of Physiotherapy), but subject to copyright law.

Reference. KEUS SHJ, MUNNEKE M, GRAZIANO M, ET AL (2014). European Physiotherapy Guideline for Parkinson's Disease. KNGF/ ParkinsonNet, The Netherlands.

Chartered Society of Physiotherapy information page, [plus fact sheet](#).

Also relevant networks for professionals are: [ACPIN](#) – the Association of Chartered Physiotherapists in Neurology and [AGILE](#), Chartered physiotherapists working with older people.

Parkinson's UK fact sheet 'Physiotherapy and Parkinson's – order code FS42' at: <https://www.parkinsons.org.uk/content/physiotherapy-and-parkinsons-information-sheet> or information about Parkinson's in general at: <https://www.parkinsons.org.uk>.

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Protecting and restoring dopaminergic nerve cells in Parkinson's disease

Parkinson's disease is a slow but progressive neurodegenerative disorder. About 1% of people aged above 50 are affected worldwide. In Europe alone 1.2 million people suffer from Parkinson's disease, 127,000 of whom reside in the UK. According to Imperial College London, the direct and indirect costs to British society are roughly £2 billion each year. These costs are expected to rise with increasing life expectancy.

Parkinson's disease

The hallmarks of Parkinson's include general slowing and paucity of movement, increased rigidity, reduced facial expression and an emerging tremor in one or both hands. While these symptoms are instrumental in diagnosis, the disorder is – by then – already ongoing for several years. Before being diagnosed with Parkinson's disease (PD), patients will have suffered a number of prodromal symptoms such as loss of smell, constipation, depressive periods, sleep disorders, lack of motivation, cognitive decline and more for several years. Each separate symptom may not have been worth visiting the GP and the symptoms do not present themselves in every patient nor in any specific sequence. Somewhere between 50 and 60 years of age, however, patients eventually develop tremors and will be referred to a neurologist and diagnosed.

In the late 1950s and early 1960s, Hornykewicz and fellow neurochemists demonstrated a clear depletion of the neurotransmitter dopamine in striatal

tissues (called caudate-putamen in man) of Parkinsonian brains. Moreover, correlating the extent of depletion with clinical records, it became clear that by the time patients got diagnosed with PD, 60-80% of dopamine was lost when compared to healthy people of the same age. Moreover, this depletion of dopamine was matched by a 40-60% loss of dopaminergic cell bodies in the substantia nigra, the origin of the dopaminergic nerve cells projecting onto the striatal brain tissue. Two important conclusions are that by the time PD is diagnosed, the patient has already lost their erstwhile massive dopamine reserve. Secondly, about 50% of dopaminergic cells are still alive and offer a promising basis for protecting these cells and restoring adequate dopamine neurotransmission, which is the basis for Genecode's innovation.

Pharmacological developments for Parkinson's disease

With the neurochemical basis for PD in hand, many research groups worldwide quickly built a comprehensive framework to monitor dopaminergic neurotransmission and to create methods that compensate for the progressive loss of dopamine in PD. Why dopaminergic cell loss speeds up in some people is still unknown. However, patients have benefited greatly from the use of the dopamine precursor L-DOPA which is converted into dopamine in the brain.

With such replenishment patients regain control of voluntary movements

and tremors and ancillary symptoms are limited. As L-DOPA therapy turned out to have a limited window of opportunity, the introduction of dopamine-mimetic drugs like Pergolide, Lisuride, Pramipexole and Talipexole, proved to be very effective to normalise motor symptoms in PD patients and to delay the need for L-DOPA as the final recourse to suppress PD symptoms.

Looking back on more than 50 years of Parkinson research, and appreciating the enormous progress that has been achieved, still, neurologists have little option but to treat symptoms only.

Neurotrophic factors

Victor Hamburger and Rita Levi-Montalcini found in their research on neurodevelopment that certain humoral factors could control the development of neural contacts. These factors were secreted by target organs such as muscle and stimulated connections between the nerve cells and their target organs. Levi-Montalcini and Stanley Cohen subsequently identified the prototypic neurotrophic factor Nerve Growth Factor (NGF), which quickly expanded with the identification of BDNF, CNTF, NT-3, NT-4, CDFN and MANF. We now know that the target-derived neurotrophism is a universal principle with the peripheral nervous system. It is logically assumed that this also applies to the formation of neural circuits in the brain to initiate and maintain neural circuits. This complex interplay between various cell systems and its dynamics during development and adulthood makes a

challenging landscape and is extremely relevant for neurodegeneration as well.

In that context, Lin et al. in the biotech company Synergen, discovered glial cell-line derived neurotrophic factor GDNF – a dimeric complex of glycosylated proteins – that was able to rescue dopaminergic neurons in vitro. This was quickly confirmed and extended towards animal experiments. Based on the accumulated preclinical data on GDNF, several clinical trials were subsequently conducted to demonstrate GDNF's importance in Parkinson's. Although some clinical benefits were seen in a few small phase I/II open-label studies with GDNF and its close congener Neurturin, the placebo-controlled large scale trials failed to reach their primary end-points. As GDNF protein does not pass the blood-brain barrier and as local brain injections do not warrant adequate distribution, the therapeutic use of GDNF appears complicated.

Genecode and small molecule GDNF-mimetics

While neurotrophic factors were being discovered, other research groups focused on their receptors. Mart Saarma and coworkers at the University of Helsinki (Finland) and a few other research groups independently identified the GDNF receptor. The GDNF receptor is made up of a signalling moiety RET and a ligand-binding moiety, called GFR α . Together they form a high-affinity receptor for GDNF. Shortly thereafter, three more GFRs were identified which show preference to either GDNF (GFR α 1) or three of its close congeners, Neurturin (GFR α 2), Artemin (GFR α 3) and Persephin (GFR α 4). These GFRs all need RET to exert their effects upon activation.

As GDNF protein is not practical as future PD therapy, Mart Saarma and Mati Karelson (University of Tartu, Estonia), together with Mehis Pilv and Tom Waldin founded Genecode to identify small molecules that mimic GDNF and trigger neurotrophic signalling in dopaminergic neurons. High throughput screens made by Maxim Beshpalov in Saarma's laboratory delivered several hits activating GDNF receptors. Subsequent optimisation of these hits by computational modelling methods by Mati Karelson and his team improved their biological activity. Yulia Sidorova and coworkers in Saarma's lab demonstrated that some compounds showed neuroprotection and promotion of neurite outgrowth, similar to the effects of GDNF. Surprisingly, in animal models selected GDNF-mimetics were found to restore dopaminergic neurons weeks after they were lesioned by neurotoxins. Thus, GDNF-mimetic small molecules can protect and regenerate dopaminergic innervation patterns in striatal brain areas which results in normalised motor behavior.

Future considerations

With protection and restoration of dopaminergic neurons by small molecule GDNF-mimetics, Genecode has established the GDNF receptor as a druggable target. With the advent of GDNF mimetics, the degeneration and death of remaining dopaminergic neurons can be stopped and surviving cells can be stimulated to reinnervate the striatum and restore adequate dopamine levels to regain movement control. The present compounds are in the process of further preclinical development but they need to be further improved and thoroughly evaluated for both efficacy and safety

before they can be tested clinically in man.

With its GDNF-mimetics, Genecode opened a novel chapter in PD research with the hope of actually curing Parkinson's disease. For patients and their treating neurologists, future therapy would consist of GDNF-mimetic drugs alone or in combination with dopamine-mimetic drugs. Genecode believes that with GDNF-mimetics PD patients may continue an active lifestyle without Parkinsonian symptoms, thereby effectively curing an otherwise progressive neurodegenerative disorder. Improved monitoring of prodromal symptoms would further contribute to neuroprotective therapy and would positively impact on the burden to society.

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Addressing speech disorders and swallowing problems

Open Access Government shares how the National Institute on Deafness and Other Communication Disorders is tackling speech disorders and impairments

The National Institute on Deafness and Other Communication Disorders (NIDCD), as part of the National Institutes of Health (NIH), reported that nearly 1 in 12 children ages 3 to 17 has a disorder that is related to voice, speech language or swallowing. As defined by the NIDCD, a communication disorder can include a child's voice that may be too weak, hoarse or strained; how a child speaks; problems making speech sounds; or problems with how a child learns and understand words or sentences.

Statistics from 2015 revealed that nearly 8% of children aged between 3 and 17 experienced a communication or swallowing disorder, within a 12 month period. Among those, 55% of children received treatment during the same 12 month period. It was reported that 5% had speech problems, 3.3% of children had language problems, and 1.4% reporting a problem with their voice.

Language is defined as the expression of human communication, by which knowledge, belief and behaviour can be experienced, explained and shared. Language disorders don't only affect children, approximately 17.9 million adults in the U.S have trouble using their voices, with between 6 and 8 million people having some form of language impairment. However, language disorders do affect children and adults differently, children can acquire an impairment from birth, whereas many adults gain disorders due to a stroke or head injury or even through some form of dementia.

Speech disorders

Speech disorders are something that is usually picked up in early childhood development stages. During early childhood years, children learn how to regulate the muscles used to produce understandable speech,

which is a gradual process. The NIDCD reports that by the first grade (6 years old), 5% of children have noticeable speech disorders.

One of the most well-known forms of speech disorder is stuttering, which affects around 3 million people in America. Stuttering can include repetitions of speech sounds, hesitations before and during speaking and the prolonged emphasis on speech sounds. The NIDCD outlines that, "the majority of speech disorders in the preschool years occur in children who are developing normally in all other areas. Speech disorders may also occur in children who have developmental disabilities."

Specific language impairment

Specific language impairment (SLI) is a language disorder that is one of the most common childhood disabilities, affecting 7 to 8% of children in kindergarten. However, despite it being one of the most common disabilities in children, SLI is still very much unknown. If not treated early SLI can affect a child's performance at school, as it affects reading and learning.

The NIDCD says: "Since the early signs of SLI are often present in children as young as 3 years old, the preschool years can be used to prepare them for kindergarten with special programmes designed to enrich language development."

The NIDCD sponsors a wide range of research and studies to help develop further knowledge on the development and treatment of speech and language disorders. The research also aims to help improve diagnostic capabilities and fine-tune more effective treatments.

"An ongoing area of study is the search for better ways to diagnose and differentiate among various types of

speech delay,” the NIDCD outlines. “A large study following approximately 4,000 children is gathering data as the children grow to establish reliable signs and symptoms for specific speech disorders, which can then be used to develop accurate diagnostic tests.”

Developing new treatments for SLI is crucial

A recent clinical trial at the University of Kansas, funded by the NIDCD, uses book reading to help kindergarten children with specific language impairment learn words. The trial was reported by the NIDCD to have helped determine the number of times a child with SLI needs to hear a word to learn it. Which is revealed as 36 times, compared with 12 times for children that develop at a typical rate.

The clinical trial could be crucial and the first step needed to develop an effective treatment for children with SLI. Holly Storkel, who directed the trial and is professor and chair of the University of Kansas’ highly ranked Department of Speech –Language- Hearing: Sciences and Disorders, said that treatment for children with SLI is a critical need.

“Children with SLI have difficulty learning new words, which puts them at risk for later reading problems and academic failure,” she said.

Using an escalation method for the trial, 27 kindergarten children with SLI were randomised to one of 4 intensities of interactive book reading: 12, 24, 36 and 48. Following 36 exposures, the trial reported that there were no further improvement in word learning.

Storkel explained that one of the promising aspects of developing a treatment based on book reading is that it could be administered by parents and teachers with minimal training.



“For now, parents of children with SLI should realise that their children need to practice a new word often to be able to learn and remember it,” she said. “When you notice that there is a word your child doesn’t know, try to find ways to work that word into everyday activities, conversations and book reading, and realise that this will need to be done over many weeks.”

The work of the NIDCD and research institutions such as the University of Kansas are crucial to help develop key treatment for speech and language disorders for SLI. Every day, NIDCD-funded researchers are working to better understand voice production and ways to improve the prevention, diagnosis and treatment of voice disorders. As something we use every day, it’s important to take care of our voices, as this year’s motto for World Voice Day said, “VO!CE, the original social media.” ■

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Overlooked by public health: Specific language impairment

Mabel L. Rice, University of Kansas highlights specific language impairment and why it often goes unrecognised as health disorder

The human language faculty has received centuries of interest by scholars of different disciplines, including philosophers, linguists, psychologists, educators, among others. It is widely admired as a remarkable gift by nature to humans, regarded as a unique characteristic of humans among the many species of living things. Children around the world acquire their native language without explicit teaching, even though languages come in many different forms – 6,000 different languages are estimated to be in use today. Just as walking is expected for young children everywhere, so is talking in sentences that can be understood by adults. The language-learning task in front of babies is now known to be incredibly complex, which makes this universal achievement even more impressive and at the same time, because it is universal, often thought to be simple because babies can do it.

Raising awareness for specific language impairment

The fact that it is so easy for most children obscures the fact that it is selectively difficult for some children. Children with Specific Language Impairment (SLI) are sometimes described as having the most common, but unrecognised, developmental disorder of childhood (and probably adulthood, too, given new outcome data). The point of this article is to bring SLI to the attention of policy makers, experts, and opinion



leaders in public health, medicine, and education, as a largely unrecognised yet high impact disorder of childhood that persists into adulthood, creates high costs to societies and life-long frustrations or shame to the affected persons. It is undoubtedly a crucial but often misunderstood barrier to personal self-actualisation in life.

According to the National Institute of Deafness and Other Communicative Diseases (NIDCD) in the U.S., Specific language impairment is defined as “a language disorder that delays the mastery of language skills in children who have no hearing loss or other development delays.” Population-based studies report 7-10% of 5-year-old children have SLI, making it the most common manifestation of

language impairments in children and the most common early childhood disorder, more common than Attention Deficit/Hyperactivity Disorder (ADHD) and autism combined. Children with SLI are at high risk for lower academic achievement relative to age peers, to encounter difficulties establishing social relationships and to end their education at high school completion^{1,2}. Language impairments are associated with increased health costs starting in early childhood and approaching the teen years³. Modelled outcomes from 5 to 34 years shows increased risk of unemployment for children with a history of SLI⁴. Girls with a history of SLI are almost 3 times more likely to experience sexual abuse as adolescents or young adults than girls without SLI⁵. Multiple stud-

ies report that only about 25% of children with SLI receive treatment when they enter school, around age 5 years.

Why SLI has a low profile in healthcare sectors

Although there is increasing reason to view SLI as an important public health issue, it has a very low profile in public health forums. An important exception is the recent inclusion of the goal to increase the proportion of children with language disorders who receive intervention services as part of the Healthy People 2020 initiative in the U.S., developed by the [Office of Disease Prevention and Health Promotion](#). In the press of life-threatening diseases around the world that threaten the well-being of children and their families, it could be argued that SLI would be a “mild” disorder that could be deferred for a later time when more resources are available. On the other hand, it is clear that in modern societies the ability to use language well is increasingly important for all sorts of life interactions. It is crucial for the effective use of electronic media, understanding the many documents of the modern world, mastering an academic curriculum, advocating for oneself whether in childhood disputes or threat situations, in applying for a first job, health literacy, and engaging in the interactions of commerce. As indicated by the few studies of long-term outcomes of children with SLI, economic risk is likely to be part of the scenario.

At the level of scientific inquiry, overlooking the presence of language impairments can complicate interpretation of outcomes of studies of children with autism, ADHD, or low nonverbal intelligence, who may or may not have language impairments^{6,7}. For example, in paediatric studies evaluating diseases such as HIV

and associated treatments, recent detailed studies of language impairments show that language impairment is the most common adverse outcome⁸ and those predictors are not the same for children who have language impairments selectively or in combination with hearing loss or low nonverbal intelligence⁹⁻¹¹.

The point here is that public policy expertise is vital for a better understanding of the social and economic consequences of SLI and possible treatment options. Conversely, a better understanding of SLI is vital for the necessary studies of public policy that bear on this important condition. This paper is the first in a series of papers to appear in subsequent issues of Open Access Government. Future instalments will address these questions: How is the language of children with SLI different from typical children? How does SLI compare to Hearing Loss, Speech Sound Disorder, Intellectual impairment or ADHD? What causes SLI? What are the social consequences of SLI? What should public policy experts consider for future investigations and ways to pursue effective treatments?

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Understanding developmental language disorder

Mandy Grist, Speech and Language Advisor at children's communication charity I CAN, sheds light on developmental language disorder – previously known as SLI

What do you know about developmental language disorder, also known as DLD? For many, the answer to this question would be – very little. Despite the fact that 2 children in every primary classroom will have DLD (7.6% of children), wider understanding of the condition is in fact limited. As researcher Courtenay Norbury reflected: “developmental language disorder is probably the most common childhood condition you have never heard of”.

Previously known as specific language impairment (SLI), children and young people with DLD have persistent difficulties in understanding and/ or production of spoken language. The cause in most cases is unknown and there is no obvious reason for these difficulties, for example there is no hearing problem or physical disability that explains them.

But why the name change? The term SLI has in recent times been felt to be somewhat ambiguous, and the belief was that confusion about the terminology has affected how children can access services, how it is identified and prioritised in schools and how research is funded. Consequently Professor Dorothy Bishop led a consortium of researchers, clinical and education practitioners, policy makers and representatives from parent organisations to achieve consensus on a diagnostic term that was more meaningful to the wider public. The panel agreed on developmental language disorder (DLD) in place of SLI.

What does DLD mean for a child or young person?

A child can be diagnosed with DLD if their language difficulties are likely to carry on into adulthood, if their difficulties impact significantly on their progress at school, or on everyday life and they are unlikely to catch up without help. DLD can look different in each



Mandy Grist, Speech and Language Advisor

child and can be complicated to understand because of this, and because the cause is unknown.

For a diagnosis of DLD a child will often have difficulties understanding language, but they may also have difficulties putting their thoughts into words and sentences. You may see the following characteristics:

- They may have difficulty saying what they want to, even though they have ideas;
- They may struggle to find the words they want to use;

- They may talk in sentences but be difficult to understand;
- They may sound muddled and it may be difficult to follow what they are saying. A child with DLD won't necessarily sound like a younger child; instead their speech might sound disorganised or unusual;
- They may find it difficult to understand words and long instructions;
- They may have difficulty remembering the words they want to say;
- They may find it hard to join in and follow what is going on in the playground.

Children with DLD often struggle at school. This is because so much learning depends on being able to understand and use language. Children with DLD won't just 'pick up' language; they will need to be taught language skills in a special way. They can do well, but they will need the right support in order to reach their full potential. This support will be from a speech and language therapist, along with other specialists like a language advisory teacher.

Children with DLD may struggle because they easily lose concentration as all their efforts are spent making sense of the language in instructions; it can be difficult to listen and work things out at the same time. These children can have difficulty learning new words and ideas, and may struggle to keep up – by the time they have thought how to say an answer, the teacher has moved on to something else.

Supporting children with developmental language disorder

Common principles of support for children and young people with DLD include repeated exposure to new words and ideas. In a typical lesson, new ideas and words are introduced once or twice, however children with DLD need to hear and use them much more than this. They require spoken instructions to be broken down into simpler, shorter sentences and/ or for the spoken information to be presented in a visual way, for example using pictures or gestures. Whilst this extra processing time may help, it is important to remember that children

with DLD won't automatically interpret and understand new meanings. There are 'rules' in every language for how sounds are put together, how we learn what new words mean, grammatical rules for sentences, social rules for conversations. Unlike their peers, children with DLD will need these rules explicitly taught.

Good speech, language and communication skills are vital for learning and a clear predictor of children's academic success and social and emotional well-being. But, despite their difficulties with language, children with DLD can achieve well at school, both academically and socially. They just learn differently. Knowing their best learning style is therefore crucial to understanding how best to support them.

“A child can be diagnosed with DLD if their language difficulties are likely to carry on into adulthood, if their difficulties impact significantly on their progress at school, or on everyday life and they are unlikely to catch up without help”

I CAN, the children's communication charity, in partnership with the Royal College of Speech and Language Therapists (RCSLT) are leading on [Bercow: Ten Years On](#) – a review of provision for children with speech, language and communication needs (SLCN), including those children and young people with DLD. The report will provide information about the current landscape for children and young people with SLCN and make recommendations for future actions to ensure their needs are a high priority for government. [Get in touch](#) with us to share your views and experiences.

If you are a parent or practitioner with concerns about a child's speech, language and communication please call 0207 843 2544 to speak to one of I CAN's speech and language therapists for information and advice. ■

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Helping Indigenous communities become healthier

Carrie Bourassa, Scientific Director, CIHR-IAPH discusses the issue of poor health among Indigenous communities and says research is the key to tackling it

The Canadian Institutes of Health Research-Institute of Aboriginal Peoples' Health (CIHR-IAPH) is one of the 13 founding institutes of CIHR, established in 2000. My recent appointment as the latest Scientific Director of the CIHR-IAPH allows me the chance to consider our mandate and our opportunities to bolster the self-determination of Indigenous communities to become healthier Nations, groups and individuals. As researchers, we are committed to working with the priorities Indigenous communities see for themselves in order to advance their progress in becoming healthier communities.



The IAPH fosters the advancement of a national health research agenda to promote and improve the health of First Nations, Inuit and Métis Peoples in Canada through research, knowledge translation and capacity building. The Institute's pursuit of research excellence is enhanced by our respect for community research priorities and Indigenous knowledge, values and cultures. Our goal is to contribute to the improvement of the health and wellbeing of Indigenous people in every part of Canada. We will stimulate health research with and for Indigenous communities, build a community of Indigenous researchers who can engage in "two-eyed seeing" research (conducted using Indigenous research paradigms side by side with other paradigms such as those involving Western epistemologies), form research partnerships with organisations in Canada and abroad, involve Indigenous communities respectfully in every project undertaken, and create new knowledge.

Addressing the issue of poor health

Canada's recent Truth and Reconciliation Commission (TRC) presented all Canadians with 94 Calls to Action. Some of these are calls to the government to address the issue of the poor health of Indigenous Peoples in Canada. The TRC calls upon governments to acknowl-

edge that the current state of Indigenous health is a direct result of previous Canadian government policies, including Aboriginal residential schools, and to recognise and implement the healthcare rights of Indigenous people as identified in international law, constitutional law, and under the Treaties. Other calls to action include having the federal government identify measurable goals to determine the gaps and to report on progress toward closing those gaps in health outcomes between Indigenous and non-Indigenous Peoples, increasing the number of Indigenous healthcare professionals, and compelling those who can effect change within the Canadian healthcare system to recognise the value of Indigenous healing practices and to make them available when treating Indigenous clients.

Good research can inform good policy and practice and thereby help to achieve good results for people in need. Good research into Indigenous health requires us to see the Indigenous communities we want to work with as partners in Indigenous health research from the early stage of setting research priorities right through to reporting on our research in a way that is accessible, meaningful and, therefore, useful to Indigenous communities. We must be guided by the



Dr. Janet McElhaney, Dr. Jennifer Walker and Dr. Carrie Bourassa

Indigenous communities that are our research partners. These communities are not subjects of research; they are active participants in the entire research enterprise. Indigenous communities have protocols for sharing knowledge, and researchers must learn and respect these protocols when undertaking research.

Building research capacity

An important part of the CIHR-IAPH mission is to build research capacity in the First Nations, Inuit and Métis communities. We will do this by mentoring, supporting, and encouraging a new generation of Indigenous people to become health researchers and to create new knowledge that will improve the health and wellbeing of Indigenous communities. We will also help to negotiate partnerships and alliances between Indigenous communities and non-Indigenous health research organisations and institutes at the local, regional, national and international levels.

It is central to our mission and our values that, in creating new knowledge to benefit Indigenous peoples, the CIHR-IAPH supports health research that respects Indigenous cultures. Part of our task is to make sure that this is how all CIHR-funded health research is conducted and to act

as a resource for all of the other CIHR institutes, to ensure that all researchers understand the Indigenous perspectives on the issues they are researching and include the Indigenous perspectives in their work.

The challenges to helping to create healthier Indigenous Peoples and communities are large, but the benefits of doing good research in a way that respects and contributes to Indigenous communities and actively involves Indigenous communities in the research project make the effort worthwhile. I look forward to seeing what we can accomplish with Indigenous communities in my years as Scientific Director. ■

Carrie Bourassa, PhD Scientific Director

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Ensuring health equity for Canadian indigenous populations

Professor Pierre S. Haddad shares the challenges of overcoming health inequality for Canadian indigenous populations and highlights solutions to the issue

Canada's Indigenous population is composed of First Nation (FN), Inuit and Métis peoples. They often suffer from a greater burden of disease, notably chronic (e.g. diabetes^{1,2}) and infectious ones (e.g. tuberculosis³), than the rest of the non-Indigenous Canadian population.

Part of the health problems faced by Canadian Indigenous populations stems from the cultural disconnect that exists between the health care and services offered by public sanitary organizations, on the one hand, and the worldview of several Indigenous peoples, on the other⁴. Thus, North American Indigenous populations are deeply connected to the Earth and nature. Their health is therefore intuitively more holistic and interconnected with their communities and their environment. Consequently, health care and the response to disease also call to a more holistic approach.

Aside from being morally and socially reprehensible, the health inequities afflicting Indigenous Canadians put a significant burden on the Canadian health care system. Apart from high health care costs related to the severity of afflictions, considerable travel and living costs are required by individuals residing in more remote areas, who must be transferred to major centers in order to receive appropriate care.

As will be argued in the next sections, Indigenous traditional medicine rep-

resents a valuable avenue to explore in order to reduce the burden of health inequities, the cultural disconnect of modern therapeutics, and the high economic cost of Indigenous health care.

Indigenous traditional knowledge and traditional medicine: Valuable opportunities for improved indigenous health

Indigenous traditional knowledge (TK) in general, and traditional medicine (TM) in particular, has shown remarkable resiliency in most Canadian Indigenous communities⁵, even though its transfer to younger generations is currently critically threatened. Indigenous TM is a science that is rooted in so-called "Natural Laws" and involves a close contact with nature, as well as a deep understanding of its elements and their uses for human health and wellbeing. It is also a common misconception to consider Indigenous TK and TM as static or retrograde. TM is a true science and as such evolves continuously. Elders are notably well aware of the precariousness of TK and TM, while they also fully understand the urgent need to help their fellow community members dealing with chronic or infectious diseases.

It is therefore both timely and pertinent to consider Indigenous TM as a feasible and, strangely enough, innovative means to reduce health inequities throughout Canadian Indigenous populations. Firstly, Indigenous TM has

proven to be safe and efficient, both in historical and contemporary terms⁶. Secondly, Indigenous TM is very culturally connected. It is thus plausible that Indigenous people will comply better with treatments originating from their own culture than they do with "modern" medicine. It must also be stressed that Indigenous TM is a holistic paradigm whereby not only the physical part of the diseased individual is encouraged to participate in the healing process (for instance, by taking a traditional medicinal plant preparation), but also the mental, emotional and spiritual parts.

"Aside from being morally and socially reprehensible, the health inequities afflicting Indigenous Canadians put a significant burden on the Canadian health care system. Apart from high health care costs related to the severity of afflictions, considerable travel and living costs are required by individuals residing in more remote areas, who must be transferred to major centers in order to receive appropriate care."

Including Indigenous TM in health care also carries great potential to reduce the economic burden of health inequities. Indeed, through the use of local human and natural resources, the cost of therapeutic regimens can be reduced. This holds true even if Indigenous people continue using both contemporary pharmaceutical treatments and TM. Indeed, it is conceivable that

combining TM with modern drugs may reduce the dose and length of treatment required with pharmaceuticals. If Indigenous TM can mitigate, even partially, the impact of several chronic or infectious diseases, a greater fraction of the population will remain healthy or will develop less severe forms of chronic diseases and their complications. This in turn should diminish the number of Indigenous patients that need to be sent to large urban centers to be treated.

Lastly, Indigenous elders or knowledge holders will get recognition and could potentially derive a non-negligible income from their practice. Of course, this raises the question of the “professional” framework within which Indigenous TM will need to be practiced, but this issue is beyond the scope of the present discussion. Given that Indigenous TM should be delivered in a safe, efficient and ethical way, additional wealth could be generated from its practice and related activities (for instance, collecting medicinal plants and preparing traditional remedies). The consequence should also involve a reduction of poverty, one of the major social determinants of Indigenous health.

Challenges and solutions

Turning to Indigenous TM to reduce health inequities comprises a fair share of challenges. Major ones are: 1) Historical devaluation of Indigenous TM, with ensuing skepticism from the medical establishment; 2) Mistrust by several Indigenous peoples of the established order, with associated concrete fear of misappropriation of TK and TM and biopiracy; 3) Potentially

harmful herb-drug interactions; and 4) The development of appropriate models to include Indigenous TM into current healthcare systems.

Many call for the integration of Indigenous TM in Indigenous health care. However, the word “integration” raises some profound questions in many FN, Inuit and Métis minds. Indeed, integration may lead to a form of assimilation or subordination that many Indigenous people fear. Given the power imbalance between the established government-run medical system and the parallel practice of Indigenous TM, such fears are legitimate.

Although these challenges can appear quite daunting, a number of fruitful endeavors have nevertheless seen the light in Canada and abroad, whereby Indigenous TM is being used safely and efficiently alongside modern health care. The key issues related to successful outcomes in such projects include the following: 1) Indigenous and non-Indigenous stakeholders must be engaged in truly equitable and empowering partnerships; 2) The agenda must be set by and for Indigenous communities; 3) Partnerships need to be based on mutual trust, mutual respect and mutual appreciation; and 4) Cultural brokers need to be involved to ensure proper knowledge transfer and exchange.

In short, Indigenous TK and TM are viable tools to consider for the reduction of health inequities afflicting Indigenous populations, notably in terms of chronic and infectious diseases. Because of the cultural and paradigm gaps that exist between

current health care approaches and Indigenous TM, it is highly recommended that partnerships be developed among stakeholders and that these include culturally competent partners.

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Alcoholic liver disease: Why research is vital

Integrated research can help understand the physiological pathways of alcoholic liver disease, says Dr Shilpa Chokshi, of the Foundation for Liver Research

Alcohol is one of the most frequently abused substances in the world and when consumed at harmful levels, which the UK Chief Medical Officer defines as more than 14 units a week, it is responsible for more than 3.3 million deaths annually, an estimated 5.9% of all deaths globally. In fact, the World Health Organisation (WHO) identifies alcohol as the 3rd largest risk factor for ill-health in developed countries, behind tobacco and high blood pressure and alcohol is a causal factor in more than 200 disease and injury conditions. The most recognised clinical manifestation of heavy and dependant drinking is the development of alcohol-related liver disease (ALD), a complex disorder which covers a wide spectrum of conditions including accumulation of fat in the liver, development of liver scarring (cirrhosis) and liver cancer. The most florid presentation of ALD is alcoholic hepatitis which is a progressive inflammatory condition with very high rates of mortality. Addressing the underlying psychological addiction to alcohol and abstinence remain the mainstay of treatment for alcoholic liver disease and there are limited therapeutic options for the underlying physical disease.

There are several reasons for this lack of options. Firstly, historically there has been very limited investment in research with a consequent dearth of basic scientific studies as well as clinical trials, despite the significant global burden. This was very sharply reflected by the dEath TO trial score (ETOh) discussed by Vijay H Shah 'Alcoholic Liver Disease: The Buzz May Be Gone, but the Hangover Remains', published in the Journal Hepatology in 2010. This ratio represents the estimated population mortality rate to the number of clinical trials focused on a particular disease, with a high score reflecting the low number of clinical trials. The ETOh score for ALD was found to be 358, compared to 1.4 for hepatitis B virus infection, 4.9 for hepatitis C virus infection and 15.2 for primary biliary cirrhosis. Why alcoholic liver disease has



received such limited research attention is a matter of debate but some people have suggested that this may be due to the stigma associated with alcohol abuse. Diabetes and obesity, both of which are also closely related to lifestyle choices and behaviours, do not seem to have suffered the same fate. However, this situation does seem to be changing and the last few years have seen an expansion in the number of senior clinical and scientific investigators interested in ALD and also in the number of grant-giving bodies and charities, including the Foundation for Liver Research which supports my own research group, which are willing to fund research in this area.



Research difficulties

The lack of good experimental models mimicking the development of alcohol induced disease has also significantly hampered progress. In vitro cell culture models and in vivo animal models do not recapitulate the complex cellular interactions that occur in humans. The complexity of the liver injury in terms of early damage and the processes leading to fibrosis and cirrhosis in humans cannot be replicated in isolated primary cells, cell lines and small animal models. The lack of this understanding has hindered the development of biomarkers both prognostic and diagnostic. Moreover, the pre-clinical testing of therapeutic targets in these models has led to the development of molecules that do not always show efficacy when tested in humans. This is now an area of intense research activity. My own group has utilised a human precision-cut liver slice model of ALD and we have found that that it is physiologically relevant and more accurately simulates the in vivo intracellular mechanisms of the hepatotoxic response to alcohol. Moreover, when these slices are cultured in combination with immune cells from the same patients, we are able to re-create the immunological interactions between the immune system and the normal/diseased liver. This is an important area to be studied as many patients who develop

significant scarring/cirrhosis in the liver as a consequence of excess alcohol consumption, actually die of bacterial infections which overwhelm their impaired immune systems. Again this is an area of much current research activity and it is especially relevant in an era of multi-drug resistant bacteria. Several studies are beginning to delineate the reasons for this immunodeficiency including our work showing that this dysfunction is reversible.

Finally, integral studies aimed at distinguishing patients seemingly protected from disease from those that go on to develop disease, are fundamental. Only 1 in 5 people drinking at harmful levels will actually develop disease. This does not seem to be an inherited trait and understanding the precise mechanisms that confer protection will, in my opinion, be key in unlocking the development of effective and targeted therapeutics. ■

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Identifying novel biomarkers for drug-induced kidney injury

The European Federation of Pharmaceutical Industries and Associations (EFPIA) explain how SAFE-T DIKI is advancing research into drug-induced kidney injury

Drug-induced kidney injury (DIKI) is not an uncommon adverse event in drug development. Kidney injury leads to a permanent impairment of the kidney function (chronic kidney disease) as the kidney is an organ with low regeneration capability. In clinical practice, acute kidney injury is defined using the Kidney Disease Improving Global Outcomes (KDIGO) criteria, which are based on serum creatinine and urine output changes.

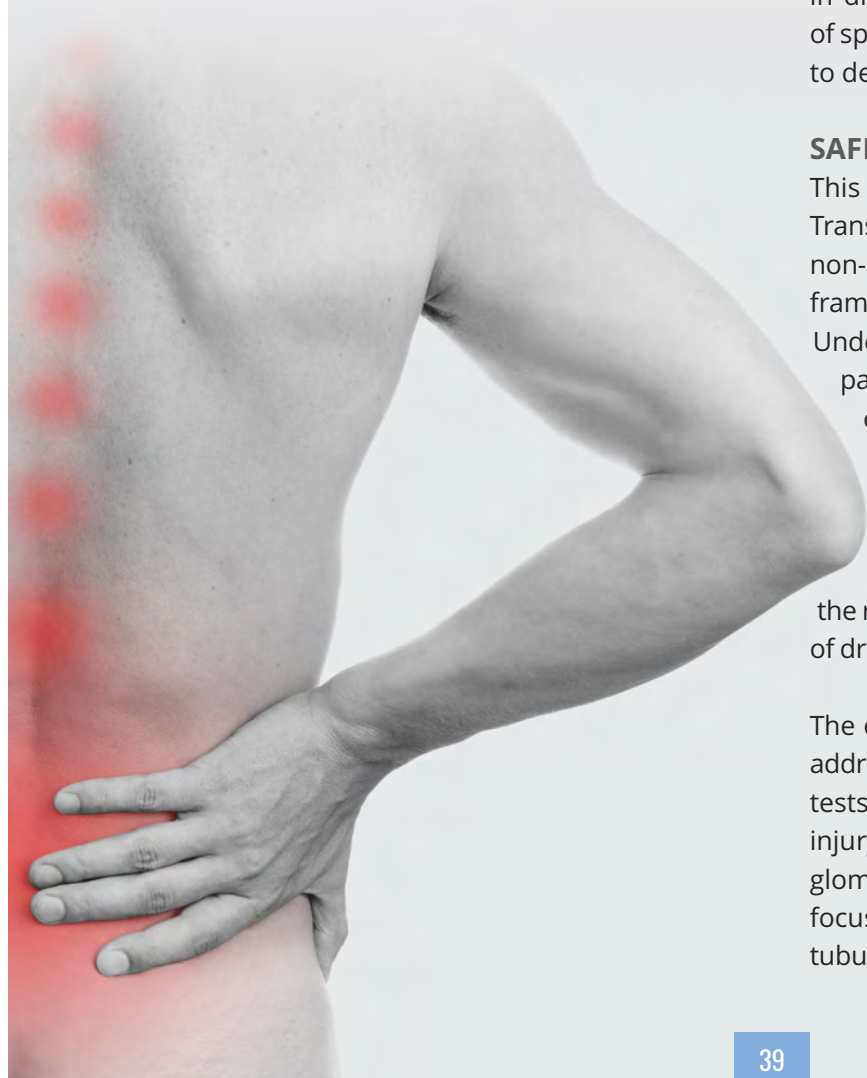
One of the greatest problems is the late identification of acute kidney injury due to the current standards – i.e. serum creatinine (sCr) and blood urea nitrogen (BUN). Both of these are in fact delayed indicators of injury and may not be changed significantly until two-thirds of kidney function has already been lost.

Species differences in drug toxicity in preclinical safety tests, the lack of sensitive translational biomarkers and non-representative patient populations in clinical trials are among the probable reasons for the failures in predicting human drug toxicity. However, changes in drug discovery practices and the implementation of specific and sensitive safety biomarkers are expected to decrease these drug development failures.

SAFE-T

This is where the Safer and Faster Evidence-based Translation (SAFE-T) Consortium comes in. SAFE-T is a non-profit, public-private partnership set up within the framework of the Innovative Medicines Initiative-Joint Undertaking (IMI-JU) - the world's largest public/private partnership in the life sciences sector. The objective of the IMI-JU is to support projects for the development of tools and methodologies to address key “bottlenecks” in the pharmaceutical research and development process. Within this framework, the overall objective of the IMI SAFE-T consortium is the regulatory qualification of clinical safety biomarkers of drug-induced injury to 3 organs, including the kidney.

The objectives of the SAFE-T DIKI work package are to address the current gaps in sensitive and specific clinical tests to diagnose, predict and monitor drug-induced injury to the kidney. After an initial assessment of glomerular damage biomarkers, the work package focused on clinical biomarkers of drug-induced renal tubular injury.





The primary objective has been to identify biomarkers with improved sensitivity and specificity relative to conventional measures. A secondary aim was to determine which biomarkers allow an earlier detection of a renal tubular injury event. Other objectives include identifying prognostic markers and markers of repair, but these require large scale studies and may be addressed in future consortia.

Within the framework of the SAFE-T DIKI work package, the following 3 studies were conducted: a study in cancer patients receiving cisplatin chemotherapy, a study to collect samples in healthy volunteers, and a study in patients being administered contrast medium for a radiological procedure.

The Cisplatin study enrolled cancer patients with normal renal function who were scheduled to receive a 1st cycle of high dose ($>65\text{mg/m}^2/\text{cycle}$) cisplatin chemotherapy. A total of 114 patients had blood and urine samples collected at the following time-points: pre-dose (baseline) and within 12 hours and 1, 2, 4, 7, 14 and 21 days after cisplatin administration. A control group of 21 patients with similar cancers receiving non-nephrotoxic treatment for the malignancy were also enrolled. The control patients had blood and urine samples collected at 2 separate visits.

Healthy subjects were recruited in 2 different studies. In one study, healthy male and female subjects attended for 3 separate visits 1 week apart to have blood and urine samples collected (N=25 subjects). In a second sample collection study, healthy male and female subjects had samples collected during 3 study visits (N=39 subjects) over a 2-4 week period.

The data for the study in patients receiving contrast media were not included in the main analysis because patients with impaired baseline renal function were enrolled and therefore this study does not represent the intended use of the novel biomarkers in subjects with normal baseline renal function.

The performance of novel urinary biomarkers was compared to that of standard measures such as serum creatinine, serum cystatin C and BUN. The novel biomarkers under review were: Urinary Alpha-Glutathione S-Transferase (α -GST), Clusterin (CLU), Cystatin-C (CysC), Kidney Injury Molecule-1 (KIM-1), Neutrophil Gelatinase-Associated Lipocalin (NGAL), Osteopontin (OPN), Urinary Total Protein.

Based on maximum percent change from baseline, serum creatinine showed relatively good performance. In this same analysis, serum cystatin C and BUN also showed good performance. Nevertheless, urinary osteopontin, albumin, KIM-1 and total protein all outperformed serum creatinine. Moreover, while urinary α -GST was comparable to serum creatinine, urinary cystatin C, clusterin and NGAL showed relatively poor performance.

Considering these results, the conclusion was that urinary osteopontin, albumin, KIM-1, total protein and possibly α -GST might all be used as individual markers in monitoring for acute nephrotoxicity. ■

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Is precision medicine for membranous nephropathy a dream?

Professor Pierre Ronco and Dr Hanna Debiec discuss the viability of precision medicine in treating patients with the rare disease membranous nephropathy

Membranous nephropathy (MN) is a rare disease that affects the kidney filter (glomerulus) and induces a massive loss of proteins in the urine. Considerable progress has occurred in the diagnosis and management of patients since the identification of the major antigens, recognised in the glomerulus by toxic antibodies circulating in the blood. Because the antigens are normally present in the glomerulus, one can conclude that MN is auto-immune in nature, and thanks to the recent advances in the disease pathogenesis, it can serve as a model for most organ-specific auto-immune diseases. The most prevalent antigen identified in 2009, the receptor of the phospholipase A2 (PLA2R1), is localised on the podocyte, a major cell of the glomerular filter where it serves as target for circulating antibodies.

Diagnosis of membranous nephropathy: Now possible with a simple serological test

Until recently, the diagnosis of MN required a kidney biopsy, an invasive diagnostic procedure with the risk of bleeding observed in less than 5% of patients. The development of assays of circulating anti-PLA2R1 antibodies and their transfer to clinical practice has been amazingly fast. The first immunofluorescence (IF) test used biochips coated with cells expressing the antigen, incubated with the patients' sera. The ELISA using the extracellular domain of human PLA2R1

coated to plastic wells enables a more quantitative and faster determination of anti-PLA2R antibodies, but it is a little bit less sensitive than IF. Detection of PLA2R1 antigen in immune deposits in biopsy specimens is also possible with the use of commercial antibody after a retrieval step to unmask PLA2R1 epitopes (domains of the antigen PLA2R that are recognised by the antibodies). These tests have ushered in a new era of precision medicine. Seventy to 80% of patients with MN have mounted an immune response against PLA2R1, which serves as a diagnostic signature since PLA2R1 antibodies are specific for this disease.

Monitoring patients with membranous nephropathy: Beyond proteinuria

For a long time, proteinuria was the only variable to follow disease activity. Now that specific antibodies have been identified, it has been shown that levels of these antibodies also predict outcome. High titers are correlated with a lower chance of spontaneous or treatment-induced remission, and a higher risk of the emergence of a nephrotic syndrome in non-nephrotic patients, and of renal function deterioration.

Furthermore, anti-PLA2R1 antibodies appear to be sensitive markers of treatment efficacy. Partial or complete depletion of anti-PLA2R antibodies precedes clinical remission, which is disappearance of proteinuria, by sev-

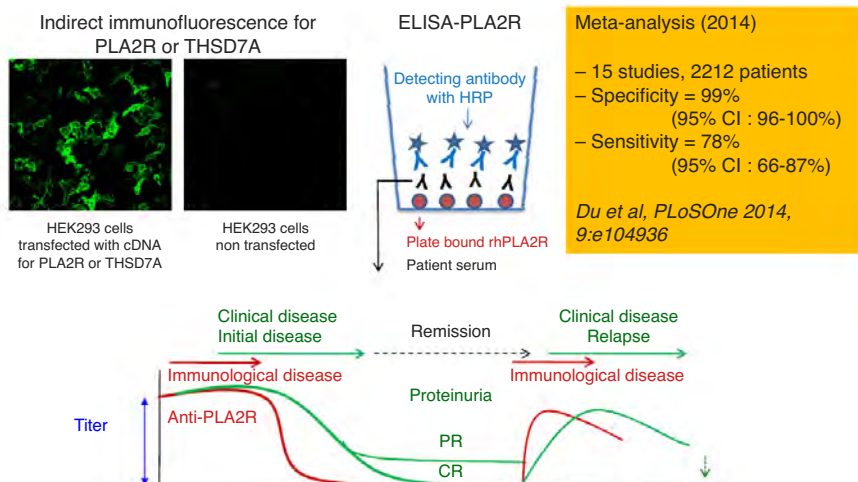
eral weeks or months, while re-emergence or an increase of these antibodies precedes by several weeks a renal relapse. The time lag of several months from immunological remission (depletion of antibodies) to renal remission is most likely accounted for by resorption of immune deposits and repair of the glomerulus. Even more, anti-PLA2R1 antibody titers at the end of therapy are predictive of later outcomes.

"Because the rate of remission (including partial remissions) does not exceed 70% with current immunosuppressive treatments, we hope that in future trials, close monitoring of anti-PLA2R1 antibody titer and epitope specificity as well as regulatory T-cells will allow a more personalised adaptation of treatment leading to increased rate of complete remission."

Toward a serology-based approach to treatment

Treatment of MN is controversial because of a high rate of spontaneous remission (up to 40%) and toxicity of immunosuppressive drugs that are used to treat patients with persisting nephrotic syndrome. Patients should not be overexposed to toxic medication if they don't need it. This is the reason why treatment is often delayed by 6 months to give the patients a chance to undergo spontaneous remission. We think that the international guidelines should be revised to include anti-PLA2R1 antibody in the

Serological tests for the diagnosis and monitoring of patients with membranous nephropathy



This picture shows the results of immunofluorescence test for the detection of anti-PLA2R1 antibodies (upper left) and those of a meta-analysis of >2,000 patients showing that anti-PLA2R1 antibodies are highly specific for MN and their sensitivity is close to 80% (upper right).

The scheme at the bottom shows that anti-PLA2R1 (in red) disappear before proteinuria (in green) and reappear before clinical relapse.

decision algorithm for patients with idiopathic MN. Measurement of anti-PLA2R1 antibodies may indeed obviate the need for a “wait and see” period of 6 months, and allow for more rapid treatment decisions. We recommend that antibodies are assessed every month in patients with a high level, and every two months in patients with low levels before starting immunosuppressive therapy to avoid unnecessary treatment in patients entering immunological remission (substantial decrease or disappearance of antibodies). This recommendation does not apply to patients with rapidly declining renal function, in whom a prompt initiation of immunosuppression is warranted.

If immunosuppression has been started, we recommend that antibodies be assessed every month during the first 6 months. Although the rate of antibody reduction varies among

studies, the general picture is that antibodies dramatically decrease during the first 3 months, and disappear over 6 to 9 months followed by remission of proteinuria over 12 to 24 months. Patients with a prompt and robust immunologic response may receive shorter than usual courses of immunosuppressive agents, whereas a conversion to an alternative therapy or a reinfusion of rituximab (for patients started on this drug which targets the B-lymphocytes involved in antibody production) should be considered in those who do not show a significant reduction in antibody titer at 6 months.

Toward more precision medicine: Lessons from molecular and cellular studies

There is more to come. Very recent studies by our group and a collaborating group in Nice suggest that diffusion of the immune response to several

domains of the PLA2R1 antigen (a phenomenon called epitope spreading) was associated with a lower rate of remission after 6 months in patients treated with rituximab. We also showed that a population of T-lymphocytes, the regulatory T-cells, involved in the control of auto-immunity, was decreased in patients with severe MN and that those who responded to rituximab had a lower percentage of regulatory T-lymphocytes at onset of treatment and an increased percentage of those cells as early as 8 days after starting treatment.

Because the rate of remission (including partial remissions) does not exceed 70% with current immunosuppressive treatments, we hope that in future trials, close monitoring of anti-PLA2R1 antibody titer and epitope specificity as well as regulatory T-cells will allow a more personalised adaptation of treatment leading to increased rate of complete remission.

Inserm

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Tackling chronic diseases through innovative health

John Bowis, Honorary President of Health First Europe highlights how innovations in health are helping with tackling chronic diseases

If we want to keep people healthy for as long as possible we need to focus on 3 Ps: Prevention, promotion and protection. Promoting good health – through healthy eating, exercise, healthy living and working conditions; Protecting citizens – by ensuring safety at work, on roads, or elsewhere; and Preventing disease – tackling all the risk factors” – Vytenis Andriukaitis, European Commissioner for Health and Food Safety¹.

The burden of chronic disease in Europe

In Europe, chronic diseases lead to the premature death of more than 550,000 people aged 25 to 64 each year, resulting in the loss of some 3.4 million potential productive life years². Approximately €700 billion is spent every year across the EU on the treatment of these diseases. Better public health and prevention policies, as well as more effective health care models need to be developed to face the challenges of an ageing population and the rise of non-communicable diseases to save hundreds of thousands of lives and billions of euros.

Tackling chronic diseases: HFE role to bring innovation

As Honorary President of Health First Europe (HFE), I have worked to bring innovation in healthcare which can prevent and diagnose chronic conditions, as well as improve quality of life of patients affected by chronic diseases. In particular, I emphasise the importance of mobile health initiatives, as valuable ways of delivering healthcare, enhancing prevention, monitoring and managing health and lifestyle across Europe.

Mobile health has the potential to maximise patients' autonomy, aid patient choice, improve diagnostics and prevention of chronic conditions, and better connect people to healthcare providers. It offers rapid access to medical records, a regular monitoring of health status and therefore it improves quality of life and



healthcare, empowering patients and their carers. In this frame, the European Commission's eHealth Action Plan 2012-2020³ provides an important roadmap to empower patients and healthcare workers, link up devices and technologies, and invest in research towards the personalised medicine of the future.

Early diagnosis and screening are other vital instruments to help prevent both the emergence and acute phase of chronic diseases. Timely diagnosis appears fundamental. Firstly, primary prevention through screening programmes can help people diagnose the disease while it is asymptomatic, with no signs or symptoms, thus improving possibilities to identify the onset of a disease. Secondly, the earlier detection of disease may impact the progression of major chronic diseases, leading to more cures or longer survival and offering time saving measures.

Encouraging the transition towards a new model of integrated care

It is the area of chronic diseases where the greatest benefit lies in developing a new model to address healthcare needs and tackle the spread of cardiovascular diseases, respiratory problems, diabetes and serious mental health issues.

HFE commitment in developing patient-centric solutions for sustainable health systems and for enhancing innovation in Europe has particularly evolved through the development of the HFE model for community care in 2014. Community care is about incorporating patient care across the continuum of life, redefining the relationship between different providers of treatment by introducing a new channel of 'healthcare' based on a more patient centric and patient empowered model⁴.

In line with this, the Expert group on Health Systems Performance Assessment (HSPA) has provided a relevant report⁵, released in March 2017 (HSPA) to assess integrated care⁶, perceived to be a fundamental component of health system reforms and innovation in Europe.

"In Europe, chronic diseases lead to the premature death of more than 550,000 people aged 25 to 64 each year, resulting in the loss of some 3.4 million potential productive life years²."

I truly support and encourage the effective design and implementation of integrated care frameworks to achieve person centred, efficient and safe care, as well as to address crucial challenges, such as population ageing, the rising burden of chronic diseases and constraints in public resources.

Coordinating efforts to achieve person centred, efficient and safe care

With integrated care being one of the key approaches to providing the healthcare that EU citizens' demand and innovative treatments and infrastructures, Europe will gradually face the challenge of chronic diseases. A holistic approach is essential. EU policymakers need to be aligned and pursue shared goals, establishing strong governance mechanisms at all levels and showing more political support on overall patient well-being, bringing integrated care and hospitals closer as partners in the provision of care. Moreover, stakeholders should create effective communication strategies and make organisational changes in terms of healthcare structures, organisation of workflows, workforce development and resource allocation to provide more responsive care delivery.

I hereby call for a strong coordination amongst EU countries to raise awareness on chronic disease challenges, applying knowledge and experiences to implement effective prevention and control policies. To consider assessing EU health systems to further foster the transition towards a model of integrated care, identifying principles and factors that will lead to the development of a new ecosystem where all patients will be members of the "care team", more involved in the decision-making processes, and where care plans will be tailored to their individual needs. ■

1 Speech of Vytenis Andriukaitis, European Commissioner for Health and Food Safety, 21 April 2016 – PREVENTING AND ADDRESSING CHRONIC DISEASES: A COMMISSION PRIORITY – MEETING ON CHRONIC DISEASES "TOWARDS THE BETTER PREVENTION AND MANAGEMENT OF CHRONIC DISEASES", available at https://ec.europa.eu/commission/commissioners/2014-2019/andriukaitis/announcements/preventing-and-addressing-chronic-diseases-commission-priority-meeting-chronic-diseases-towards_it

2 <http://www.oecd-ilibrary.org/docserver/download/8116231e.pdf?expires=1492007125&id=id&accname=guest&checksum=C48289011E9331E29026CEF65EA3D9C7>

3 eHealth Action Plan 2012-2020: Innovative healthcare for the 21st century, available here <https://ec.europa.eu/digital-single-market/en/news/ehealth-action-plan-2012-2020-innovative-healthcare-21st-century>

4 HFE Model for Community Care "Delivering positive health outcomes for citizens", available here http://healthfirsteurope.org/uploads/Modules/Newsroom/131124_hfe_model_cc_a4_v06_lr.pdf

5 Report "Tools and methodologies to assess integrated care in Europe, released in March 2017 by the Expert group on Health Systems Performance Assessment"; http://ec.europa.eu/health/sites/health/files/systems_performance_assessment/docs/2017_blocks_en_0.pdf

6 Integrated care includes all initiatives seeking to improve outcomes of care by overcoming issues of fragmentation through linkage or coordination of services of providers along the continuum of care.

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Shining a light on brain functionality after stroke

Professor Saverio Pavone, of the European Laboratory for Non Linear Spectroscopy and Department of Physics highlights the latest advances in stroke research

Stroke is a major cause of illness and mortality, and a major socio-economic burden. The mechanism underlying the insurgence and temporal evolution of stroke needs to be further elucidated. In vivo imaging provides clinically relevant data on the spatiotemporal patterns of tissue injury and repair processes, help improve interventional therapies, and lead to the discovery of novel markers of recovery, as well as selective targeted therapies. Recent improvement in clinical imaging technologies has made it possible to resolve small, previously invisible lesions in the brains of elderly humans, associated with age-related mental decline and dementia. These microscopic and focalised lesions caused by disruptions of small blood vessels are known to affect distributed patterns of synchronised neural activity throughout the brain. Accordingly, recent human neuroimaging studies indicate that spontaneous fluctuations in neural activity, as measured by magnetic resonance imaging of functional connectivity, are significantly affected following a stroke. Disrupted functional connectivity is associated with behavioural deficits and has been linked to long-term recovery potential.

Repair and recovery

Among the highest priorities in translational neuroscience, facilitation of repair and recovery have the ultimate goal of improving functional outcome after injury. Neuronal plasticity has

been long deputed as the basic mechanism for restoring functions suddenly lost after stroke. The phenomenon of neuronal circuit rewiring encompasses multiple scales, from neuronal contacts, i.e. synapses, to large areas of the brain. Indeed, we are now aware that individual cells and cell types in the brain act and react to a stroke as part of an ensemble. Cell to cell interaction takes place at multiple levels (electrical, chemical, mechanical) and might causally trigger a specific reaction to injury. How this complex cellular and molecular response to injury happens is not well understood yet. Comprehending the mechanism of repair will build a track to guide appropriate interventions. Towards this goal, structural and functional changes have to be visualised both at the macro-area and at cellular level.

Imaging the brain

A valuable tool for understanding the link between molecular mechanisms of stroke repair and human findings at the system level can be achieved by extending functional connectivity methods to mouse models of stroke. Consequently, there is an obvious need for appropriate animal models and imaging techniques for visualising how neurons rewire at multiple scales.

Historically, optical imaging has been a major tool for investigating the physiological processes from cellular compartments to entire organs, owing to its unique properties, such as high

temporal and spatial resolution and numerous contrasting mechanisms. Traditional optical microscopy techniques such as wide-field imaging provide large-scale maps of functional activation. In animal models of stroke wide-field microscopy allows investigating the meso-scale disruption and following remapping of functional connectivity.

What do we mean for “remapping”?

In the brain version of Google Maps, location is everything: if a single spot is removed, the cortical territory devoted to that target rapidly remaps to represent the intact digits that project to the neighbouring cortex. This phenomenon of intense competition for available cortical map territory can be easily visualised by wide-field optical microscopy. Works from Tim Murphy's lab combined this imaging technique with voltage sensitive dyes (i.e. dyes that shine proportionally to neuronal activation) to investigate large area remapping after stroke.

By analysing the sequence and kinetics of the activation of peri-infarct cortical circuits after a stroke, they found that the surviving portion of cortex actively relays enhanced signals to the adjacent areas, resulting in remapping of the lost function. Some diffuse off-target signalling are strengthened over the days, weeks and months over which recovery from stroke damage occurs. These findings indicate that the recovery

of functions after stroke and brain remapping involve changes in the temporal and spatial spread of information processing across local and distant sites.

In another study, they found that the focus of cortical activity is rapidly redistributed after ischemia. Given that it occurs within an hour, the effect is likely to involve surviving accessory pathways and could potentially contribute to rapid behavioural compensation or direct future circuit rewiring.

Real time imaging

These intriguing studies performed with wide-field microscopy give a view of the large picture, but are not capable of penetrating into the optically highly scattering brain tissue. Recent technological advances in optical imaging allowed for observing and interrogating single cells in real time in their natural environment, thereby preserving the complex ensemble. Analysis of individual neurons can help determine whether stroke-induced plasticity is achieved by surviving neurons giving up their usual function or whether individual neurons may be able to process multiple sensory streams. Optical imaging technologies capable of penetrating into the tissue have been developed and applied to in vivo brain imaging. High-resolution imaging of stroke injury and repair in rodents has been now implemented in many labs.

Several important characteristics of the imaging modality are critical to assess cells in their natural environment during stroke, like the ability to image the same region longitudinally,

the spatial resolution, sufficient to resolve individual cells, the temporal resolution to resolve the time course of dynamic cellular processes and the penetration depth to enable imaging through the cortex. Only a few optical microscopy technologies satisfy these requirements and have been applied to image ischemic stroke in rodents, like two-photon microscopy (TPM), optical coherence tomography (OCT), and photoacoustic imaging (PAI). Among these, TPM imaging is the most mature and widely applied.

Two-photon microscopy (TPM)

TPM detects photoluminescence that comes from endogenous or exogenous chromophores, and the images are typically created from sequential measurements.

The development of TPM imaging of variation in calcium ion concentration has had an enormous influence on the investigation of the plethora of diverse neuronal functions. By optically recording neuronal activity with in vivo imaging of calcium-associated fluorescence, previous work assessed stroke-induced changes in function and spatial organisation of more than 10,000 individual neurons.

In vivo two-photon calcium imaging within reorganised functional maps determined how the response properties of individual neurons were altered during recovery from ischemic damage over several weeks. Single-cell imaging revealed that the selectivity of individual neurons was altered during recovery from ischemia, e.g. neurons normally selective for a single contralateral limb processed information

from multiple limbs. Altered selectivity were most prominent in border regions between stroke-altered macroscopic map representations, and peaked 1 month after the focal insult. With longer recovery, these cells developed more specific response characteristics and restored a defined preference. These forms of plasticity indicate that apparently hardwired cortical neurons first adopt wider functional roles as they develop strategies to compensate for loss of specific sensory modalities after stroke.



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The development of anti-infective drugs

University of Strathclyde's Professor Colin J Suckling shares research being undertaken into anti-infective and immunomodulatory drug discovery programmes

As we continue the development of our anti-infective and immunomodulatory drug discovery programmes at the University of Strathclyde, applying our skills and experience in heterocyclic chemistry in collaboration with specialist biology groups from around the world, it is interesting and also challenging to read in the scientific literature of work in other laboratories directed to the same ends. New papers describe not only what the international competition has achieved, which contributes to the challenge, but also tangential observations that can lead to new lines of enquiry for our own work.

Readers who have followed my [recent contributions](#) in this medium will be aware that in my teams we have a compound in clinical trials and many compounds at advanced preclinical stages for the treatment of infectious diseases caused by bacteria, fungi, and parasites coming from our DNA minor groove binders programme, compounds that we refer to as S-MGBs. These are heterocyclic compounds, the field of chemistry, which is the focus of our synthetic work. We also have a series of compounds with the potential to treat diseases of imbalance including asthma, rheumatoid arthritis, and lupus erythematosus, to name three, which come from what we call 'the worms project', reflecting the biological starting point for the project. In writing this article, I've selected four publications from around the world that have attracted our attention at Strathclyde because

of their relevance to our programmes. Each of them illustrates a different impact on our studies.

Antifungal compounds

The first concerns new antifungal compounds [doi/10.1073/pnas.1608304113] discovered through research in England and the U.S. Most of the politics around antimicrobial resistance refers to bacteria, which most people recognise as the so-called superbugs. However, fungi can be just as life threatening to susceptible patients and around 1.5 million deaths are caused by fungi each year. Many millions more suffer from a long-term chronic debilitating disease with an associated world-wide financial burden of \$13.9 billion by 2018. Unlike bacterial infections, for which there are many types of drug available, only four classes of antifungal agents are available to treat invasive fungal infections all of which have practical limitations, not least of which is the emergence of resistance to the limited number of available treatments. Not only did the research I'm highlighting produce a new candidate antifungal compound it also discovered a new biological mechanism for antifungal activity, an enzyme target known as dihydro-orotate dehydrogenase. Both of these features are very encouraging for development because high activity without resistance can be expected. In our S-MGB research we have also identified some highly active antifungal compounds that work by a novel mechanism. So there is competition between different teams



Strathclyde Institute for Pharmacy and Biomedical Sciences, Glasgow City Centre, home to much of our in-house biological evaluation

and different compound classes which is a good thing.

Antibacterial drugs

Turning now to antibacterial drugs, one of the biggest challenges concerns the class known as Gram-negative bacteria. This large class of bacteria presents its problem because of its double cell wall and its ability to pump drug molecules out of the cell before they can do any damage. The biological pumps are embedded in the cell wall structure. Many groups around the world are tackling this problem sometimes with new compound classes but more successfully with strategies that try to deal with the double cell wall and the pumps. If the cell wall can be weakened or the pumps reduced in activity, for example, perhaps the new drug could get into the Gram-negative bacterial cell and kill it. One of our S-MGB projects is looking at these approaches with some encouraging results and we are further encouraged by a paper from Canada, my second example [doi: 10.

1038/nmicrobiol.2017.28], that showed that an old class of minor groove binders, pentamidines, that has been used widely in anti-parasitic therapy can make resistant Gram-negative bacteria susceptible again to the drug colistin. Disruption of the cell wall is believed to be the mechanism of action and we think that some of our S-MGBs work partly in the same way.

But there's an alternative approach to deal with the cell wall, namely to arrange for the bacterium actively to absorb the drug using its natural uptake mechanisms. One such mechanism uses compounds known as siderophores, which have evolved to bring iron, an essential element, into the bacterial cell. By attaching a small siderophore through specific chemical bonds to an established drug to which Gram-negative bacteria are resistant, a beta-lactam known as a Monobactam, a Chinese group has shown that extremely potent new compounds active against Gram-negative bacteria can be obtained [doi: 10.1021/acs.jmedchem.6b01261]. This beautiful piece of research reached proof of concept stage by showing that their

most active compound could successfully treat mice infected with the Gram-negative bacterium, *Klebsiella pneumoniae*. We have some S-MGBs active against this organism but no *in vivo* data yet. We have not tried the siderophore approach yet; maybe we should.

Whilst new antimicrobial compounds are one world-wide need, new drugs to treat diseases of aging are also high profile. For example, researchers have been looking over decades for drugs to treat Alzheimer's disease by targeting the protein modification mechanisms that have been found to occur in the brains of Alzheimer's patients but without significant success. A big question then arises about where a new drug should intervene in the pathology of Alzheimer's disease. Some very recent work from England and Germany has suggested that certain inflammatory pathways controlled by a protein known as Nrf2 might be relevant [doi:10.1371/journal.pgen.1006593]. This surprised us because we have found that one of our compounds from the 'worms project' with anti-arthritis activity engages exactly this pathway [doi.org/10.1016/j.jaut.2015.04.005]. Does this mean that a drug candidate designed to be an immunomodulatory might turn out to be important in a major disease of neurodegeneration? We'll have to do the experiments to see.

International approach

These selections serve to highlight the truly international character of scientific research and also illustrate the penetration of heterocyclic chemistry. When I used to preside at graduations at the University of Strathclyde, I would encourage the new graduates to see what they could make possible for the world using their academic and practical training. Well there's some exceptionally good academic research into



Thomas Graham Building, University of Strathclyde, where our synthetic chemistry is carried out

new anti-infective agents out there answering exactly that challenge. The real question now is whether all of this international science can be translated into medicines available to the public for health care world-wide. Current commercial development models don't work because good antibiotic stewardship, which minimises the rate at which resistance arises to new drugs, runs counter to selling large quantities and making lots of money for the pharma company and its shareholders. Things will have to change somehow.



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What will happen if the Affordable Care Act is repealed?

Dr Virginia M Stewart asks what will happen if the Affordable Care Act is repealed, sounding a warning for the health and lives of millions of Americans

United States (US) citizens have the right to emergency care and medical treatment for life threatening injuries. With rising health care costs over prior decades, a single trip to the Emergency Department may cost thousands of dollars. Health insurance significantly reduces those costs; however, prior to the implementation of the Patient Protection and Affordable Care Act (PPACA) in 2014, an estimated 41 million Americans lacked health insurance.

The PPACA, also known as “Obamacare”, was enacted in 2010 to expand insurance coverage to uninsured Americans, and to lower the costs of health care. PPACA also addressed healthcare delivery system improvement, and increased the use of technology to improve health outcomes among patients. Major provisions of PPACA went into effect in January 2014.

Most insured Americans under the age of 65 years old obtain insurance through their employer. However, prior to PPACA, businesses were not required to offer insurance to their employees. Starting at the age of 65, Americans who have worked and paid into the system through their payroll taxes are eligible for Medicare. Medicare is a national social insurance program administered by the US Government.

Prior to PPACA taking effect in 2014, private insurance was sold to individ-

uals, and the insurer could determine the extent of insurance or even decline individuals seeking coverage, due to pre-existing health conditions. In other words, an individual with a chronic illness could be denied coverage for that illness, or any other illness.

According to the 2015 Centre for Disease Control's National Health Interview Survey (NHIS), approximately 52 million (27%) adults between the ages of 18-64 years reported at least one of the medical conditions listed in Figure 1. A limitation of the survey was that state identifiers were not included; many states did not have population sizes sufficient for this survey sampling. Therefore, the impact for each state could not be immediately extrapolated. Since it is the individual states that offer insurance plans through Medicaid, and exchanges developed for PPACA, the impact of repealing PPACA would vary from state to state.²

A regression model constructed by The Henry J Kaiser Family Foundation (a non-profit, non-partisan group), for the CDC's 2015 Behavioural Risk Factor Surveillance System (BRFSS), estimates the prevalence of declinable conditions at the state level. This model relies on respondent age, self-reported health status, and self-reporting of declinable conditions. Applying this prediction model yielded a nationwide prevalence of 28% of the total population with a declinable condition, which is significant when compared to the NHS



Figure 1: Examples of Medical Conditions that are Declinable for Medical Insurance Coverage¹

nationwide estimate of 27%. States such as California face an estimated 5,865,000 non-elderly adults with declinable pre-existing medical conditions. Arizona, Florida, Hawaii, Illinois, Iowa, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Texas, Virginia,

State	Number of Adults with Declinable Conditions	State	Number of Adults with Declinable Conditions
Alabama	942,000	Montana	152,000
Alaska	107,000	Nebraska	275,000
Arizona	1,043,000	Nevada	439,000
Arkansas	556,000	New Hampshire	201,000
California	5,865,000	New Jersey	1,234,000
Colorado	753,000	New Mexico	332,000
Connecticut	522,000	New York	3,031,000
Delaware	163,000	North Carolina	1,658,000
District of Columbia	106,000	North Dakota	111,000
Florida	3,116,000	Ohio	1,919,000
Georgia	1,791,000	Oklahoma	706,000
Hawaii	209,000	Oregon	654,000
Idaho	238,000	Pennsylvania	2,045,000
Illinois	2,038,000	Rhode Island	164,000
Indiana	1,175,000	South Carolina	822,000
Iowa	448,000	South Dakota	126,000
Kansas	504,000	Tennessee	1,265,000
Kentucky	881,000	Texas	4,536,000
Louisiana	849,000	Utah	391,000
Maine	229,000	Vermont	96,000
Maryland	975,000	Virginia	1,344,000
Massachusetts	999,000	Washington	1,095,000
Michigan	1,687,000	West Virginia	392,000
Minnesota	744,000	Wisconsin	852,000
Mississippi	595,000	Wyoming	94,000
Missouri	1,090,000		
United States total		52,240,000	

Table 1: Estimated Number of Non-Elderly Adults in 2015 with Declinable Pre-existing Conditions under Pre-PPACA Practices²

and Washington, all have over 1 million non-elderly adults with declinable pre-existing conditions.

What will happen if the Affordable Care Act is repealed?

Without the increased coverage and measures to decrease health care costs provided through PPACA, there is anticipated to be an increased strain on Emergency Care Services. Rather than providing mostly life-saving measures, emergency departments have become part of a safety net for those without access to healthcare. By evaluating the impact of loss of insurance due to loss of jobs in 2000s, the impact of loss of insurance from repealing PPACA may predict the impact of delivery of healthcare within emergency departments (ED). A 2009 qualitative interview study among ED administrators throughout the US summarised 10 major observations resulting from loss of insurance coverage. Academic, community,

urban, suburban, and rural hospitals were included in four major US regions, and included the below findings.³

1. ED capacity was strained with almost all emergency departments reporting a rise in volume.
2. Many departments observed a new “recession” population, who previously had health insurance through their employer, but became uninsured from job loss.
3. Most uninsured people did not have other options to obtain primary care services other than the ED. Clinics that served uninsured individuals or that had a sliding fee schedule for care were not accepting new patients.
4. ED volumes of insured patients increased because they could not obtain a timely appointment with their primary care provider.
5. High volume and high occupancy in the ED and hospital led to overcrowding in the ED, which increased overall

wait times to care. In the study, one facility had wait times within the ED of 18-24 hours.

6. Lack of insurance and access to primary care, led to sicker patients and repeated ED visits.
7. Patients refused recommended care due to their concerns about the costs.
8. Anxiety, depression, and stress increased among patients.
9. Uninsured patients did not have follow-up care from their ED visit. This impacted the care patients received, meaning more tests were performed at each visit.
10. EDs did not have financial and personnel resources to meet the rising patient volumes.

Repeal of PPACA may potentially mean the loss of medical insurance for approximately one-third of non-elderly American adults. The economic recession and increased unemployment in the 2000s may serve as a warning as to how PPACA's repeal could adversely affect healthcare and the lives of millions of Americans.

1. Claxton G, Cox C. Pre-existing Conditions and Medical Underwriting in the Individual Insurance Market Prior to the ACA. Issue Brief, December 12, 2016.

2. New State Data: ACA Marketplace Enrollees Receiving Estimated \$32.8 Billion in Tax Credits, Which Would be Eliminated Under Repeal of the ACA. Issue Brief, December 5, 2016.

3. Emergency Departments Under Growing Pressure. Issue brief, July 30, 2009.



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Health Accord: Healthcare for all

Open Access Government highlights how Health Minister, Jane Philpott aims to improve the lives of all Canadians through their new Health Accord Plan

In September 2016, Canada's Health Minister, The Honourable Jane Philpott, revealed plans for Canada's new Health Accord Plan to the CANADA 2020 Health Summit. The Summit was in partnership with the Canadian Medical Association, aimed to open debate and discover solutions to help Canadians lead better and healthier lives – particularly for the more elderly population of the country.

In the opening of her speech, she stated that, "Already, Canada is one of the world's highest spenders on healthcare and yet we are not achieving the kind of results Canadians need and deserve."

This is evident from in the CMA National Report Card 2016, where only 37% of Canadians assigned a letter grade of A to the "overall quality of health care services available".

Philpott went on to outline the Federation's "shared priorities for health", which include homecare, pharmaceuticals, mental health, and improved healthcare for the Indigenous population. Overall, the Federal Government's priorities for healthcare spending align with aspects of the healthcare system that Canadian citizens prioritised in the National Report Card.

Homecare

One of the key priorities for the Health Accord is improving investment for homecare. The Minister outlined how in Canada \$10 billion, around 5% of total health spending is spent on home and community care.

"That's a lot of money, but it's probably not enough, especially since our population is aging and burdened by increasing rates of chronic disease," Philpott stated.

Philpott went on to say, “Today, some 15% of hospital beds are occupied by patients, who might be better off at home or in long-term care. This has a huge financial impact. For example, in Ontario, basic homecare costs \$42 a day, compared to a minimum of \$840 a day in a hospital.

“More importantly, it’s not the best way to care for them – we know the hospital is not where they want to be, unless it’s absolutely necessary. We have a golden opportunity to put in place robust systems of services and supports that will address these gaps.”

Not only was Philpott’s argument for better investment, she also stressed the importance of putting more resources into homecare, so that patients, carers, and families have more support and “don’t burn out”.

Mental Health

The National Report Card stated that 83% of Canadians placed mental health services within the top funding considerations. This emphasis on mental health is no surprise when the Canadian Centre for Association and Mental Health (CAMH) [found that by](#) the time Canadian’s reach the age of 40, half have, or have had, experiences of mental illness. Furthermore, a third of people who had reported mental health issues in the past year said that their needs had not been met.

At the Health Summit, Philpott added mental health to her priorities as part of the Health Accord Plan to improve healthcare across the country. She highlighted mental health as something that needs to be discussed openly between families and even communities.

The Minister said, “For too long, mental illness was something to be hidden, something to be ashamed of. Today, we talk about it somewhat more openly in our families and in our communities, and that is a good thing.

“But as the full extent of the burden of mental illness in Canada becomes clear, it’s become obvious that our systems are not well-equipped to heal the trauma caused by mental illness.”

She also admitted that while “doctors and other front line workers do their best”, they “often don’t have adequate training”.

However, she did mention plans to “build systems where mental health services are widely available and supportive”.

Indigenous populations

Canadians placed better healthcare for the Indigenous populations below many other healthcare improvements, with only [64% of people believing](#) it to be an important area of funding.

However, Philpott clearly stated that this was an important issue for the Government. She argued that challenges within the healthcare system are “magnified many times over for Indigenous peoples in Canada”.

Evidence for this includes the [2017 life expectancy statistics](#) that found that life expectancy among the total Canadian population is 79 years for men and 83 years for women. However, for the Indigenous populations, the projected life expectancy is much lower, 64 years for men and 73 years for women.

Philpott summarises this gap in healthcare by saying “If you are an Indigenous, your life expectancy is up to a decade shorter than for other Canadians. Your rates of diabetes are 3 times that of the national average. In First Nations, rates of tuberculosis are 33 times that of other Canadians. For Inuit, the rates of tuberculosis are 375 times higher than those for non-Indigenous Canadians”.

In her speech at the Health Summit, Philpott ended by emphasising the “need to adapt to new ideas” and renew Canada’s “approach to health policy”, concluding with the message that “by working together, Canada can be a world leader to ensure our ultimate collective goal, that is, health for all”.

The full speech from the Minister at the Canada 2020 Health Summit can be found [here](#). ■

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Using Positron Emission Mammography to detect breast cancer

Dr Alla Reznik, Canada Research Chair in Physics of Medical Imaging, explains how Positron Emission Mammography is effective when detecting breast cancer

Breast cancer accounts for approximately 26% of all cancers diagnosed today. One in 8 women are expected to be diagnosed with breast cancer in their lifetimes. According to the National Cancer Institute, in 2016 there were 246,660 new cases and 40,450 deaths from breast cancer in the U.S alone. Like other cancers, breast cancer is most successfully treated if the disease is diagnosed early. In addition to better health outcomes, there are economic benefits to accurate screening and early diagnosis of the disease. It is estimated that the cost of treating early stage breast cancer is about \$12,000, while late stage treatment costs start at around \$150,000.

Common practice for breast cancer screening is x-ray mammography for women over 50. Unfortunately, for too many women, x-ray mammography is too ambiguous to detect their disease in time for effective treatment. The problem is that the specificity of mammography suffers from its difficulty in distinguishing between benign and malignant masses: dense breast tissue appears similar to cancer on x-ray mammograms, leading to inconclusive imaging results. Patients with suspicious mammograms are prone to either unnecessary biopsies or late identification of serious disease. Of the women that are screened with mammography, roughly 18% have a suspicious but inconclusive finding and a third of these are sent for

biopsy. Roughly 75% of biopsies prompted by mammography come back negative and in the U.S alone these account for 1.5 million unnecessary biopsies that could be prevented with more cancer-specific diagnostic imaging. The situation is the most urgent for women with a known high and intermediate lifetime risk for breast cancer. High-risk patients have to be screened at a significantly younger age than average risk women. Younger high-risk women tend to have denser breast tissue which does not produce accurate images when scanned using x-ray mammography.

The inconclusive nature of breast cancer detection with either mammography or its combination with MRI means that a large cohort of women (especially, high-risk patients) cannot rely on imaging to start disease treatment at the early stage. These women are forced to contemplate prophylactic mastectomy because the predictive power of current imaging is so poor.

Early detection

Radialis Medical Corporation, a joint venture (spin-off) of the Thunder Bay Regional Health Research Institute (TBRHRI) and Lakehead University, Ontario, Canada, addresses this important unmet patient's need. Radialis is manufacturing an advanced Positron Emission Mammography (PEM) system for molecular (or functional) imaging of breast cancer. PEM detects small cancerous breast lesions based

on their increased glucose metabolism and in such its imaging performance is inherently independent on breast tissue density.

The core technology of the PEM system was developed in Dr. Alla Reznik's research laboratory at Lakehead University and TBRHRI. Radialis PEM employs 2 planar high-resolution detector heads placed on both sides of gently steadied breast (Figure 1). Each detector head contains a large field-of-view (17cm x 22cm) gamma-photon sensor based on the novel type of solid-state (silicon) high-gain detection technology. During image acquisition, detectors fully cover the entire breast that allows for improved sensitivity capable of significant radiation dose reduction (by the factor of 4) in comparison with commercially available scanners.

Another advantage of Radialis's design is its slim detector head and minimised "dead area" (the distance between the imaging part of the detector and its housing). This comparatively small step allows for significant clinical benefits since it tremendously improves visualisation of deep chest lesions, provides more options for detector heads positioning around the patient breast and access to lymph nodes to evaluate its possible metastatic involvement.

The assembly and imaging performance evaluating of Radialis's PEM are



underway. Initial results with phantoms mimicking breast lesions of different sizes demonstrate that tumours as small as 1.2mm in size will be detectable in a clinical setting. The ultra-high resolution achieved combined with a large field-of-view detector design enables high-resolution, low-dose molecular breast imaging.

Additionally, large area stationary solid-state sensor design means that there will be less radiation that will escape Radialis's device.

In addition to improved early breast cancer detection for a large cohort of patients, the use of PEM for screening of the high risk population will allow

for significant improvement in patients' compliance for frequent tests. Indeed, at the current stage of mammographic detector technology, extreme breast compression is applied. The associated pain and anxiety is so strong that a large number of patient refuse mammography after their first experience. In contrast, PEM only requires breast immobilisation rather than compression and hence completely eliminates pain. This has the potential to significantly improve compliance and the effectiveness of cancer detection.

Overall, once implemented in clinical practice, Radialis's PEM technology can be used as (1) an adjuvant technique for breast cancer detection, and (2) an integral part of the surveillance protocol of women at high and intermediate lifetime risk of breast cancer. In addition, the technological advances used will reduce manufacturing cost for PEM devices facilitating their widespread clinical usage, thus positively influencing people health.

Dr Alla Reznik

Dr Alla Reznik is a Canada Research Chair in Physics of Molecular Imaging and an Associate Professor in the Physics Department, Faculty of Science and Environmental Studies, Lakehead University. She is also affiliated as a Senior Scientist in the Thunder Bay Regional Health Research Institute (TBRHRI). Dr. Reznik has completed her PhD in solid-state physics at the Technion- Israel Institute of Technology. After several years as a Senior Physicist at the GE Medical Systems she decided to return to academia and accepted a Research Associate position at the University of Toronto, Canada. In 2008 she was appointed a Canada Research Chair in Physics of Molecular Imaging and in 2013 re-appointed as a Canada Research Chair in Physics of Medical Imaging. She is a specialist in photoconductive materials and technologies for radiation medical imaging. The focus of her work is on solid-state technology for organ-specific Positron Emission Tomography (PET). The goal is an improvement in resolution and sensitivity over commercially available PET imagers. Another focus of her work is on advanced low-dose direct conversion x-ray imaging detectors based on novel x-ray-to-charge transducers. Reznik group's PET research has led to the launch of Radialis Medical – the first joint Lakehead – TBRHRI spin-off-company, which will produce a commercial version of the technology for breast cancer detection.

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Fighting against breast cancer in Canada

Canadian Cancer Society's Dr Rob Nuttall and Shawn Chirrey explain how fighting against breast cancer requires ongoing support for research and screening

In 2016, an estimated 26,000 Canadian women and 230 Canadian men were diagnosed with breast cancer. Breast cancer occurs when cells change and no longer grow or behave normally. A Canadian woman has a 1 in 9 chance of getting breast cancer during her lifetime.

Research in Canada and across the world has managed to boost survival rates from 70% in the early 1970s to 87% today. Thanks to this research and advances in screening, today we know more about how to diagnose and treat breast cancer than we ever have.

"Thanks to organised screening programmes, research, improved treatment options and prevention recommendation we now have more breast cancer survivors than ever. We're grateful to now be able to turn more attention to survivorship and how we support women who are able to live their lives thanks to research."

What increases my risk of getting breast cancer?

In general, about half of all cancers can be prevented by not smoking, exercising and maintaining a healthy body weight. The same goes for breast cancer – if you're able to lead a healthier lifestyle, then your chances of getting breast cancer will go down.

While the risk of breast cancer increases with age, a personal or family history of breast cancer may further increase your risk. Additionally, studies have shown that women with inherited BRCA1 or BRCA2 gene mutations have up to an 80% chance of developing breast cancer in their lifetime. Women with these inherited mutations also have a higher risk of developing breast cancer at a younger age (usually before menopause) than other women.

Drinking alcohol also increases a woman's risk for breast cancer. Even low levels of alcohol consumption (just over 1 drink per day) can increase a woman's risk. The risk increases with the amount of alcohol consumed. One possible reason for this is that alcohol is thought to cause higher levels of estrogen. Other factors that can increase a woman's risk of breast cancer include obesity and hormone replacement therapy.

Are there tests for breast cancer?

In Canada, there are breast cancer screening programmes in each province and most territories. For women at average risk for developing breast cancer, mammogram screening is most effective every 2 years, between the ages of 50 and 74. It's important to note that breast cancer risk varies from woman to woman, so you should make a point of discussing your personal risk with your doctor. If you have family members who have had breast cancer, or you carry a certain gene mutation, then you may be recommended to start breast cancer screening earlier and more often. If you have high breast density (75% or greater) you may be asked to screen annually.

Breast cancer screening is done via a mammography. A screening mammogram is used to look for breast cancer in women who don't have any symptoms of the disease. It may be done in a clinic, screening centre or mobile screening mammography unit. During a mammogram, a plastic plate will be slowly pressed down to flatten your breast and hold it in place for a few seconds while two images of each breast are taken. You will feel some pressure on your breast during the x-ray.

Like most screening tests, there are benefits and limitations to mammography. Scientific evidence tells us that regular mammography screening leads to fewer deaths in women with breast cancer. This is because it



helps finding breast cancer when it is smaller and more treatable, which increases the chances of survival. Limitations of mammography include having false positives, false negatives, or finding cancers that may never cause any symptoms (over-diagnosis).

If you want to learn whether a mammogram is right for you, then we encourage you to use our screening-decision aid tool called [My Breasts, My Test](#). Launched last year, the tool will help you understand what factors to consider and help you to ask questions of your health-care provider.

Supporting more survivors than ever before

Thanks to organised screening programmes, research, improved treatment options and prevention recommendation we now have more breast cancer survivors than ever. We're grateful to now be able to turn more attention to survivorship and how we support women who are able to live their lives thanks to research.

Since merging with the Canadian Breast Cancer Foundation earlier this year, CCS is better equipped than

ever to fund more research, prevent more diagnoses and support more Canadians affected by breast cancer.

For those in Canada, if you'd like to speak with someone about yours or a loved one's breast cancer diagnosis, you can visit www.cbcf.org/support to speak with a CCS representative, or call 1-888-939-3333 to speak with someone from CCS's Cancer Information Service. ■

Dr Rob Nuttall
Assistant Director, Health Policy

Shawn Chirrey
Senior Manager, Health Promotion and Community Engagement

Canadian Cancer Society
www.cancer.ca
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The AIRC: Supporting cancer research in Italy

Open Access Government provides an insight into how the AIRC – the Italian Association for Cancer Research is supporting cancer research in Italy

The AIRC – the Italian Association for Cancer Research is a non-profit organisation, which has now become the most important charity devoted to cancer in Italy. With a yearly budget of over €101m in 2016, the charity mostly funds research projects and raises awareness of progress in cancer research. The funds raised through the charity each year are allocated to research projects throughout the country and throughout Europe that are approved by the AIRC's scientific committee.

AIRC is predominately committed to:

- Funding research carried out at universities, laboratories, hospitals and scientific institutions;
- Completing the education of young researchers in Italy and abroad by offering grants for further study;
- Informing the public and raising awareness of the progress made in cancer research.

Since the charity was founded in 1965, it has funded more than €984m worth of projects for cancer research and given €39m for study grants to young researchers.

The AIRC's scientific committee is led by Scientific Director, Federico Calligaris Cappio, who states: "With the fair independent and transparent AIRC peer review process, the most competitive and scientifically meritorious proposals are funded. The money donated to the AIRC is used to support only the best research in the country."

Members of the scientific committee who review and select the most promising research programmes for the AIRC to fund are said to be men and women who

are "at the forefront of Italian oncology". Research is the key focus of the charity and it is imperative that only the most promising projects are chosen to receive funding. Projects that are selected are usually ones that prove to be innovative as well as having a substantial impact on cancer patients.

Funding research

For 2017, the AIRC and its foundation has reportedly raised €102m to help fund research projects and continue the fight against cancer. This huge investment will enable around 5,000 researchers to work in universities, laboratories, as well as hospitals and research institutions. This funding just tops the investment from 2016, which totalled just over €101m. The 2016 funding was invested into projects such as a molecular clinical oncology programme, early detection and supporting young researchers.

Scientific research is one of the key elements for developing new treatments or therapies for cancer. There are many types of scientific research which the AIRC funds: basic research, translational research, pre-clinical research, clinical research and epidemiological research.

Each of these plays their own role in achieving the ambitious goals for defeating cancer once and for all. The funds that organisations such as the AIRC raise are crucial to achieving this goal, and supporting many patients throughout Italy who are fighting the disease.

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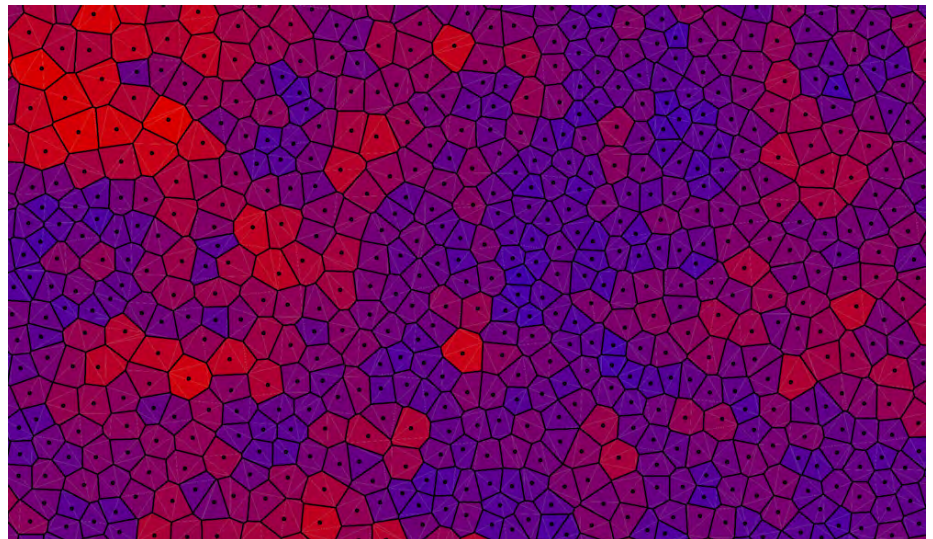
Jammed inert particles and their role in understanding cancer

Professor Roberto Cerbino of the University of Milan discusses how cell tissues may be ruled by the same laws of jammed inert particles

For a long time, cancer has been considered a strictly biological problem involving the birth, survival and proliferation of tumour cells through an abundant number of complex biochemical processes and pathways that may be triggered by genetic alterations. While this view is fundamentally correct, as confirmed by a large amount of scientific studies, in the last decade it has become increasingly clear that physics may have a relevant role in understanding some aspects of cancer. Multidisciplinary research teams made of biologists, physicists, chemists, engineers, etc. are more and more often involved in the quest for a cure to cancer. In this respect, physicists are typically trying to understand how far the available description of collections of inanimate entities, such as particles, can be used in explaining the more complex systems made of cells, living and motile objects ruled by a myriad of internal processes, powered by metabolic reactions and reacting to biochemical signalling.

Cellular jams

A notable example of powerful analogy that can be transferred from physics to biology is the so called jamming transition, a transition from a fluid-like state into a solid-like state usually observed in systems of inert particles when the number of particles in a prescribed region of space becomes too large. Think for instance to the behaviour of a granular material



such as corn or rice that flows like a liquid through a funnel until it cogs and becomes akin to a solid. Similar behaviour is also exhibited by non-granular inert materials such as foams and dense colloidal suspensions for large densities.

Epithelial tissues are made of a large number of cells in close contact. It has been recently understood that it is this crowding that convinces the otherwise very motile epithelial single cells to stop moving and building a tissue as we know it by conferring to its physiological properties. Unexpectedly, this crowding inhibition of cell locomotion bears many similarities with jamming¹ and provides a simple mechanism to explain why proliferating cells that are very motile in isolation become arrested at large densities. Finding a physical basis that explains a dynamical arrest mechanism in dense cellular assemblies is an important result

because it provides a purely physical mechanism that may help biochemical signalling in inhibiting cell motion in dense tissues.

“Of course, laboratory experiments are only the first step toward understanding the role of jamming and unjamming in real tumours. In the near future, it will of paramount importance to check if this JUT transition is also found in more realistic laboratory systems that mimic in a closer fashion the complex three-dimensional nature of tumours and their surrounding environment.”

Metastatic cells may escape from the jam

Cells in a tissue may however escape this configuration. A typical example of such an escape is the so called Epithelial-to-Mesenchymal transition (EMT), literally a change of identity of an epithelial cell that becomes mesenchy-

mal i.e. it loses adhesion with the surrounding cells and it acquires a motile behaviour that makes possible for this cell to move at large distances from the original position. It has been proposed that the EMT is involved in the dissemination of cancer from the primary tumour through metastasis, a complex process that is responsible for the large majority of the deaths due to cancer. Once a tumour cell finds a mechanism to move inside interstitial tissues and reach the blood circulation system it can reach distant regions and colonise them by creating secondary tumours, a largely unwanted process. Unfortunately, tumours exhibit a degree of plasticity that allows them to adopt a variety of strategies to disseminate in a healthy organism far away from the primary tumours. Knowing and understanding the largest number of them might be of paramount importance in controlling cancer dissemination.

Unjamming a tissue

A different gateway to cellular motility in jammed tissues, is represented by the recently discovered Jamming-to-Unjamming (JUT) transition, a phenomenon by which motility has been restored either via the action of a mechanical force² or by the activation of a protein (RAB5A) that plays a fundamental role in aggressive mammary tumours³. Surprisingly, the changes leading to cellular unjamming are mostly physical in that they involve, for instance, an increase of the adhesion between different cells and/or the activation of a 'social' alignment mechanism such as the one used by birds to fly in flocks. In this last case, we have observed [3] that cells tend to move in groups, in an organised way

that resembles the strategies enacted by crowds to pass in narrow spaces. Unjamming is thus a mechanism that represents an alternative strategy that may be used by cells in pathological conditions as an alternative to other strategies, such as the EMT, in the same way as jamming may be used to ensure the proper development of barrier properties of mature epithelial tissues. It should be however noted that unjamming is also used during wound healing, where cells need to move quickly, in a liquid-like fashion to close the wound.

“While this view is fundamentally correct, as confirmed by a large amount of scientific studies, in the last decade it has become increasingly clear that physics may have a relevant role in understanding some aspects of cancer.”

Relevance of jamming and unjamming to cancer

Our findings³ suggest that tumours do not emerge solely in response to genetic alterations but rely extensively on the physical contact and interaction with the surrounding environment. While genetic alterations do require some time to become operative, physical-based changes might be faster and thus more dangerous. Of course, laboratory experiments are only the first step toward understanding the role of jamming and unjamming in real tumours. In the near future, it will be of paramount importance to check if this JUT transition is also found in more realistic laboratory systems that mimic in a closer fashion the complex three-dimensional nature of tumours and their surrounding environment.

Physics at the service of cancer biology

The results briefly described here are only one of the many problems obtained by cross-disciplinary teams in which the ideas and concepts of physics are borrowed to tackle intrinsically biological probes. Interestingly, terms such as forces, tractions, tensions, cell mechanics, elasticity, viscosity and many others that have been originated in a physics context are now becoming part of the current language of cell biologists. This trend may be somehow interpreted as a kind of acknowledgment of the increasing usefulness of a physics-based approach in understanding the complex and multifaceted essence of cancer.

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Chronic lymphocytic leukemia: getting closer to a cure?

Associate Professor of Medical Genetics, Silvia Deaglio, highlights the research strides being made in the fight against chronic lymphocytic leukemia

Next generation sequencing and functional genomic studies have contributed to bring about a radical change in our approach to the diagnosis and treatment of cancer. With the identification of recurrently mutated genes and constitutively activated signaling pathways, therapeutic approaches in oncology are becoming highly specific and personalised with the aim of maximising results and minimising side effects.

Chronic lymphocytic leukemia

Chronic lymphocytic leukemia (CLL) is an outstanding example in this context. This disease, which represents the most common form of adult leukemia in Europe and North America, has now several highly effective targeted therapeutic options that are rapidly substituting the “old” regimes of chemo and immunotherapy. The most advanced clinical experience has been accumulated using the btk inhibitor ibrutinib, which targets a specific kinase in the signaling pathway activated by the B cell receptor, clearly the driving force in the progression of the disease. Even if clinical trials using btk inhibitors are proving highly successful, with very few cases progressing under the drug and with durable responses even in the case of patients with unfavorable genetic aberrations, the cure is still out of the picture. Importantly, some studies have suggested that discontinuation of the drug leads to rapid disease

relapse and progression, posing questions on the long-term effects of these therapies and also on its costs.

The Immunogenetics Unit of the Human Genetics Foundation, an institution that opened in Turin at the end of 2010 from the joint efforts of the local University, the Polytechnic and the Compagnia di SanPaolo, has been working since the beginning in the CLL field, with the aim of unraveling pathways and mechanisms controlling leukemia proliferation and survival. These studies, significantly supported by the Italian Association for Cancer Research (AIRC), have contributed to our knowledge on how the CLL cell grows and how it manipulates its microenvironment to create local conditions that favor growth and survival.

One of the areas of research that has attracted our attention as potentially interesting from the therapeutic point of view is based on data indicating that leukemic cells need to be surrounded and supported by non-tumor cells to survive and proliferate. These dangerous liaisons take place in privileged niches within the lymph nodes known as proliferation centers (Figure 1). Our group has shown that extracellular adenosine is one of the means through which CLL cells obtain T and myeloid cell cooperation. This small molecule is the final product of extracellular ATP metabolism, generated through enzymes expressed on the surface of both CLL and non-

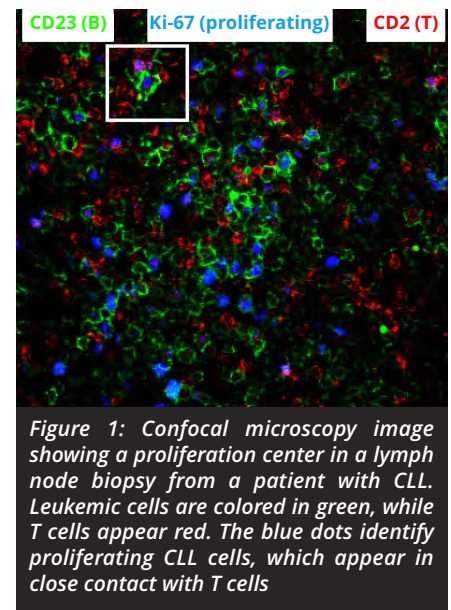


Figure 1: Confocal microscopy image showing a proliferation center in a lymph node biopsy from a patient with CLL. Leukemic cells are colored in green, while T cells appear red. The blue dots identify proliferating CLL cells, which appear in close contact with T cells

leukemic cells, and signals through specific membrane receptors. We showed that adenosine effects on CLL homeostasis are twofold: on one side, it directly protects leukemic cells from spontaneous and drug-induced apoptosis; on the other side, it shapes the environment towards immune tolerance, by inhibiting T-cell responses and inducing differentiation of supportive myeloid cells (Serra et al., 2011; Serra et al., 2016).

In addition to tricks adopted to mold a tumor-friendly environment, CLL cells exhibit intrinsic features that heavily impact their behavior, and whose functional characterisation represents the second main topic of our research activity. Before the advent of next generation sequencing, there were few markers to identify patients with an aggressive disease



and the expression of CD38 was one of them. Our group has extensively investigated the role and the signaling properties of CD38 and revealed that it actively favors survival and proliferation of leukemic cells by cooperating with chemokine receptors and integrins. By blocking CD38 enzymatic activity, we also provided proof of the principle that drugs or monoclonal antibodies targeting this molecule might be therapeutically useful in CLL (Vaisitti et al., 2015).

More recently, the use of ultra-deep sequencing platforms, led to the identification of recurrent mutations associated with worse disease outcomes and likely conferring advantages to leukemic cells. These platforms are also used to monitor disease evolution, clearly showing that the genetic profile of CLL evolves with time and therapy. This observation implies that either leukemic cells acquire novel genetic lesions as a result of micro-environmental conditions that lead to genomic instability, or that sub clones of the leukemic population, carrying specific mutations are progressively selected during the course of the disease. This discovery pointed out the importance of understanding and predicting the effects exerted by mutated genes in the disease context

and how they affect leukemic cell behavior and therapy responses. Our team has focused on NOTCH1 mutations, as they are relatively frequent in newly diagnosed CLL, increasing with the progression of the disease and in conditions of therapy resistance. We have shown that NOTCH1 mutations deregulate its activities as a transcription factor, remodeling gene expression of leukemic cells through direct (transcription-mediated) or indirect (epigenetic) mechanisms. Functionally, mutated NOTCH1 promotes growth and migration of leukemic cells by increasing expression of the chemokine receptor CCR7, through a complex network of nuclear signaling. As a result, mutated cells exhibit increased chemotaxis toward CCL19, the ligand of CCR7 and an important chemokine regulating trafficking of CLL cells to lymphoid niches. The relevance for the disease is that NOTCH1 mutations may contribute to an unfavorable prognosis by promoting the migration of leukemic cells to the lymphoid organs, where the protective micro-environment provides stimulatory signals favoring a more aggressive behaviour (Arruga et al., 2016).

Even if it is difficult to predict the future of this highly interesting and rapidly evolving field, the shared hope

is to obtain a cure suitable for the majority of patients. It is possible that this will come by combining drugs that target central pathways in leukemic cell biology together with drugs that alter connections and communications with the environment, making it inhospitable. The next decade will likely tell if these approaches work.

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Asbestos exposure can cause significant risks to health

Dr Christopher P. Weis of the National Institutes of Health, shares with Editor Laura Evans the dangers of long-term asbestos exposure

Asbestos is a term used to describe a group of 6 naturally occurring minerals that were mined and commercially marketed for a wide variety of products. Asbestos is just a small subset of dozens of naturally occurring elongated minerals that can cause disease if people come into contact with them on a daily basis. In the U.S exposure to these materials is fast becoming a major health problem. Although the 6 commercial forms of asbestos are regulated in the U.S for occupational exposure, some people argue that those regulations don't go far enough to protect the public because they are outdated.

Open Access Government Editor, Laura Evans spoke to Dr. Christopher P. Weis, Toxicology Liaison and Senior Science Advisor for the National Institute of Environmental Health Sciences (NIEHS) in Bethesda, MD, about the many health problems asbestos exposure can cause and the importance of raising awareness.

"Commercial asbestos is a silicacious mineral containing magnesium and oxygen that can exist in a variety of mineral forms," explains Weis. "It is made up of long thin fibrous forms of minerals or rock. It's the shape of those minerals, their long, thin nature, along with other physical-chemical characteristics, which causes them to be very poisonous.

"The shape is important because these long particles can make their way deep into the lung by travelling along the laminar flow of the air, as it is breathed in. Since they are made out of rock, they don't dissolve easily, so the lung has a very difficult time removing, dissolving and eliminating them. When the materials that contain asbestos are disturbed or damaged, fibres are released into the air. Once these particles are then breathed in, they can have a devastating impact on a person's health. Although sometimes the health prob-

lems do not arise until later in life so it's often hard to tell where the exposure occurred or if it was even asbestos exposure in the first place.

"When someone breathes in asbestos, it causes a series of inflammatory reactions in the lung. When the cells that normally remove particles from the lung cannot remove these elongated mineral particles, they send out signals called cytokines, that trigger inflammation and the formation of reactive oxygen species, which results in fibrosis or scar tissue forming in the lung," Weis says.

"Essentially, when asbestos is breathed in it causes a series of biochemical responses that further aggravate the problem. This can lead to a variety of diseases including asbestosis, lung cancer, and a very lethal and aggressive form of cancer called mesothelioma.

"Importantly and frequently, asbestos may cause non-cancer diseases that progress and become debilitating later in life and that we see a lot of that going on today, in several areas, there seems to be an epidemic of that non-cancerous disease associated with asbestos," he adds.

Problems caused by asbestos exposure

Mesothelioma is an extremely aggressive form of cancer that is almost exclusively related to asbestos exposure - often referred to as Meso. If someone gets Meso it's almost certainly because they were exposed to asbestos. One of the main problems with diagnosis is not always knowing when exposure happened and how, as Weis explains.

"Like most exposures there is a dose-response relationship, the higher the dose the more quickly and more severe the disease. That said, there are many

cases of short term exposure that result in disease later in life, the time between exposure and disease is called a latency period. Exposure can occur today or tomorrow, and they don't see the effects of that exposure for months or years and sometimes even decades, which can be problematic for many reasons.

"It's often difficult for physicians to diagnose the cause of the disease because the patient affected doesn't even remember being exposed in some cases. They may never even know that they were exposed until they are much older and could develop lung cancer or a non-cancer disease that could be lethal."

Asbestos-related diseases from exposure have become a major problem in the U.S. People assume that because the mineral is regulated that the problem is under control, however this couldn't be further from the truth. There are still many ongoing exposures to non-regulated asbestos that can cause debilitating or lethal diseases.

"There is a growing epidemic of asbestos-related disease in the U.S and worldwide that is going on un-addressed," says Weis. "This is because we are still measuring asbestos the same way we did back in the late 1800's. The Environmental Protection Agency, under recent revisions to the Toxic Substances Control Act has proposed regulation of the 6 forms of asbestos using assumptions that came into play decades ago. Unfortunately, regulations have not evolved with our understanding of how the disease has occurred.

"Many elongated mineral forms that occur naturally pose public health hazards," adds Weis. "They just simply have never fallen under any regulatory map in this country and that's unfortunate because the exposure to these non-regulated forms is increasing nation-wide.

"One example of this is a tragedy that occurred in a small mountain town in Montana called Libby. Several hundred people were killed and thousands injured by a form of asbestos that was not regulated. There are also cases of similar exposure that are not as focused as the occurrence in Libby, such as the use of asbestos-bearing gravel on roads and for construction materials in California, Nevada, and in the upper United States, for example. The dust from the roads can contaminate

vehicles, migrate into homes, and provide a source of ongoing exposure that may last for years."

Raising awareness to the risks of asbestos exposure

Raising awareness of the health problems caused by asbestos exposure is key to ensuring people are aware of the risks. Especially as there is such a close link between exposure and lung disease. Some people will be unaware, for example, that if you smoke and work in places where you are likely to be exposed to asbestos, you run a greater risk of developing lung cancer.

Without people knowing the true damage that asbestos exposure could cause, they are at risk. Weis highlights how the incorrect assumption that asbestos is regulated puts people at risk.

"Awareness is probably one of the most important things, but the only way to really reduce the risk is to break the exposure pathway. For example if there is a residential development in an area known to have asbestos – we have one just south of Washington DC for example – and one is aware of the fact that basements and houses are being built on naturally occurring asbestos, there are many steps that can be taken to minimise or eliminate the exposure. However, without knowing about this problem and without taking the necessary actions to understand what the exposures are, there is really no way to eliminate the exposure and therefore the disease.

"The key thing to remember and think about is that asbestos exposure occurs to a wide variety of elongated minerals outside of the 6 that are regulated. Until we understand that and take active measures to protect public health for the un-regulated forms of asbestos, the health epidemic that is increasing worldwide and in this country will continue," Weis concludes.

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Adverse health effects of hazardous asbestos waste

Hazardous asbestos waste causes serious problems in communities in the U.S., Ian A Blair, Penn Superfund Research and Training Program Center details

The community of primary interest to the Penn Superfund Research and Training Program (SRP) Center is surrounded and potentially impacted by the [BoRit EPA region 3](#) Superfund site. The site is located in the Ambler Borough, Upper Dublin and Whitpain townships in Pennsylvania.

This community has a long history of impact from hazardous asbestos waste. The waste disposal site is proximate to at least 2 very different types of communities: the relatively poor communities of West (predominantly African American) and South (Italian immigrant) Ambler which adjoins the site raising issues of environmental justice. The asbestos fiber used was predominantly chrysotile, which is the fiber considered to be a major cause of mesothelioma in the US.

It is of significant concern that in the Ambler zip code 19002, where the BoRit site is located, a cluster of mesotheliomas has been observed. In 1881, Henry G. Keasbey and Dr Richard Mattison moved their pharmaceutical company to Ambler, known initially for the production of milk of magnesia. Dr Mattison discovered that milk of magnesia (magnesium carbonate) could be combined with asbestos to make pipe insulators and shingles. The Keasbey and Mattison Co. was the leading manufacturer of asbestos textiles and products until it was acquired by England's largest asbestos

- **Can asbestos be remediated?**
- **Is asbestos transported by water?**
- **Why is there a cluster of mesotheliomas among women in Ambler?**
- **Is there a genetic pre-disposition to asbestos-induced mesothelioma?**
- **Can asbestos-induced mesothelioma be prevented?**
- **Is it possible to develop blood tests for asbestos exposure and mesothelioma?**

Figure 1: Six questions posed by BoRit Community Advisory Group to Penn's Center of Excellence in Environmental Toxicology (CEET)

company, Turner Newhall, Ltd., which manufactured asbestos textiles and products in Ambler from 1934 to 1962. Asbestos-containing waste from the plant was dumped in several surrounding areas, a practice that continued when CertainTeed Corporation and Nicolet Industries took over in 1962. CertainTeed ceased operations in 1974, followed by Nicolet in approximately 1988. Site remediation by the EPA under the Superfund Programme began in 1993. This remediation has involved capping the asbestos piles, adding a soil layer and hydroseeding. However, 3 other contaminated sites, in total about 32 acres and up to 42 feet deep, collectively known as the BoRit Site, and the abandoned plant site itself continue to present an unremediated hazard. The BoRit site was added to the EPA's National Priorities

List of the most hazardous waste sites on April 9, 2009, making it eligible for cleanup, using the federal Superfund Programme funding.

Research to reduce effects of hazardous asbestos in the Penn SRP Centre

Despite clean-up efforts, there is considerable residual community concern about the effectiveness of the remediation and the health effects of potential exposure to chrysotile asbestos. This has led to 6 major concerns being brought to the attention of Penn's Centre of Excellence in Environmental Toxicology (CEET). Dr Trevor Penning as Director of the CEET engaged his long-term collaborator Dr Ian Blair to establish a SRP programme configured around these community concerns (Figure 2).

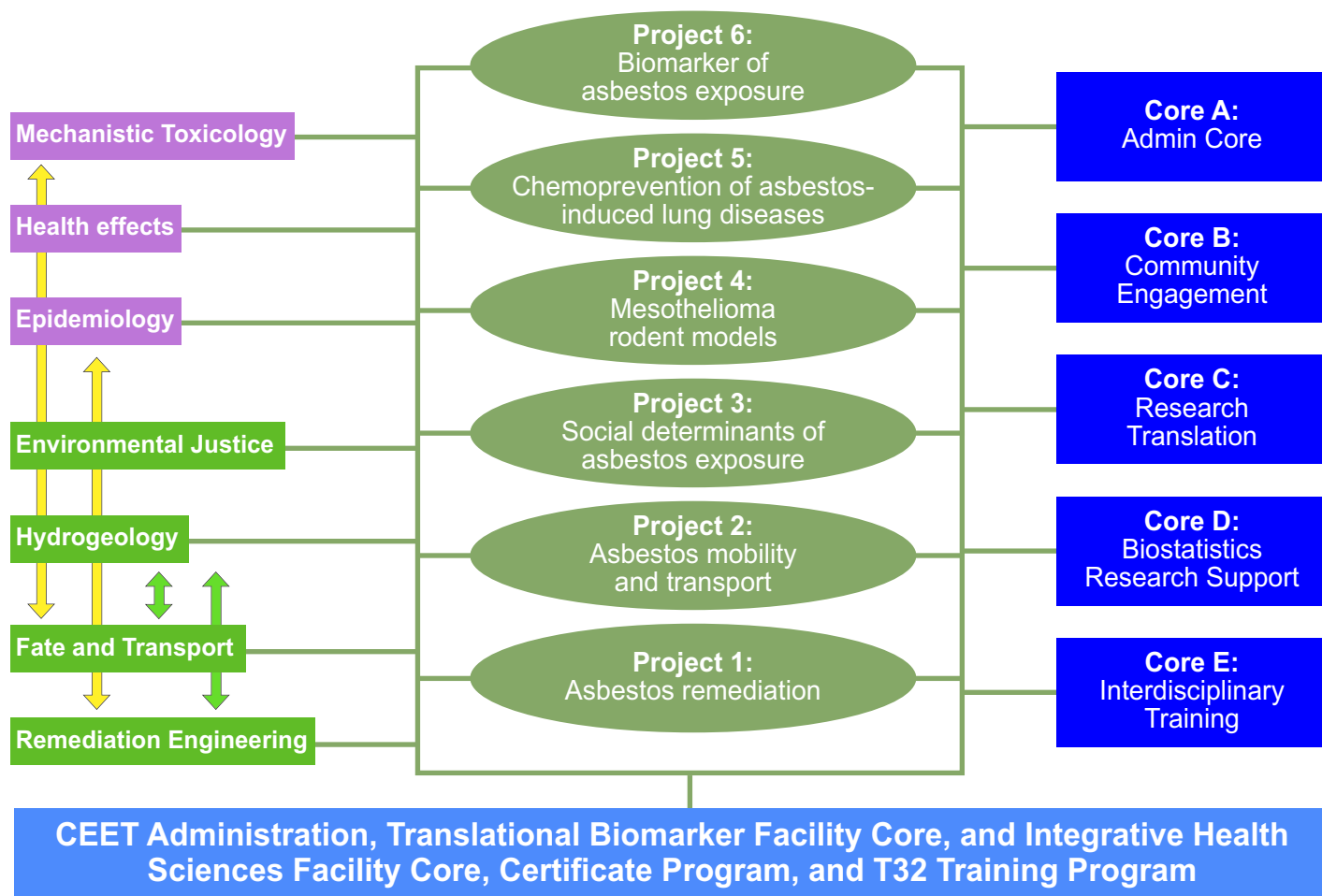


Figure 2: Organization of the Penn SRP Center

Project 1, which is one of the 2 environmental science projects, underpins all the other projects.

Project 2 assesses the physics that govern how asbestos fibers move through and become trapped in soil. The project works closely with **Project 3**, as community exposure to remediated asbestos in Ambler (and other areas) is strongly determined by the transport pathways of asbestos fibers in the environment.

Project 4 will enhance our understanding of the pathogenesis of asbestos-related disease, specifically malignant mesothelioma, using genetically defined mouse models.

Project 5 will develop chemoprevention strategies to prevent mesothelioma.

Project 6 will develop sensitive and specific serum biomarkers of asbestos exposure to assess potential inter-individual risks of developing mesothelioma or lung cancer. The six projects are supported by four conventional Cores as well as the Research Core in Biostatistics.

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Identifying pancreatic cysts that might turn into cancer

There are many challenges associated with identifying potentially cancerous pancreatic cysts. Here, Dr. Annabelle L. Fonseca et al explain

Doctors and patients usually do not know that a problem was even there. It is estimated that millions of people have pancreatic cysts (2% to 13% of the general population in the United States undergoing imaging). Because of the prevalence of these cysts, physicians often see them in patients undergoing diagnostic imaging, but the patients commonly do not have any symptoms from the cyst itself. This usually represents a conundrum for the doctor and patient because the cysts were not expected. The imaging is usually ordered for reasons unrelated to the pancreas (like gallbladder stones or other benign or malignant conditions). The challenge lies with the fact that the vast majority of pancreatic cysts are benign, but a small proportion of cysts can turn into pancreatic cancer, one of the deadliest diseases that afflicts humans.

The common initial reaction:

How do I get rid of it?

Currently, the only way to cure pancreatic cysts is with major surgery that may involve removal of part of the stomach and bowel, along with the pancreatic cyst(s). The surgery can be life-altering, and the procedure carries a small risk of death. Even after considering the morbidity and mortality of the surgery, many patients receive too much treatment (also described as over diagnosis) for an otherwise benign condition, largely out of fear that a cancer might be lurking.

Refocusing the question: What are the needles in the haystack?

Techniques to characterise these pancreatic cysts are urgently needed to spare patients with benign cysts from unnecessary surgery and to identify the patients with potentially malignant cysts who need surgery. In

our analogy, the haystack represents all the patients with pancreatic cysts. The needles represent the small number of patients who have cysts that may turn into cancer.

There are multiple forms of pancreatic cysts. The most common types that can turn into pancreatic cancer are



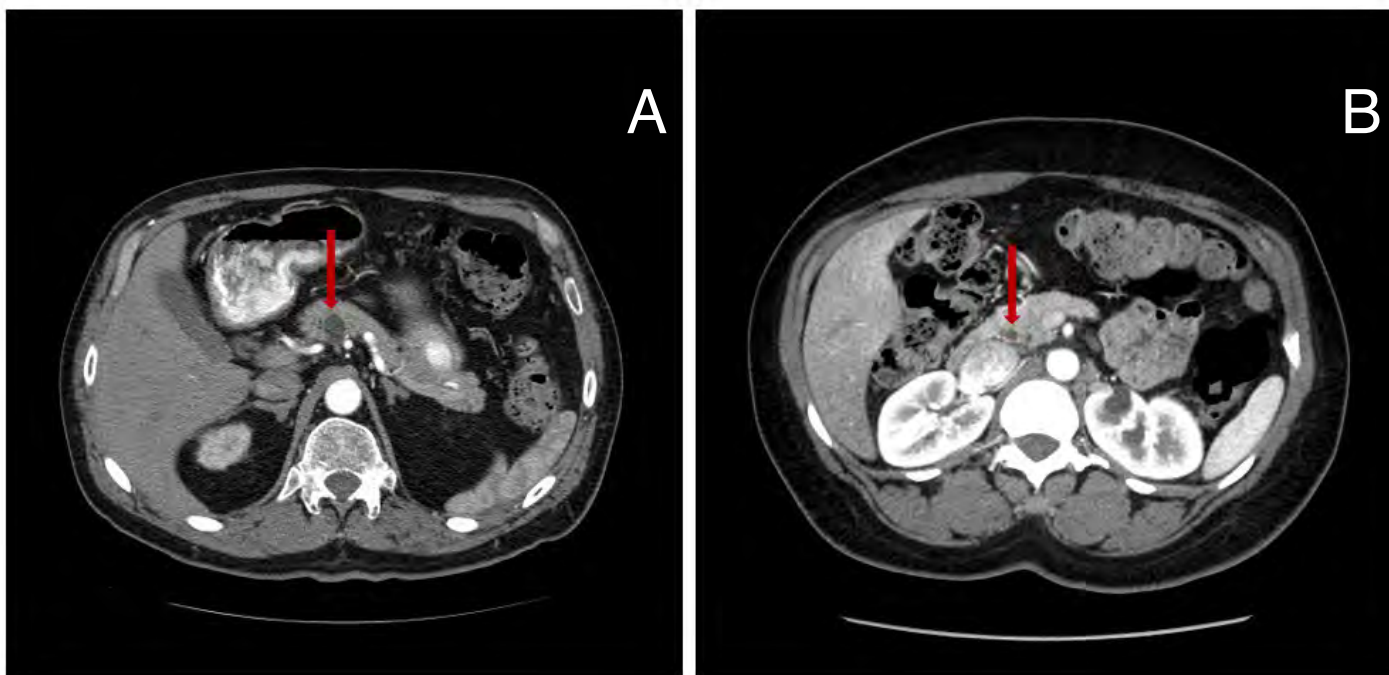


Fig 1: Image A shows an IPMN with low grade dysplasia. Image B shows an IPMN with high grade dysplasia. Both cysts have smooth walls and look generally "benign". The challenge lies in differentiating between these 2 pre-operatively, so that the patient in Image A can be prevented from having a potentially unnecessary operation.

intraductal papillary mucinous neoplasms (IPMNs) and mucinous cystic neoplasms (MCNs). Studies have shown that surgical removal of IPMNs or MCNs when they have not yet turned into cancer results in 5-year survival rates of 90-100%. Conversely, if any cancer component is found in the cyst after surgery, the survival rate is reduced by half. The current thinking by experts is that benign cysts exhibit a cellular pattern known as low grade dysplasia, and that cysts with a higher likelihood of becoming cancer have high grade dysplasia. Currently, the only reliable method to get the correct diagnosis involves major surgery so that a pathologist can see the entire tissue specimen; a small biopsy is not usually sufficient for an accurate diagnosis. So how do we select patients with pancreatic cysts for surgery?

The current approach:

More hay than needles

The current approach to deciding which patients should receive surgery involves the use of consensus guidelines: If a patient meets the criteria,

which a group of experts decide on, then the patient is recommended to undergo surgery. This approach does not involve evidence based clinical trials, unfortunately. Although the consensus guidelines have a relatively high sensitivity of around 90% or more (it can detect most cysts with cancer), there is a relatively low specificity of 50-60% (it incorrectly classifies benign cysts as high risk), feeding the over diagnosis problem. How can we accurately identify the high risk pancreatic cysts non-invasively?

A multi-faceted, biophysical approach to the problem

In the next few articles, we will explore the approaches to better identify high risk pancreatic cysts. Our approach involves the use of genetics, proteomics, physics, and math to overcome the current challenges that pancreatic cysts pose to physicians, patients, and the general healthcare system.

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Cancer immunotherapy: Are we ready to take the next big step?

Dr. Kularatne, vice president of Research and Development at On Target Laboratories highlights cancer immunotherapy as the treatment of next generation to cure cancer

Immunotherapy is starting to play a major role in cancer treatment and it was named as “the breakthrough treatment of the year” in 2013. Cancer immunotherapeutic agents have earned over \$60 billion revenues in 2016 and is expected to have a market value of about \$80 billion in 2020. Thus, pharmaceutical companies are evaluating new ways to use immunotherapy to treat cancers and develop a wide range of immunotherapeutic drugs for various cancers.

Cancer immunotherapy can be defined as “use of a person’s immune system to fight against cancer either by teaching it to work smart or stimulating the immune system by man-made immune components to attack cancer cells”. It can also be defined as a “treatment for cancer by inducing, enhancing, or suppressing an immune response”. However, the therapeutic outcome of the immunotherapeutic agents highly depends on the type of cancer, type of the immunotherapy, and treatment modality (mono or combination therapy).

Whilst the immune system is supposed to eliminate cancer cells within the body, it is not able to differentiate cancer cells from normal healthy cells. Cancer cells also express CD47 (Cluster of Differentiation 47) as healthy cells do. CD47 is also known as integrin-associated protein (IAP) and it produces a protein named signal-regulatory

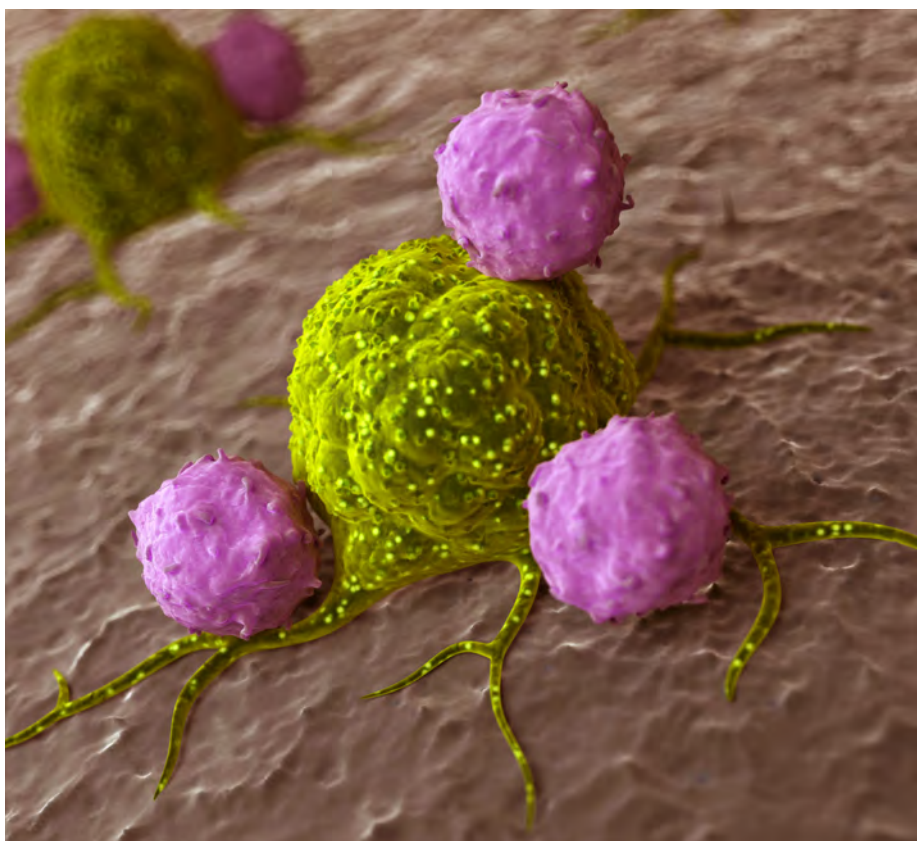
protein alpha (SIRPα) that sends don’t eat me signals to the macrophages, a type immune cells, and do not activate to attack me signals to T-cells, another type of immune cells. On the other hand, if it recognised that the response might not be strong enough to destroy the cancer cells. Moreover, cancer cells recruit immune cells such as tumour-associated macrophages, a subtype of immune cells, which keep the immune system in check and chase away T-cells that come to attack the cancer cells.

Cancer immunotherapeutic agents can mainly be classified into 4 major categories: Monoclonal antibodies, immune checkpoint inhibitors, cancer vaccines, and non-specific immunotherapies.

Monoclonal antibodies in the immunotherapeutic sector can be defined as man-made antibodies that induce antibody-dependent cell mediated cytotoxicity (ADCC), by recruiting immune cells or activating the complement system to attack tumour cells. Recruitment of immune cells can also be accomplished by designing a bispecific antibody that has 2 different monoclonal antibodies with one to recognise biomarker on cancer cells and a second to recognise biomarkers on immune cells. Blincyto (Blinatumomab) is a bispecific antibody that is used to treat acute lymphocytic leukaemia or B-cell lymphoma. It binds to the CD19 protein on B-lymphocytes

and to CD3 on T cells. By binding to both of these biomarkers, blinatumomab brings T cells closer to cancer cells and eliciting an immune response to diminishing cancer cells. Blincyto was developed by Micromet and then later acquired by Amgen, which has conducted further clinical development and is predicted to generate sales revenues of over \$1.5 billion in 2019.

The second class of immunotherapeutic agents is immune checkpoint inhibitors that take the ‘brakes’ off the immune system to attack the cancer cells. The immune system has checkpoint proteins, such as programmed cell death protein 1 (PD-1) and cytotoxic T-lymphocyte-associated protein (CTLA), that help to keep it from attacking other normal cells in the body. Unfortunately, cancer cells take advantage of these checkpoints to avoid being attacked by the immune system. A joint effort by Bristol-Myers Squibb and Ono Pharmaceutical yield to launch blockbuster PD-1 inhibitor, Opdivo (nivolumab), in Japan for melanoma in 2014 and it expects to generate sales revenues of \$4.3 billion in 2019. Keytruda (pembrolizumab), PD-1 inhibitor developed by Merck for melanoma, is predicted to generate sales revenues of \$2.9 billion in 2019. Yervoy (ipilimumab) is an example of a monoclonal antibody that activates the immune system by targeting CTLA-4, a protein receptor that down-regulates the immune system. While



Yervoy was developed by James Allison, clinical development of anti-CTLA4 was initiated by Medarex, which was later acquired by Bristol-Myers Squibb. Industry experts have predicted that Yervoy will generate sales revenues of \$1.5 billion in 2019.

Cancer vaccines are made from altered cancer cells that have been removed from the patient during surgery, immune cells that have been isolated from the patient's blood, or antigen such as protein, peptide or hapten that have been used to boost immune cells. Cancer vaccines can be used as prevention or therapeutic methods for cancer. In the case of cancer cell vaccines, cells are altered chemically in the lab to ensure they are recognised and attacked by the immune system and then injected back into the patient. On the other hand, isolated immune cells from the patient are exposed to cancer cells, cancer antigens, or chemicals to activate and then injected back into the

patient, where they should cause an immune response to cancer cells in the body. Sipuleucel-T (Provenge) is a dendritic cell (a type of immune cells) vaccine manufactured by Dendreon and received FDA approval to treat metastatic prostate cancer in 2010. Provenge generated \$303.8 million revenue in 2014.

The fourth category can be classified as non-specific immunotherapeutic modalities that boost the immune system in a general way. Chimeric antigen receptor (CAR) T-cell therapy is promising non-specific immunotherapeutic modality to fight cancer. In this technique, T cells are removed from the patient's blood and genetically engineered in the lab to express CAR. The T cells are then multiplied in a culture dish and infused back into the patient's blood. Theoretically, these T-cells should seek out the cancer cells and launch a precise immune attack against them. Juno Therapeutics, Kite Pharma, Novartis,

and Cellectis are conducting clinical trials on CAR-T cell therapies for different types of cancers. While some patients have shown promising results with high remission rates, a large number of patients have experienced untoward toxicities due to non-specific nature of this treatment. It's Obvious that recent deaths in the Juno ROCKET trial are creating uncertainties about CAR-T technology, researchers are currently trying to improve to overcome challenges of current CAR-T cell therapies.

We have to get immune cells ready to battle against cancer cells. To out-compete the intelligence of cancer cells, we have to prepare immune systems well by recognising weakness and strengths of cancer cells. Due to tumour heterogeneity, we have to prepare immune cells differently for each cancer type.

"Every battle is won before it is fought" – Sun Tzu, The Art of War, 400 B.C. That's how I see cancer immunotherapy.



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Gynaecologic research: Improving health for women

Dr. Lisa Halvorson, U.S. National Institutes of Health discusses the importance of gynaecologic research to develop new treatments and keep women healthy

In 2012, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) established the Gynecologic Health and Disease Branch to serve as the epicenter of gynaecologic research at the National Institutes of Health (NIH). Gynaecologic disorders affect women's quality of life in ways distinct from reproduction and infertility and, therefore, require an independent research focus and support. Here, Dr. Lisa Halvorson, Chief of the branch, answers Open Access Government's questions on the importance of gynaecologic health and of research to advance our understanding of gynaecologic disorders.

What is gynaecologic health and why is it important?

Gynaecologic health includes the health, structure, and function of internal organs, including those in the pelvis, and external genitalia that allow for normal menstruation, sexual function, and reproduction without chronic or recurrent pain. Many disorders, although not fatal, can impact gynaecologic health. These include menstrual abnormalities, ovarian cysts, uterine fibroids, endometriosis, and pelvic floor disorders (pelvic organ prolapse, urinary incontinence, and fecal incontinence), to name a few. In addition, there are several gynaecologic pain syndromes, such as chronic pelvic pain, chronic pain in the area around the opening of the vagina (vulvodynia), pain associated with menstrual cycles (dysmenorrhea), and painful sexual intercourse (dyspareunia). Obstetric fistula, defined as a hole in the birth canal, and female genital cutting also are important.

Gynaecologic disorders are fairly common and have far-reaching health and societal impacts. For instance, the most common non-cancerous gynaecologic tumor in women is uterine fibroids, with a lifetime prevalence of 70 to 80%, of which 30% are symptomatic. Another disease, endometriosis, affects approximately 10% of



reproductive-age women. Also, it is estimated that several million women in the United States suffer from vulvodynia alone, although the true prevalence of this and other gynaecologic pain syndromes remains unknown. Pelvic floor disorders affect almost 25% of U.S. women between ages 20 and 80 years. As the U.S. population ages, the number of women with pelvic floor disorders is expected to increase substantially. The detrimental health effects of gynaecologic disorders can range from abnormal uterine bleeding, pelvic pain, infertility, and sexual dysfunction to substantial psychosocial illness and limitations in daily activities. The financial burden of these conditions is also very high, with endometriosis and fibroids alone costing the United States billions of dollars every year in health care resources and lost work hours.

How important is research to develop new methods for prevention and diagnosis?

Despite the health and financial burdens of gynaecologic diseases, large gaps remain in our understanding of the key processes contributing to the development and progression of these disorders. Without ongoing

research, the gaps will remain, leaving millions of women without evidence-based prevention methods, diagnosis, or treatment.

What key target areas comprise the focus of research in the NICHD Gynecologic Health and Disease Branch?

Current efforts aim to support research in selected gynaecologic areas that have traditionally been overlooked or underfunded, such as socioeconomic, racial, and ethnic disparities in reproductive health outcomes. Although NICHD funding is allocated for studies of fibroids, endometriosis, pelvic floor disorders, and gynaecologic pain, our goal is to expand our portfolio to address a wider range of problems.

Over the past year, branch research has focused on the following:

- Supporting longitudinal studies to better understand the natural history of gynaecologic disorders, particularly in adolescents, to help identify risk factors, possible prevention strategies, and treatments;
- Fostering partnerships with experts in relevant clinical and basic science fields (e.g., neurobiology, muscle biology, cell biology, and immunology) to enhance knowledge and resource-sharing across disciplines;
- Applying powerful “-omics” approaches (e.g., genomics, epigenomics, and proteomics) to gynaecologic conditions;
- Investigating stem cells as a cause and potential therapy for gynaecologic disorders, from studies of their role in causing such disorders to projects that utilise stem-cell based therapies to treat the disorders;
- Developing new, non-hormonal pharmacologic treatments to improve gynaecologic health;
- Applying novel imaging methods and biomarkers to gynaecologic disorders.

How does your branch support such research and help raise awareness for gynaecologic health?

The NICHD Gynaecologic Health and Disease Branch funds basic, translational, and clinical research to investigate gynaecologic diseases. We also identify research needs and develop grant opportunities to address new or underdeveloped areas of investigation. To ensure that we have our fingers on the pulse of the various fields within gynaecologic health, branch staff participate in national and international meetings and maintain ongoing communication with the scientific community, advocacy organisations, related government agencies, and the general public.

“Gynaecologic disorders are fairly common and have far-reaching health and societal impacts. For instance, the most common non-cancerous gynaecologic tumor in women is uterine fibroids, with a lifetime prevalence of 70 to 80% of which 30% are symptomatic.”

These contacts enable us to distribute information related to research aims, funding opportunities, and study results to better convey the importance of gynaecologic health. The branch also supports research training and career development programs to create a future of excellence in women’s health research. In short, the branch serves as a link between the scientific community, the public, health practitioners, and different levels of government with the ultimate goal of advancing gynaecologic research and health. ■

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Uterine fibroids: Where is research heading?

Uterine fibroids represent a prevalent benign gynaecologic problem in the U.S, here Romana A. Nowak of the University of Illinois explains

Uterine leiomyomas (fibroids) represent the most common gynaecological tumours in women. These tumours disrupt the functions of the uterus and can cause excessive uterine bleeding, anaemia, defective implantation, recurrent pregnancy loss, pelvic discomfort and urinary incontinence, as well as possibly mimicking or masking malignant tumours in many U.S. women at some time during their reproductive life. By age 50, nearly 70% of Caucasian women and more than 80% of African-American women bear at least one fibroid and 15 to 30% of these women develop severe symptoms. Uterine fibroids disproportionately affect African-American women, who develop significantly larger fibroids at a higher rate and earlier ages, have more severe symptoms and sustain tumour growth for longer periods compared with Caucasian women.

Approximately 200,000 hysterectomies, 30,000 myomectomies, and thousands of selective uterine artery embolisation's and high-intensity focused ultrasound procedures are performed annually to remove or destroy uterine fibroids with an estimated total annual cost to the U.S of \$5.9-34.4 billion. It would not be an exaggeration to state that uterine fibroids represent the most important and prevalent benign gynaecologic problem in the U.S. There is a critical need to identify alternative therapeutic

approaches for leiomyomas that do not involve surgical intervention.

Surgery, either hysterectomy or myomectomy, is currently the primary avenue of treatment for leiomyomas, since effective non-surgical treatment options are extremely limited. Uterine artery embolisation is effective only in specific subgroups of patients with small fibroids and is not recommended for patients who intend to become pregnant. Gonadotropin-releasing hormone (GnRH) analogues, which suppress steroid hormones have significant side effects that restrict their use. There is also a high rate of recurrence of leiomyomas once GnRH analogue treatment is discontinued. Success is now being achieved with the use of the selective progesterone modulator ulipristal acetate. Several recent clinical studies have shown that ulipristal treatment was able to control myoma-associated uterine bleeding in over 90% of cases and significantly reduce myoma volume in more than 80% of women. This treatment is considered safe, even at the level of endometrial changes and is viewed as a promising alternative drug therapy.

Uterine fibroids are still misunderstood

Currently available treatments for fibroids are limited due in large part to the fact that the mechanisms regulating the development and growth of

these tumours are still not well understood. Many investigators in the field hypothesise that leiomyomas develop in the uterine myometrium as a response to inflammation or injury caused by local hypoxia during menstruation or the presence of bacterial or other pathogens. We and others also hypothesise that dietary intervention, with compounds known to inhibit inflammation-associated pathways, will decrease growth of fibroids leading to decreased size and amelioration of symptoms and this is now a very active area of research.

Several studies from the laboratory of Dr. Al-Hendy and colleagues have supported the use of vitamin D as a dietary intervention for leiomyomas. His group reported that the vitamin D receptor activator, paracalcitol, inhibited leiomyoma tumour formation in a rat model and that vitamin D also inhibited proliferation and collagen production in cultured human leiomyoma cells. Dr. Al-Hendy has also shown that green tea extract, given orally to women with fibroids, caused a reduction in fibroid volume and symptoms. Green tea is a natural product, commonly used as a nutritional supplement for multiple purposes. Epigallocatechin gallate, the major catechin in green tea, exhibits several useful biological effects, including anti-inflammatory, antiproliferative, and antioxidant effects. Studies carried out in animal models

have tested the potential benefits of adding lycopene to the diet to slow the growth of fibroid tumours.

Lycopene is a major carotenoid present in tomatoes and has been shown to be a powerful antioxidant. The results show that treatment with lycopene reduced the size and incidence of leiomyomas in quail by approximately 45-52%. Recently our lab has characterised oviductal leiomyomas that occur spontaneously in hens as they age, as a relatively inexpensive, naturally occurring animal model for fibroids. We now have preliminary data showing that hens fed a flaxseed diet showed a decrease in the size of the fibroids compared to hens fed the normal corn-based diet. Thus, dietary intervention for treatment of symptomatic fibroids has great potential but there is a critical need for larger scale dietary trials in naturally occurring animal models as well as in women.

Fibroid tumours represent many genotypes and somatic mutations and are also strongly influenced by epigenetic factors including inflammation, ethnicity, parity, metabolism and diet, and hormonal environment. Several physiological pathways have been implicated in the development of leiomyomas. However, genetic mutation is strongly thought to be the root cause of leiomyomas. Approximately 40% of leiomyomas have non-random chromosomal abnormalities. These cytogenetic abnormalities likely reflect general genomic instability, however mutations in leiomyomas that may underlie such genomic instabilities are only beginning to be understood. Mutations in a small number of genes including fumarate hydratase (FH), the high mobility

group AT-hook 2 (HMGA2) gene, tuberin (TSC2) and mediator complex subunit 12 (MED12) have been implicated in the initiation of these tumours. Several studies have now been published demonstrating that MED12 mutations are present in 56-73% of uterine fibroids. Polymorphisms in genes such as CYP17 and catechol-O-methyltransferase, have also been associated with a higher risk of developing leiomyomas. Recent studies have indicated a role for miRNAs in that many miRNAs including miR-21, miR-363, miR-490, and miR-137 have been shown to be differentially expressed in leiomyomas. As new therapies are developed, the heterogeneity of this disease becomes therapeutically relevant, and a broader knowledge of its genetic basis is vital for tailoring specific therapies to patients. Identification of previously unknown genes whose altered expression and function may contribute to the initiation and growth of fibroid tumours will lead to better therapeutic treatments.

In contrast to other areas of tumour biology, the number of published studies reporting whole-genome or whole-exome deep sequencing of leiomyomas is relatively few. These studies have confirmed the high prevalence of MED12 mutations in leiomyomas and have also confirmed aberrations in HMGA2 and TSC2. However, the populations studied appear to have limited diversity, and the data sets from most of these papers are not freely available to the scientific community, leaving a significant gap in our understanding of the genetic and molecular underpinnings of this disease. Thus there is a critical need to provide better insight into leiomyoma biology through the identification of

previously unknown genes whose altered expression and function may contribute to the initiation and growth of leiomyoma tumours. This includes investigating the potential role of viruses in leiomyoma pathology, by using RNAseq methods to detect actively transcribed viral genes.

“By age 50, nearly 70% of Caucasian women and more than 80% of African-American women bear at least one fibroid and 15 to 30% of these women develop severe symptoms.”

The Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) has established the Gynaecologic Health and Disease Branch whose focus is on gynaecological diseases and women's reproductive health. One of the priority areas for NICHD is uterine fibroids and there have recently been funding announcements for proposals focusing on gene sequencing studies and on new therapeutic approaches to treat fibroids. The next 3-5 years will likely lead to major advances in the treatment of uterine fibroids as a result of these studies.

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CATCH-IT: helping to prevent depression and mental illness

University of Illinois' Dr. Benjamin Van Voorhees explains how the CATCH-IT intervention is fighting against depression using a behavioural vaccine approach

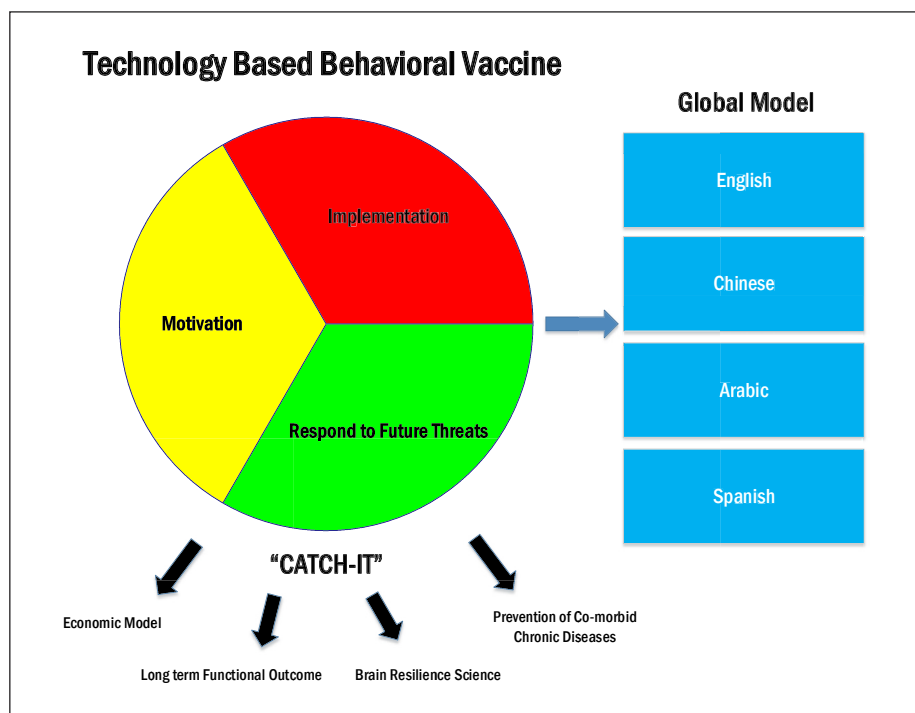
In 2009, the Institute of Medicine declared that the National Institutes of Health (NIH) should establish a comprehensive 10-year plan for prevention and promotion research.¹ One year later, the Patient Protection and Affordable Care Act of 2010 listed prevention – particularly in the context of primary care – as a key element in its plan to improve health outcomes and reduce total health care costs.

Innovations in preventive care may result in decreases in health care expenditures and increases in the proportion of the target audience reached². Online interventions are one such innovation that also provide the opportunity to facilitate health care in a stigmatised area: mental health.³

“Our eventual goal is conduct a global clinical trial using English, Chinese, Spanish, and Arab versions of CATCH-IT to determine if this technology-based behavioural vaccine could potentially reduce the worldwide, life course burden of major depression.”

CATCH-IT

The NIH estimates that in any given year the prevalence of mental, emotional, and behavioural problems among adolescents is between 14 and 20%¹. There are disparities in access to mental health care within this population. To address the dearth of prevention interventions for adolescents and their mental health, Dr Benjamin Van Voorhees MD, MPH, and Dr Tracy



Gladstone, PhD, are completing a phase 3 randomised control trial, funded by the National Institutes of Mental Health (NIMH), to evaluate a behavioural vaccine for adolescent depression prevention.

Drs Van Voorhees and Gladstone developed a primary care internet-based depression prevention intervention, Competent Adulthood Transition with Cognitive Behavioural Humanistic and Interpersonal Training (CATCH-IT), to evaluate a self-guided, online approach to depression prevention.⁴ The CATCH-IT website involves a series of modules developed using the therapeutic modalities of interpersonal therapy, cognitive behavioural therapy, the resiliency model, and behavioural activation.⁵ CATCH-IT has demon-

strated evidence for efficacy in preventing depression in adolescents in phase 1 and 2 clinical trials⁶, with a large phase 3 clinical trial ongoing.

This approach targets youth at risk for a major mental disorder with what we call a behavioural vaccine. There are 4 key components of Behavioural Vaccine Model: 1) Life-course schedule, which is theory-driven and includes booster doses; 2) effective components (information and training to encode responses to future threats); 3) Motivational framework to boost response to behaviour prescription; and 4) Structured implementation strategy. The dose in this context, is the amount of time spent on the CATCH-IT website, the number of characters typed, and the number of

modules completed. A booster dose would be attained when an adolescent, in order to maintain the effects of the original dose, returned to and completed modules again that had previously been effective.

The behavioural vaccine intervention of CATCH-IT is staged to be implemented globally and is proving to be acceptable culturally with changes that are sensitive to the youth of a specific culture. It is important to maintain core general application elements, such as cognitive behavioural therapy techniques. However, at a relatively low cost, expert consultation, focus group, and user testing can be used to complete the cultural translations.

We have chosen Chinese, African American, Latin American, and Arab youth as the first audiences for our culturally adapted versions of CATCH-IT⁷⁻⁹. A Chinese version of CATCH-IT, *Grasp the Opportunity*, has been developed and a successful trial in Hong Kong has been completed. Adolescents randomised to the *Grasp the Opportunity* arm demonstrated lower levels of depression one year after enrolment, compared to those in a control group.¹⁰⁻¹¹ We developed CURB (Chicago Urban Resiliency Building), which was adapted specifically for urban African American and Latino youth.¹² As a cultural adaptation, CURB included a full translation of the parent component to Spanish. We are refining CURB with focus group data to further refine the intervention with more cultural changes. We are planning a Spanish language version of CATCH-IT, which will in part be based on our results from CURB. Further, CATCH-IT is poised to be translated for Arab youth. This program integrates

CATCH-IT within the familial and cultural context of the Middle East.¹³

Online interventions for adolescents with symptoms of pre-depression have the possibility of preventing the onset of major depressive disorder. CATCH-IT has had success in its early phases and we believe it can be adapted to successfully treat culturally diverse populations. Our eventual goal is to conduct a global clinical trial using English, Chinese, Spanish, and Arab versions of CATCH-IT to determine if this technology-based behavioural vaccine could potentially reduce the worldwide, life course burden of major depression.

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HIV and sexual health services require a long-term strategy

The future of HIV and sexual health services is far from certain, says Debbie Laycock, Head of Policy and Parliamentary Affairs at Terrence Higgins Trust

Last month we welcomed the news that the ring-fence on local authority public health spending will thankfully remain in place until 2019.

Last week during a parliamentary debate on HIV, Minister for Public Health Nicola Blackwood MP reiterated her decision to extend the local authority public health ring fence for an additional year. One of the reasons the Minister gave for the extension was the need to see “how we look at transparency and accountability in public health spending”. We agree. We need to get this transition right. As it currently stands, after 2019, the future of vital HIV and sexual health services remains uncertain.

2017 started off positively for those of us that work in the sexual health sector. News continued to come through that some areas of London had started to see a huge reduction in new diagnoses of HIV in men who have sex with men – up to 40% reduction in some areas.

Then in March, after a long battle fought by Terrence Higgins Trust, other charities, teachers and young people, the government finally agreed that all young people should receive Relationships and Sex Education – an essential public health intervention. We are also expecting the large-scale trial of the highly-effective new HIV prevention drug PrEP (pre-exposure prophylaxis) to start imminently. Finally. The pieces of the HIV and sexual health prevention puzzle are coming together – and local authorities have been a key partner in making this happen.

Yet it's not over. We must not lose these gains we have all fought so hard to achieve. HIV rates in other at-risk populations and in areas outside London haven't seen significant reductions in new HIV diagnoses, and rates



Debbie Laycock, Head of Policy and Parliamentary Affairs

of sexually transmitted infections including gonorrhoea and syphilis continue to soar. A recent [Kings Fund report](#) showed that the number of new attendances in genito-urinary medicine (GUM) clinics has increased by nearly a third between 2011 and 2015.

Yet the same Kings Fund report indicated that one in 4 local authorities reduced GUM spending by more than 20% between 2013/14 and 2015/16, with budgets for 2016/17 showing that cuts are set to deepen as spending on GUM will reduce by 7%.

The Kings Fund also found cuts to sexual health prevention, promotion and outreach services aimed at high risk groups – reductions in funding of 14.6% between 2013/14 and 2015/16. A recent National AIDS Trust report highlighted a similar trend – HIV support services had seen a 28% decrease in expenditure between 15/16 and 16/17.



Joint responsibility

Local authorities, alongside the NHS, charities and community groups, have a key role to play in continuing to address HIV and poor sexual health. There is a joint responsibility – as HIV charities and community members we need to clearly make the case as to why it is vital that investment is needed in HIV and sexual health services and the positive patient outcomes that are delivered as a result. Some local authorities, in the face of continued funding cuts from central government, are investing, innovating and collaborating to provide sustainable, reliable sexual health services. This investment can't stop now.

That's why we welcome the extension of the public health ring fence. In April 2019 when this expires, we – the local communities and the organisations supporting people affected by HIV and poor sexual health, need to ensure that it is clear how we can support and,

where needed, hold to account local authorities for the degree to which they are meeting the sexual health needs of their local population.

It is good news that the ring-fenced public health budget is protected for another year. But the question remains – what happens next? The future of HIV and sexual health services is far from certain, and it is clear that sexual health needs will continue long after the 'sell by date' of the public health ring fence has expired. ■

Debbie Laycock
Head of Policy and Parliamentary Affairs

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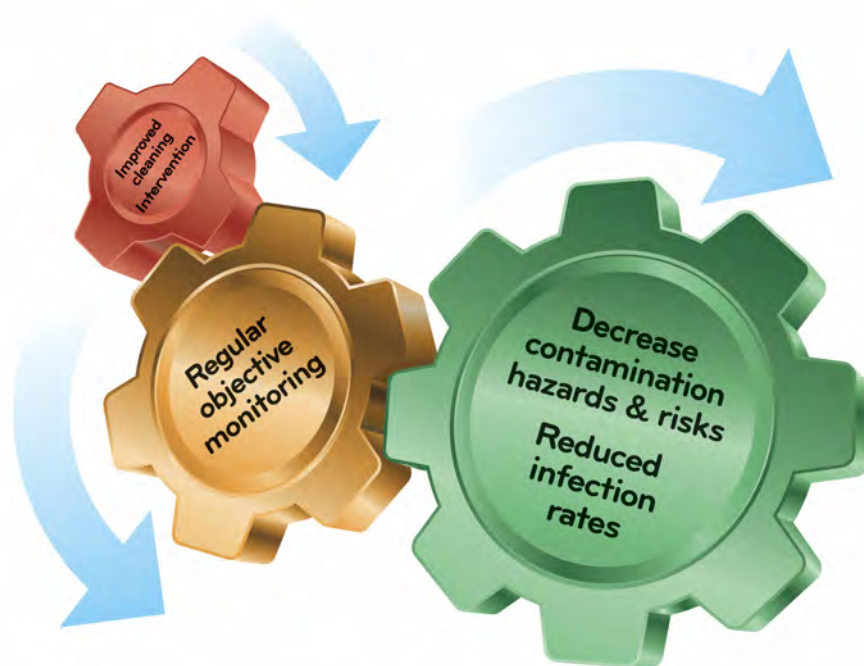
Hand hygiene and beyond: Its influence on infection control

Infection control relies on good hand hygiene practices. Martin Easter, General Manager, Hygiena International Ltd explains why it is so important

The importance of hand hygiene in the healthcare environment is a well-known fact. Each square cm of skin contains approximately 1500 bacteria. Proper hand hygiene disrupts the transfer of germs and microorganisms to and from patients, healthcare workers, and environmental surfaces. Hands are the vector for the transmission of contamination and that works both ways.

Hand hygiene reduces pathogen transmission

In the light of the proliferation of antibiotic multi-drug resistance, the World Health Organization (WHO) launched a global campaign in 2009 on hand hygiene and has subsequently shown that improving and implementing hand hygiene practices can reduce pathogen transmission in healthcare by 50%. In England the MRSA rate declined by 56% over a 4 year period as a result of a £120 million investment in cleaning and other improvement measures. Yet, the WHO reports the average rate of hand-hygiene compliance in healthcare personnel is still only 38.7%. Since 2011, financial restrictions and cuts to cleaning services are simultaneously associated with a 20% increase in infection rates, particularly MSSA and E. coli. Research also shows that MRSA infection rates are 50% higher in hospitals that outsource cleaning contracts, compared to those that keeping cleaning services in-house. However, implementing change requires engagement and an objective measurement system.



"Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it." (H James Harrington)

The introduction of simple modern technology have driven significant changes at the Mater Private hospital in Ireland. This stems from behavioural research that shows "individual experience is of greater importance than formal education in explaining hand hygiene behaviour". Ann Higgins has shown that compliance rates increase significantly by capturing the imagination and engagement of staff. A baseline audit showed that compliance to hand hygiene procedures was approx-

imately 20%. The introduction of a video training tool and a rapid ATP measurement system not only increase the compliance level but also provided quantifiable level of cleanliness. Over a 2 year period, the pass rate for a high level of cleanliness increased from 50% to 100% and the fail rate decreased from 50% to 0%, but also compliance to an even higher cleanliness level increased from 20% to 87%.

Cleaning of hands or surfaces is a matter of training, the use of the correct material and processes and resources and available time. Since cleaning is time and labour intensive (90% of cost), shortcuts can be taken and cleaning is often a soft target for cost savings. However, cleaning is a fundamental preventative measure in

HOW IT WORKS



the fight against infection and super-bugs. Subjective visual assessment methods have been used historically to measure cleanliness but they are not fit for purpose and only detect gross lapses of practice. Visual assessment gives a “misleading over-estimate of cleaning that undermines infection control strategies” (Jones 2009). Using an objective quantitative method of cleaning verification such as the ATP system enables standards to be set and measured and engages with staff to effect behaviour change. This simple rapid and cost effective method has many uses in healthcare and can be used anywhere that hygiene matters, to save time, money and lives.

Failure costs are high

Cleaning cost the NHS £725m per annum but research shows that only 40% of hospital cleaning policies are delivered in practice, resulting in potential wastage of more than £400m. The NHS Productivity review 2016 showed that a small improvement in cleaning practices alone would save £93m.

The cost of failure is high. A single infection is estimated to cost £5000 – £10,000. The National Patient Safety Association states that there are more than 200,000 slip injuries per annum that result in 26 deaths. It estimates

that the average trust spends £92,000 per annum on slip related injuries.

“Hand Hygiene is arguably our most important life skill. So Teach it well and Teach it often.”

Michael J Blackburn, CEO

The ATP test is simple and easy to use giving a numerical result in 15 seconds. ATP bioluminescence is a simple rapid method for measuring organic soil. It requires a small hand held instrument and an all-in-one sample collection and testing device, and generates giving a numerical result in 15 seconds. The use of ATP bioluminescence for cleaning verification is well established and has also been the highest recommendation by the Rapid Review Panel of the Department of Health and Public Health England in support of the fight against HCAI. The test is also recognised by the CDC in USA and is written into a standard for cleaning in Denmark and Sweden.

Monitoring compliance

Many users and applications testify to the benefit and value of an instant objective test for cleaning verification from infection control training and compliance of hand hygiene, house-keeping and environmental monitoring to sterile service and catering. “ATP gives you a clean hospital,” said Val

Hulme (Team leader Domestic Services). “When you’re doing a deep clean the staff know they are going to be tested but they do everything to a very high standard now. ATP has helped us to achieve that. “When you have a number – like the ATP machine gives you – it’s more objective than subjective. You can’t argue with it. ATP makes the staff competitive. They all want to score five or below. And ideally zero.”

Regular objective monitoring of cleaning increases compliance of cleaning policies from 40% to 82%. This decreases contamination levels, reduces infection rates, maximises the use and value of existing resources thus saving time, money and lives.



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The evolution of malaria drug development

David H Peyton at Portland State University outlines how research has discovered that heme is key to malaria drug development

The loss of the antimalarial drug chloroquine to drug resistance was among the most significant detriments to the antimalarial effort over the last half century. This is in part because chloroquine's target is not a protein – but rather heme, the by-product of haemoglobin digestion by the parasite. This made the evolution of resistance very slow – even in what must be regarded the worst and chaotic of circumstances. Even today's artemisinin combination therapies, that are the current standards of care, require a heme-targeting partner drug for the artemisinin. Many current malaria drug discovery projects are aimed at finding targets other than heme, but these often will usually lead to the evolution of drug resistance much quicker, rather than leading to a new heme-targeted drug.

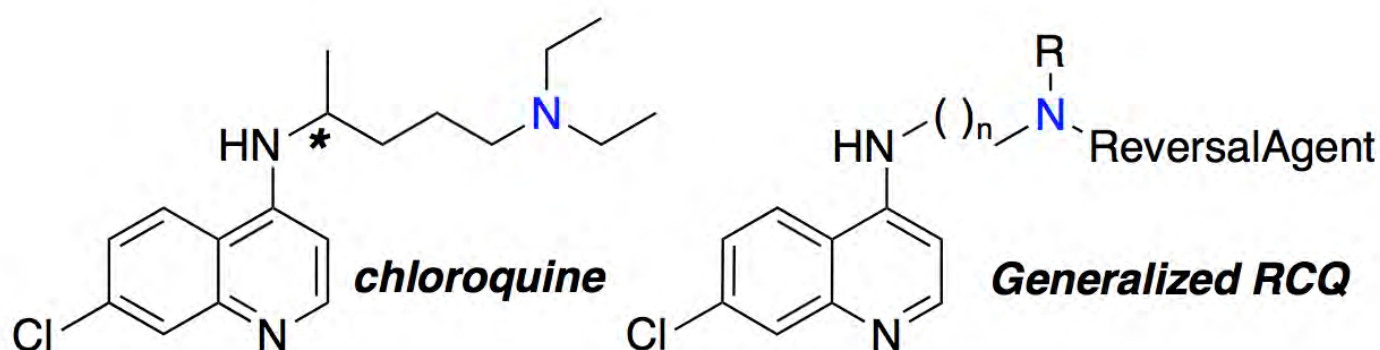
The goal of our work has been to provide a drug superior to what

chloroquine ever was, specifically by appending to the chloroquine structure another portion that inhibits Plasmodium falciparum chloroquine resistance transporter (PfCRT), the primary transporter whose mutation is responsible for the resistance to chloroquine and drugs like it. Exports of the drug from the parasite's digestive vacuole (DV) means that the drug can't build up to a sufficient concentration at the site of action to kill the parasite. The resulting hybrid drugs, including our lead molecule, were designed to be at least as potent and safe as chloroquine and could be less susceptible to the evolution of resistance. This is especially because it has been 'tuned' to have a shorter residence time in the blood at sub-therapeutic dose levels, and because they have never been available as a monotherapy in the regions of the world where malaria is found. Yet these new drugs would be fast-acting,

potent, and very reticent to develop drug resistance. We call these new drugs, reversed chloroquine drugs (RCQ drugs).

“Many current malaria drug discovery projects are aimed at finding targets other than heme, but these often will usually lead to the evolution of drug resistance much quicker, rather than leading to a new heme-targeted drug.”

We tried the approach with a prototype RCQ drug a few years ago and then refined the structures to make a more practical drug in terms of what might make an orally dose-able medicine. We studied the mechanism of action of the RCQ drugs, to make sure that they were still working like chloroquine did, and to show that they were not very susceptible to resistance, both against strains of malaria from patients and evolved in the laboratory. This all gave rise to our



Design of RCQ drugs: The Reversal Agent portion turns off the export of the drug via PfCRT



lead molecule but the time and effort between deciding on a molecule and getting approved for a Phase 1 safety study (first-in-humans) are large, especially for an academic (university) laboratory.

“The goal of our work has been to provide a drug superior to what chloroquine ever was, specifically by appending to the chloroquine structure another portion that inhibits *Plasmodium falciparum* chloroquine resistance transporter (PfCRT), the primary transporter whose mutation is responsible for the resistance to chloroquine and drugs like it.”

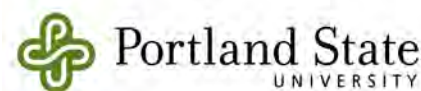
Laboratory tests conducted for malaria drug development

There are also extensive studies required to demonstrate the likelihood of safety (non-poisoning) and a lack of genotoxicity (e.g., not carcinogenic) that are needed before a Phase 1 study is approved by a governing body, such as the Food and Drug Administration (FDA) in the U.S. These

studies must be done under good laboratory practice conditions, which are generally available only from Contract Research Organizations (CROs), and not in-house at the university. In fact, a university researcher generally doesn't even know what tests to do during this process, so consultants need to be hired. For these reasons, and others, I co-founded a start-up company, DesignMedix, Inc., which has the mission of discovering and developing drugs against infectious diseases, especially those which are evolving drug resistance. This began with malaria but now includes bacterial diseases.

We have therefore spent the last few years learning the process of bringing a candidate molecule from “Lead” to Phase 1 candidate. Last week we announced a contract with the National Institutes of Health/NIAID to carry out the Phase 1 first-in-human study. Of course, even a successful conclusion of this study will not be the end of this process: There will be at

least one Phase 2 study that will be needed to be successfully completed, and then it will need to be partnered with another drug (and so, likely, another company) before the Phase 3 study (or studies). The entire process, from the start of the Phase 1 study, will likely be at least another 5 or 6 years before bringing a drug to market. That is if all goes well.



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The transformation of local authority leisure facilities

Over the past decade local authority leisure facilities have revolutionised how they operate. Here, Cheryl Hersey, of Action PR Ltd explains

Local authority leisure facilities are becoming more impressive, in many cases starting to rival those in the private sector. Around 75% of councils have outsourced leisure provision to third party operators – compared with less than 50% 20 years ago – and with it we've seen a rise in standards as they become self-sustaining profit making entities.

Ageing leisure stock is being redeveloped or replaced and it's bringing opportunities for additional revenue streams, a wider variety of facilities as well as more forward thinking or less traditional activities. It's an exciting time for leisure operators and their local authority partners.

The changing landscape

One of the first things you notice upon entering a renovated or newly built leisure centre is the difference in quality compared with a decade ago. From the buildings themselves to how they are fitted and kitted out. When it comes to changing facilities, showers, lockers and gym equipment, there's very little to separate the private and public sector today.

"Many of our centres surpass the private sector in terms of quality of facilities and breadth of offering," says Duncan Jefford, Regional Director for Everyone Active who operate 150 leisure centres across the UK. "It's typical to find a pool, 25m or longer, indoor climbing, gyms with over 100 stations and multifunctional studios. We're also starting to introduce more high end spa facilities and hot yoga studios into our facilities.

"Service is an area which allows us to create a point of difference from both budget gyms and other local authority leisure operators," continues Jefford. "We have higher colleague ratios and invest more in staff training than our competitors, this represents significant change



from where the local authority sector was 10 or even 5 years ago."

Facility mix is changing in line with activity trends and we're seeing more non-traditional facilities such as indoor climbing, trampolining and even BMX tracks being incorporated into both new builds and renovations.

"More people want to exercise outside which is both a challenge and an opportunity for the leisure sector," says Jefford. "We are viewing our new build and redeveloped leisure centres as community hubs from which you can choose a multitude of workout options, whether that is a gym workout, an outdoor running club or an indoor or outdoor triathlon session, there is something for everyone. This protects revenue while increasing participation, it's win, win."

Investment = profit

Ultimately, local authorities have realised that there is money to be made from investing in leisure. Historically, local authorities paid leisure operators to run their facilities, now forward thinking councils are turning that on its head, investing in facilities and charging the management fee to the operator.



"Ten years ago we were paid a management fee to run every one of our centres, because they lost money," says Jefford. "In 2008 we retained our contract with Spelthorne Borough Council, who after committing to a significant investment in the centre, became one of the first authorities to charge a management fee. Now we pay the local authority in more than 30% of contracts. Investment by a local authority is a smart move. It generates facilities with the potential to make significant profits so they can command a higher management fee from the operator."

The next 10 years

Jefford, who has been in the sector for more than a decade, is seeing more new builds year on year. "Previously, we might have been involved with one new build every couple of years, this year we're involved with 4," he explains. "I predict we will see growth in the number of new leisure centres over the next 10 years as local authorities realise the revenue potential."

Local authorities are asset rich, and with the potential to relocate leisure facilities and build new centres they are in a unique position to free up capital. “We’ll see more land sales generating affordable housing, which in turn will fund the building of more leisure facilities,” says Jefford. “These facilities will likely be built in areas with a lower land value, but will be larger and offer a greater selection of facilities.

“We’ll see leisure centres taking a more holistic approach to fitness and wellness, with centres incorporating relaxation facilities, such as spas, and healthy eating venues, as well as a broad range of activity opportunities. Health and leisure will become more joined up, already we are seeing health services being

commissioned as part of the main operational tender, and this makes total sense as operators have the resource and skills to deliver health services.”

Barnet council are in the process of running a joint procurement for health and leisure services. Ten years from now, Jefford predicts that 95% of local authorities will have contracted out their leisure facilities because they recognise it generates them more revenue. ■

CASE STUDY

Westminster Lodge Leisure Centre

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Health literacy: Developing healthy communities

The University of Applied Sciences in Nordhausen and Pfalzlinikum explain why rural areas have advantages over cities in developing healthy communities

A protection shield that makes you resistant and crisis-proof: resilience is the unshaken belief in the ability to influence and shape one's own life – and that can be learnt. People's health competence and how communities develop it plays an important role in this context.

In daily life, how can I obtain information about what promotes my health, prevents diseases and improves my quality of life as a whole? Am I in a position to form my own opinion and to make my own decisions? The development of health competence is the responsibility of each individual. However, it depends even more on the quality and availability of information about health, on the way it is conveyed and the participation of people in the competence-shaping processes, in their community.

“The common aim is the creation of a resilient Palatinate Region until 2025, in which people help each other to stay healthy and to cope better with crises. Apart from the approach in the local community the initiative also promotes among others, the development of resilience in small and medium-sized companies, as well as in a school setting.”

Indeed, local communities in the rural area have to deal, for example, with a shortage of medical specialists and



hard-to-reach educational and health offers. When developing health competence they have, however, important advantages over cities because of their tight structures: The direct contact to influencers as the mayor, the general physician or school, to neighbours or clubs, strengthens the solidarity among people and, thus, the readiness for common processes of change. Accompanied by local moral concepts, social-environment-related identity is fundamental for resilient communities. These tight structures, often grown

over decades, can be used to develop future-oriented concepts of how people within their community can support each other.

In one of their fields of work the initiative, 'The Palatinate makes itself/you strong – Ways to Resilience', aims to strengthen the local resilience in the more rural Donnersberg district, in Rhineland-Palatinate. In 2017 the citizens will be asked which health-promoting structures they see in their social environment, how they are net-



worked among themselves and how people get involved. From the results of this citizen participation, citizen-oriented offers and development projects for a healthy region shall be derived and implemented.

“In daily life, how can I obtain information about what promotes my health, prevents diseases and improves my quality of life as a whole? Am I in a position to form my own opinion and to make my own decisions? The development of health competence is the responsibility of each individual.”

This interdisciplinary initiative was founded in 2014 by Pfalzlinikum and international project partners – among them universities, communication experts and further service providers for mental health. The common aim is the creation of a resilient Palatinate Region until 2025, in which people

help each other to stay healthy and to cope better with crises. Apart from the approach in the local community the initiative also promotes among others, the development of resilience in small and medium-sized companies, as well as in a school setting.

More information about the projects and contact details for the initiative can be found at: www.resilienz-pfalz.de or info@resilienz-pfalz.de.

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SEND reforms: Planning for education, health and care

Mark Raeburn, Managing Director at Capita One, looks at the steps local authorities are taking as they enter the next phase of SEND reforms

By April 2018, the old-style statements for children and young people with special educational needs and disabilities (SEND) will cease and all cases will be transferred to an education, health and care (EHC) plan.

With just under a year until the deadline, local authorities are considering how best to implement the transition. To renew the focus on the initiative, the government has announced that an additional £40m will be made available to support councils as they move towards the EHC plans.

A tailored plan

The philosophy behind the EHC plan is that it will span the life of a child from birth right through to the age of 25, and will contain all the records relating to the education, health and social care needs of the child, stored in one place.

As a single record, the EHC plan is designed to grow with the child until they reach young adulthood, preparing them for independence and equipping them, if appropriate, for the workplace. As the child's needs change, the plan should ensure that the support they receive stays in line with these needs.

Sharing information

The different teams involved need to be able to work together and share key information efficiently and securely about the child or young person with SEND.

Technology will be key to supporting this. Some local authorities are looking to provide a secure, central place for all the different teams in contact with a child to record and store relevant data. This might include details of previous assessments, information from the child's school or college or notes from meetings with the child, their parents or carers.



quickly and easily, at a time that's convenient to them.

Parents can also upload information that is relevant to their child's case, and provide evidence to back up an application or to identify a specific need. This approach should reduce the number of telephone and email enquiries from families, as information on the case is held centrally and can be accessed by the various people authorised to see it.

With online access, local authorities can also ask the child or young person to upload their own views into a plan, which is another important element to the EHC plan.

Managing trends

A major advantage of storing data centrally is that local authorities can use this information in the planning and delivery of services. With greater insight into the origins of referrals, it is possible to identify whether these are coming from the families themselves, local health services or schools. Knowing this enables councils to match up service need with service delivery more effectively, and ensure the most appropriate support is put in place where it is needed to help families through the process.

There have been changes to some of the statutory deadlines local authorities need to meet around SEND provision – the timeframes for responding to information requests, for instance. But, with the right tools, on-screen notifications can be set up for practitioners to alert them automatically when deadlines are approaching, and outline what needs to be completed, and when.

There may be both challenges and opportunities in moving children across to EHC plans, but for local authorities, the focus, as always, will be on ensuring that the plans help to ensure timely and effective support is put in place for children with SEND and their families. ■

Mark Raeburn Managing Director

Capita One
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This central store of information can hold key notes and documentation from other professionals too, such as social workers, GPs or education psychologists. This will help to ensure that an EHC plan includes all relevant details about the child so that informed decisions can be made about what support they might require.

Family view

A key feature of the EHC plan is that the views of the child and their family need to be captured and built into decisions about the type and level of support that the child should receive. Storing everything in one place that can be made accessible to parents and carers is an efficient and effective way to enable them to contribute to the evolution of their child's plan.

One way that councils are addressing this is to introduce a secure, online portal which gives parents the opportunity to check on the progress of their child's case,

Healthcare analytics: Best practice from all over the world

David Bolton, Director, Public Sector & Healthcare, Qlik Global Industry Solutions highlights how healthcare analytics vary between countries

In any country, the state of public healthcare will always find itself under intense scrutiny. In recent times, however, it feels like it is under the spotlight even more than usual. Just take a look at the NHS in recent months, whether it's waiting times, ambulance responsiveness or bed shortages – the UK healthcare system is having to cope with these challenges with the added pressure of reduced budgets, an ageing population and increased demand.

While the challenges are great we should be hopeful as there are innovations that are being deployed today that are easing these issues. Technology is playing a large part in this, with data analytics and visualisation helping healthcare organisations deal with some of its greatest challenges; waiting times, clinical variation and moving to a population healthcare approach. We take a look at some of the best examples from the UK, Europe and beyond.

Sahlgrenska, Sweden

Sahlgrenska in Sweden is one of the largest hospitals in Northern Europe, and like many organisations has struggled with clinical variation. However, the use of data analytics has enabled them to make great progress addressing this issue by working on a value based care program which specifically uncovered variation in orthopaedic care. This program has reduced adverse events by 18%, reduced reoperation by 17%, increased the number of surgeries by a staggering 44% and, as a result, reduced waiting time by more than 40 days for hip and knee replacements. This was only possible by engaging clinicians with data, uncovering variations and dispelling widely held myths.

Wrightington, Wigan and Leigh, UK

Wrightington, Wigan and Leigh (WWL) NHS Foundation Trust, like all NHS trusts, is under huge pressure to

decrease A&E waiting times. In a response to this challenge the trust has created an application that provides live A&E intelligence to all staff – doctors, nurses, clinicians and the board, giving a greater understanding of where patients are in their journey through the hospital – improving discharge levels, reducing delays and minimising re-admissions. By putting analytics into the hands of employees at the point of decision and empowering data-driven decisions to be made at all levels, its A&E department has been able to decrease patient waiting times by 30 minutes.

Veiligheidsregio Noord-Holland, Netherlands

Veiligheidsregio Noord-Holland is an aggregated organisation in the Netherlands comprising of the regional fire department, the GHOR (medical assistance), Ambulancezorg (ambulance care) and the Gemeenschappelijke Meldkamer (communal emergency control centre). One key insight showed that the further a citizen lived from a city, the worse the life expectancy forecast would be following a heart attack or stroke. By creating a dashboard and collaborating on data across all 19 communities in the region, the organisation was able to reduce the total time from the first emergency call through to the life-saving operation by up to 20 minutes. Not only does this help save lives but means that the quality of life following the operation is improved as treatment commenced at an earlier stage.

New South Wales, Australia

New South Wales (NSW) Health covers all aspects of public health in New South Wales, Australia, and has been making strides to improve healthcare efficiencies across the region. Using visual analytics, NSW Health are delivering self-service analytics through the ABM Portal to the local health districts. By using and linking up financial, clinical and patient data they are able to



deliver better health services to all, both for short-term treatment, and long-term care.

The Need for a Cultural Shift

It's clear then that fantastic work is being done in pockets. However, what is needed now is greater awareness for these success cases, enabling knowledge sharing and establishing best practice at a national and international level. One of the main challenges is creating a culture of data literacy – the ability to not only read but understand, analyse and work with data – across the healthcare system. The ones that really deliver results are those that have clinicians as key stakeholders in the process and where the data is accessible and relatable to hospital staff from ward to board. That means approaching healthcare analytics from a 360-degree view perspective.

Healthcare analytics: A prescription for change

With this in mind we've outlined the key criteria to help stakeholders create an enterprise-wide, sustainable and progressive environment for analytics:

- A framework to ensure stakeholders properly embed analytics strategy within the wider organisational environment to generate value;
- A value generation checklist outlining the critical factors in building pathways to tangible results;

- Examples of healthcare organisations which have successfully generated value from analytics.

This checklist is based primarily on lessons from the healthcare transformation, improvement and analytics frontlines as we've seen from these examples. However, a one sized approach does not fit all, and the best analytics strategies are those that are aligned to an organisation's specific characteristics, potential and limitations.

The challenges facing healthcare are not going away; in fact they are likely to intensify. But what we have seen is the potential technology can have in not only improving efficiency in the wake of limitations, but also most importantly improving patient care. More should be done to celebrate the great improvements being made across the world, so others can learn from these successes. ■

David Bolton

Director, Public Sector & Healthcare

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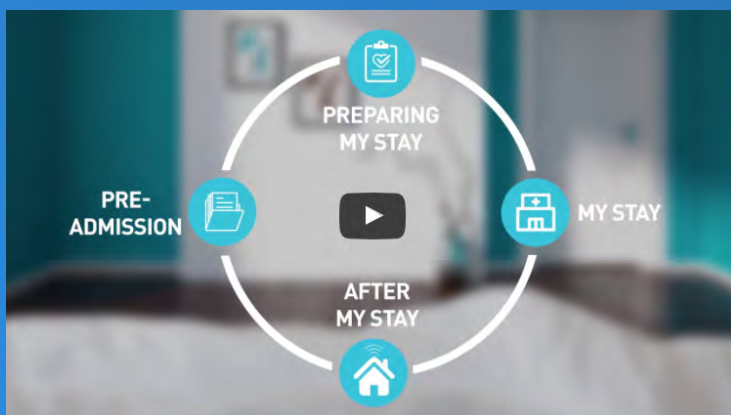


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Space Strategy pushes the boundaries of knowledge in Europe

Maroš Šefčovič, Vice President of the European Commission in charge of the Energy Union, outlines the EU Space Strategy and explains how the sector makes lives better, safer and healthier

Many people immediately associate the field of space to exploration of the unknown, a field which our colleagues at the European Space Agency (ESA) are working on, making us proud and excited with every new discovery.

But space also enables a wide range of technologies which are necessary for many fields of our lives here on Earth. These include fighting climate change; smartening our transport; ensuring safety of critical infrastructure for energy, telecommunications or transport; enabling modern farming; providing disaster response; supporting border and maritime surveillance; monitoring of the ground, sea levels or the atmosphere.

Europe's space industry is doing well, and it has many reasons to be proud; it already captures a third of the global market, employing some 230,000 professionals and with an annual value of approximately €50 billion.

Yet, our ambition does not end here, given the tremendous potential of Europe's space industry in creating more jobs, enabling more disruptive technologies and allowing more satellite-based services. To be perfectly honest, Europe's space industry is also facing new risks and growing competition from new players.

That is why before the end of last year, the Commission presented the first Space Strategy for Europe with a clear shared vision for the years to come. It is the fruit of long discussions with numerous stakeholders and with our partner organisations, like ESA and with Member States' national space agencies.

A strategy for European space

The EU Space Strategy is our way to continue Europe's historic quest 'far and beyond'; far above the skies and beyond Europe's current space capacities. It will ensure



Image: © European Union, 2015 / Source: EC - Audiovisual Service / Photo: Claus Bjørn Larsen

Europe's space industry can serve us humans, boost our economy, and protect our environment.

Take geo-localisation for example. Without us realising it, geo-localisation technologies make some of the most mundane (yet critical) activities possible; from drawing out cash out of an ATM, zapping between (satellite) TV channels, or using GPS navigation when driving. It is also a necessary component of more advanced technologies that are omnipresent in our lives (like interactive maps, shared car services, or location-based technologies).

Thanks to our joint EU efforts, the new generation of geo-localisation just started, as we just launched the initial services of Galileo, the EU Global Satellite Navigation System (GNSS) that provides radio signals for position, navigation and timing purposes.

Galileo, which just became operational in December, is very much like the American GPS but offers a more precise free public service. Once completed in 2020, it will be 10 times more precise than the best geo-localisation signals currently available.

It will shift us from 10 meters to 1 meter precision level! Galileo will also provide services to public authorities and commercial companies that will be even more precise.

Just to mention one recent example - Galileo, Europe's own satellite navigation system (GNSS), will be able to locate the caller of emergency number 112 with much greater accuracy. We have looked into how Galileo can improve caller location using the Advanced Mobile Solutions, through an EU-financed project HELP 112. It was tested in the UK, Lithuania, Italy and parts of Austria.

“The EU Space Strategy is our way to continue Europe’s historic quest ‘far and beyond’; far above the skies and beyond Europe’s current space capacities. It will ensure Europe’s space industry can serve us humans, boost our economy, and protect our environment.”

We also have Copernicus which is a leading provider of Earth observation data across the globe. Copernicus is already helping to save lives at sea, improve our response to natural disasters such as earthquakes, forest fires or floods, and is allowing farmers to better manage their crops – by collecting data from earth observation satellites, as well as ground and sea-bound stations.

2016 was a very exciting year for Europe’s space industry, but we’re not quite done. We have to continue implementing the strategy.

For example, in order to bring Galileo to its full capacity, more satellite launches will be needed. We will therefore see 4 additional satellites launched on a single Ariane5 missile within a few months. In the coming year we will also see 3 launches of Copernicus satellites – the world’s largest single earth observation programme.

A commitment to advancement

The European Commission is committed to ensuring the market uptake of both Copernicus and Galileo, through various means. We will launch 2 networks to help raise awareness about the programmes at regional and local levels. We will co-organise 2 Space



Weeks this year with the 2017 EU Presidencies (in June in Malta and in November in Estonia). We also continue organising competitions for innovative start-ups that use data from Copernicus and Galileo in new, innovative ways. It will furthermore build on this support by launching the Copernicus accelerator and incubation programme, to help start-ups develop ideas into real applications and products.

All in all, the Commission has dedicated some €1.4 billion from the Horizon2020 budget (of 2014-2020), yet we see a very high return on this investment. The benefit for the economy from €1 invested in space is €7 back.

As you can see, space is not only the domain of the unknown and it's not only thousands of kilometres away from our planet. It is about how we make human lives here better, safer, healthier, more convenient, efficient and secure.

For all those reasons, the Commission will continue supporting Europe's space technologies and industries, for the benefit of all our citizens. ■

Maroš Šefčovič

Vice President in charge of the Energy Union

European Commission

https://ec.europa.eu/commission/commissioners/2014-2019/sefcovic_en

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Asteroseismology: It's written in the stars

The power of asteroseismology – what can we learn from the stars? Saskia Hekker from the Max Planck Institute for Solar System Research reveals here

Nearly a century ago Arthur Eddington had the foresight to question “Our telescopes may probe farther and farther into the depths of space; but how can we ever obtain certain knowledge of that which is hidden beneath substantial barriers? What appliance can pierce through the outer layers of a star and test the conditions within?”

The answer is asteroseismology, the study of the internal structure of stars through their intrinsic global oscillations. As with musical instruments, these oscillations resonate in a cavity specific to the “instrument”, i.e. a star in this case. In this way, the oscillations reveal information about the properties of this cavity and thus the star.

It has been long known that stars can show periodic brightness variations that originate from an intrinsic mechanism in a star. In such a mechanism energy flowing from the core to the surface could be trapped in an opaque layer before reaching the surface. This causes the star to expand. Upon expanding the opaque layer becomes more transparent to the energy flow removing the blockade and making the star contract again (Eddington 1926, Aerts et al. 2010). These breathing oscillations of a star change its radius by a few percent in a coherent manner while at the same time changing its surface temperature and brightness.

An early remarkable result from stars

with such breathing oscillations (Cepheids) is a relation between the period of the oscillations and the luminosity (absolute brightness) of the stars, the so-called period-luminosity relation (Leavitt and Pickering, 1912). This relation plays an important role in measuring distances of galaxies and star clusters and ultimately the expansion of the universe.

In the 1960's non-coherent oscillations with low amplitudes (much less than a percent) were first discovered in the Sun. These oscillations are stochastically (i.e. in a random way) excited by the turbulent convection in the outer layers of the Sun. Effectively some of the convective energy is transferred into the energy of global oscillations. This type of oscillations is referred to as solar-like oscillations.

The oscillations detected in the Sun have provided unprecedented detail of the stellar interior. We know now that the Sun rotates as a solid body in its radiative region up to about 0.7 of its total radius. Above this region there is latitudinal differential rotation in the convective layer, i.e. the outer layers of the Sun rotate faster at the equator than at the poles. At the boundary between solid body rotation and differential rotation, there exists a shear layer, the so-called tachocline. This tachocline could play an important role as a dynamo to form large magnetic fields. Additionally, seismology of the Sun was pivotal in the discovery

that neutrinos are not massless and that low energy neutrinos change flavour (Nobel Prize for physics 2015).

Other stars with an outer convection zone also excite solar-like oscillations. Among these are stars similar to the Sun, with similar mass and hydrogen fusing to helium in the core, as well as more evolved stars (the future of our Sun). These evolved stars have exhausted their core from hydrogen and either fuse hydrogen in a shell around an inert helium core, or around a core in which helium fusion takes place. These stars are red (cold at the surface) and large (up to 100 times the Sun) and are referred to as red-giant stars (Hekker and Christensen-Dalsgaard 2017). Over the past decade, dedicated space telescopes have made it feasible to observe solar-like oscillations in red giants, as well as solar-like stars; these observations resulted in an asteroseismic revolution.

It was discovered that red-giant stars are like musical instruments with 2 cavities, having one cavity located in the deep interior of the star and one in the outer layers. The oscillations that resonate in both cavities are so-called mixed oscillation modes and provide a direct means to pierce into the cores of red-giant stars and reveal its properties; for instance, whether the helium in the core is inert, or fusing (e.g. Bedding et al. 2011). The mixed modes also allow for studies of the rotation of the stellar cores and



envelopes. In red giants, the cores are rotating about 10 times faster than the envelopes (e.g. Beck et al. 2012).

Through their sensitivity to the internal structure of the stars, the oscillations combined with surface properties (temperature and chemical composition) can also reveal the stellar mass, radius and age with unprecedented accuracy. Although the ages are dependent on comparisons with stellar models, asteroseismic ages are superior to other age determinations in terms of precision and accuracy.

The power of asteroseismology

The power of asteroseismology reaches farther than the structure and properties of stars. It also impacts significantly on our knowledge of extra-solar planets, the Milky Way and as mentioned before the expansion of the universe. The determination of the planetary properties (mass, radius and age) critically relies on the knowledge of the same properties of the host star. Indeed, it was thanks to asteroseismology that it was possible to detect earth-mass planets in the

habitable zone (e.g. Borucki et al. 2012). Furthermore, stars are a main observable ingredient of the Milky Way and galaxies in general. To understand the formation and evolution of the Milky Way (galactic archaeology) knowledge of stellar properties, and particularly stellar ages are indispensable. With asteroseismology, it now becomes possible to derive stellar masses and ages to an accuracy level that they can indeed be used for galactic archaeology.

To utilise the full extent of the power of asteroseismology it is essential to fully understand all the oscillation features that are present in the data and understand their physical origin. This work is still in its infancy and will require many in-depth asteroseismic studies as the field matures.

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Space



Thales Alenia Space UK (TAS-UK) established in 2014 employs over 170 highly skilled mechanical, electrical and space systems engineers, with sites in Bristol, Harwell and Belfast. TAS-UK is a leader in propulsion systems, mission subsystems and next generation payloads for telecoms, military satellites and UK constellations and is at the forefront of innovation with projects such as Omnisat and Skimsat. TAS-UK contributes to major ESA science programmes such as ExoMars, providing the Rover's Inertial Measurement Unit, the Broadband Radiometer for EarthCare and the Remote Interface Unit for BepiColumbo.

Thales Alenia Space is a joint subsidiary of Thales (67%) and Leonardo (33%), and a partner in the Space Alliance alongside Telespazio. The company has 8,000 employees across 9 countries, posting total revenues over €2.1 billion in 2015.



Advancing space science in Europe requires collaboration

Open Access Government's M F Warrender highlights how the European Space Agency and the EU are working together to drive space science

The European Space Agency (ESA) is seen as Europe's gateway to space, with a mission to shape the development of Europe's space capability. The ESA has a budget of around €5.75 billion for 2017, which is invested into space programmes to deliver benefits to the citizens of Europe and the world.

This is a common aim that the ESA shares with the European Union (EU) and they are working together more and more to achieve this. So much so that some 20% of the funds managed by the ESA, now originate from the EU budget. In more recent years, the 2 institutions have come together and reinforced by the increasing role that space plays in supporting Europe's social, political and economic policies.

A shared vision

In December 2016, the European Space Agency and the European Commission signed a joint statement on the shared vision and goals for Europe in Space, allowing both organisations to work even more closely together to strengthen Europe with the common objective of benefitting its citizens as much as possible. The vision is to foster a future European space sector that maintains Europe's world-class space industry while ensuring that the scientific discoveries of future space programs are fully integrated into European societies and economies.

Further developments in European space activities were also set as a priority on December 2nd by the ESA ministerial Council in Lucerne. A resolution titled "Towards Space 4.0 for a united Space in Europe" was adopted and in this resolution, the member states of the ESA stated that their priority is to make ESA capable of channelling regional, national and European

demands for space programmes. "Using its 50 years of experience in designing and implementing European space programmes across all space domains, ESA is ready to support European states in realising their shared visions."

2016 marks the European Commission's effort to boost this competitive and innovative sector, making the most of space for Europe's society and economy in the form of the Space Strategy for Europe.

"EU space programmes already provide countless services, which benefit millions of people throughout Europe. The European space industry employs over 230 000 professionals and generates a value estimated at EUR 46-54 billion (representing around 21% of the value of the global space sector)."

Vice-President of the European Commission Maroš Šefčovič said: "The European Union is a key player in space policy. We want to build on that and use this leadership role strategically to create jobs and growth and deliver on our common policy priorities: security, climate change, transport, data economy, and management of natural disasters. This requires cooperation with our partners and stakeholders in Europe and internationally."

Space Strategy for Europe

The Space Strategy for Europe clearly states, "The potential of space for Europe and the world is enormous. Europe faces huge global challenges, which require global responses. Europe must contribute to this collective responsibility. No single Member State can do this alone. The EU, alongside its Member States and ESA, must act as a global stakeholder to promote and preserve the use of space for future generations."



The new Space strategy for Europe is focussing on 4 strategic goals:

- Maximising the benefits of space for society and the EU economy;
- Fostering a globally competitive and innovative European Space Sector;
- Reinforcing Europe's autonomy in accessing and using space in a secure and safe environment;
- Strengthening Europe's role as a global actor and promoting international cooperation.

EU space programmes already provide countless services, which benefit millions of people throughout Europe. The European space industry employs over 230 000 professionals and generates a value estimated at EUR 46-54 billion (representing around 21% of the value of the global space sector). Europe is manufacturing a third of the world's satellites. It has achieved

many successes in space with breakthrough technologies and exploration missions. However, the overall international space context is changing fast: competition is increasing, and there are constantly new challenges being brought about alongside new ambitions in space. In order to maintain this global role in Space, Europe must continue to stay ahead of the fast moving industry. ■

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Optimising the communication plan of a basic research project

European-supported project “Darklight” shows how basic research can have an impact at several levels, including the general public, if properly communicated

The relationship between publicly funded basic research and its wider impact on society is important. How this happens in practice is less obvious than in the case of applied research, where the goal of the project is more practical and its results easier to identify. To make an example, the utility of a research project on HIV vaccines is immediately obvious both to specialists and the general public, while that of a project to map the large-scale distribution of galaxies in our Universe or to look for the Higgs Boson is more subtle and indirect, yet possibly equally relevant. Basic research has in general more sophisticated and usually long-term consequences, which require different levels of communication and thus

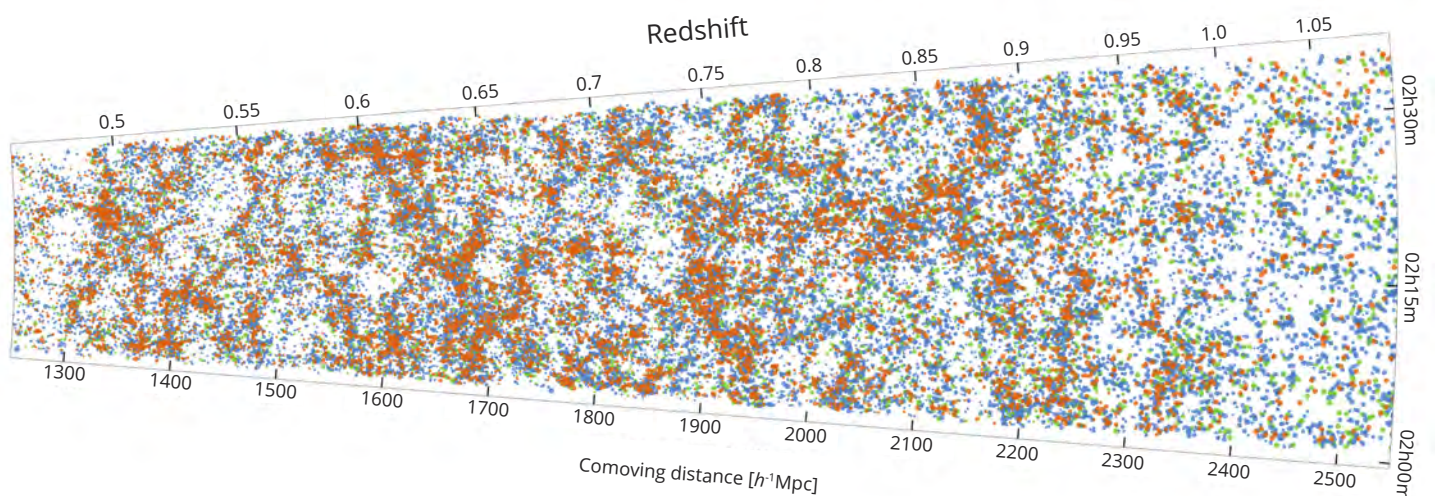
a well thought-out communication plan, to be properly appreciated.

Darklight

“Darklight” is one such endeavour. A 5-year project led by Professor Luigi Guzzo at the University of Milan and the National Institute for Astrophysics in Italy, it is supported by an advanced grant of €1.7m by the European Research Council (ERC). Its aims are to build maps of galaxies to describe the large-scale structure of the Universe and to develop the mathematical tools to interpret them. The final goal is to provide a key contribution to the quest for understanding the nature of the mysterious “dark matter” and “dark energy” that seem to permeate the Universe, i.e. what represent the

current key open questions in cosmology. The plain deliverables are thus not a new vaccine or a new engine or an electronic device, but simply the increase of human knowledge. As such, the communication plan for such a project had to follow different routes, which can be divided into essentially 3 levels.

The first communication level has been internal, i.e. focused on communication within the research group created with this grant. At its peak, the group involved about a dozen people, among staff, postdocs and students. The opportunity of having such a concentration of talent and skills, all focused on the same goals defined by Darklight, was unique. We had to



The large-scale distribution of galaxies in one of the two fields explored by the VIPERS survey. Each point is a galaxy, with its colour reflecting the age of its stellar population (blue = young; red = old) and its size proportional to the galaxy luminosity. The bottom scale gives the distance from us in millions of parsecs; one parsec corresponds to 3.28 light years, thus the centre of this sample, at 2000 Mpc, corresponds to about 6 billion light years from us. Developing the tools to optimally analyse data like these is the subject of the ERC-funded Darklight project. Making people aware of these advancements is also one of the goals of the project (courtesy Ben Granett and the VIPERS collaboration)



Group picture from the 2014 Darklight international meeting held at Sexten (South Tyrol, Italy). The meeting gathered some of the recognised leaders in the field, including a founding father of modern cosmology, Nick Kaiser (University of Hawaii, 5th standing from the right). At his left, John Peacock (University of Edinburgh), another renowned cosmologist with whom the young members of Darklight had the benefit to interact through these small, focused meetings

properly support it, as to maximise its effectiveness. Periodic group meetings, weekly journal club discussions, personal discussions and tutoring were the tools through which these exchanges were fostered. In addition, 2 summer group retreats of a few days were organised during the first 3 years of the project, and a closing meeting will be held near its end in September 2017.

The second communication level addressed the interaction of the group members with fellow scientists, i.e. experts in the specific field of the project, i.e. cosmology. First, an “expert visitor” program was conceived as part of the project since its very beginning, as to feed the young students and fellows through lectures by and discussions with recognised leaders in their field. Second, 2 summer workshops with ~50 participants, obviously

including the full Darklight group, were held on the Italian Alps. These were further occasions for the project members to discuss with the founders and leaders of their research area, learn new concepts, mature new ideas and create ties and connections with other scientists. Both the first and second communication levels had eventually a broader impact in terms of new job opportunities for these young scientists, which indeed arose abundantly.

The third level of communication has been the one towards the general public. This was implemented first of all through a regular activity of public lectures, performed by the project Principal Investigator. Popular articles for both specialised magazines and newspapers were also written, often in connection to press releases presenting the achievement of specific research

milestones. Impact on the wider public was eased by the fascination that cosmology produces on people of all ages, a clear demonstration of how basic research can be of great interest, if properly communicated.

Finally, there are also other subtle ways, yet meaningful, through which the project has been important for society at large. For example, the Darklight group has been an international one, with 2 postdoctoral fellows from the U.S and one each from France, the UK, Japan and Italy. This international presence has been a significant exception in the Italian scenario, in which the brain drain of young scientists towards foreign countries is not adequately compensated by a corresponding incoming flow from abroad. Thus, the European contribution was instrumental to show that when a front-ranked, well-funded project exists, the process can be easily inverted: a great goal achieved by Darklight in particular, a positive message to the Italian society in general.



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The ASI/COSMOS project provides knowledge of the universe

Prof. Nicola Vittorio, of the Università degli Studi di Roma 'Tor Vergata', shares details on the ASI/COSMOS project and how it will advance cosmology

Investigating the physics of the early Universe is the great goal of modern cosmology, which shifted over the years from the discovery to the current precision measurement epoch. The Cosmic Microwave Background-CMB, the first and oldest light emitted when the universe was 380,000 years old, is by far one of the most powerful tools of the experimental cosmology. We observe it today, 13.4 billions of years after the Big Bang, having a unique insight on how the universe was at the beginning and how it evolved with time. Thus, the CMB observations constitutes the natural tool to constrain models of particle physics at energies which will never be reached by laboratory experiments and trace new physics beyond the standard picture. The discovery of the CMB by Penzias and Wilson in 1965 provided the first and strong evidence for the so-called hot Big Bang. Tiny variations in the

mean CMB temperature (or intensity) with the observing directions (the so-called CMB temperature anisotropies) were first detected on large angular scales in the 1992 by the DMR experiment on board of the NASA COBE satellite. This detection provided the first and robust confirmation of the theories describing the formation and the evolution of the large-scale structure of the universe based on the gravitational instability scenario, pioneered in the 1940's by Lifshitz.

The ESA Planck mission (with the Italian leadership of the LFI experiment) has by all practical means exhausted the information content of the CMB temperature anisotropies and definitely established a breakthrough in the comprehension of the current concordance model of cosmology, the so-called Λ CDM model, where only about 5% of the universe constituents

is formed by ordinary matter (protons and neutrons). The other 95% is a combination of what is called dark matter (presumably formed by still unknown weakly interacting massive particles) and dark energy (something conceptually very similar to the cosmological constant introduced by Einstein 100 years ago). In the concordance model, dark matter and dark energy are in a rough proportion of 3:7. Thus, the dynamics of the universe is today dominated by the dark energy, responsible for the presently accelerated expansion of the universe. The very first evidence for such an accelerated expansion was obtained using the supernovae Ia observations by Adam Riess and Samuel Perlmutter at the end of the 1990s, which has been further confirmed by the most recent supernova data and by other low redshift data such as the Baryonic Acoustic Oscillation datasets.

The ASI/COSMOS project

At the beginning of the 1980s, Alan Guth proposed the so-called cosmic inflation to explain why the universe is so smooth on large scales and to resolve some known puzzle of the standard Friedmann models. Cosmic inflation requires an early phase of accelerated expansion and it was at the beginning considered a very interesting but speculative theoretical paradigm. The precise mapping of the CMB temperature anisotropy lent credibility to this scenario and the case for cosmic inflation has strengthened significantly over the years. However, the conclusive evidence for the inflationary theory of the early universe will be provided by a detection of tensor perturbations of the space-time metric, which lead to a primordial gravitational wave background. This background imprints a unique pattern (the so-called B-modes) in the polarisation of CMB photons. Therefore, the primary scientific exploitation of CMB B-mode data aims to a definitive probe of the inflation paradigm and to an estimate of the energy scale at which inflation occurs. Unfortunately, the amplitude of these modes is model dependent. Thus, while the observations of the weak polarised CMB signal (the so-called E-modes) have opened a new channel and a new era in the observations of the polarised microwave sky, the hunt for the elusive B-modes is much trickier and has only started.

This is a very ambitious goal in which the whole Italian CMB community intends to be involved, participating to the main international collaborations of future challenging orbital and sub-orbital experiments. To reach this goal, the Italian Space Agency (ASI) has decided to support this effort by funding the Cosmic Orbital and Sub-orbital Microwave Observations

(COSMOS) project. The goal is to exploit in an integrated and synergic way, all the competences that the Italian CMB community has developed over the years, also thanks to the Planck mission. COSMOS has the following main objectives.

“The Cosmic Microwave Background-CMB, the first and oldest light emitted when the universe was 380,000 years old, is by far one of the most powerful tools of the experimental cosmology.”

First, the study of the scientific potential and technical feasibility of a medium long-term (5-15 years) program to measure the CMB polarisation from sub-orbital platforms, identifying the best observational strategies. Second, to acquire full control of a number of foregrounds: the B-modes from diffuse Galactic foregrounds, in spite of the Planck results, are still far from being detected with the deepest details; gravitational lensing removal is a subject that requires to be further developed and understood if we want to accurately measure B-modes; clusters of galaxies and point source contribution in the observed data set must be also known to high precision.

Third, a coordination at the national level of the ASI balloon based Large-Scale Polarisation Explorer (LSPE) data analysis pipeline that will heavily rely on the use of synthetic data, produced by an instrument simulator, taking into account a sky model, as well as instrument characteristics, performance, calibration, uncertainties and systematic effects. Last but not least, the COSMOS project will provide resources for the formation of a new generation of cosmologists and astrophysicists active in observations, theory and simulation/data analysis activity, which will be able to ensure to

the CMB Italian community the leading international role that it has played up to now. In fact, even if focused on the CMB B-modes, it must be remembered that the observation of the microwave sky is also important for other, not less important, astrophysical problems which are on the frontier of current research, such as clusters of galaxies, lensing, point sources and, the not yet fully explored, CMB spectral distortions.

COSMOS started with the beginning of 2017 and will be financed until the end of 2019. To the project contribute 11 nodes: Università di Roma “Tor Vergata” (coordinating node), Università di Milano, Università di Milano-Bicocca, Scuola Internazionale di Studi Superiori Avanzati (SISSA), Università di Padova, Università di Ferrara, Università di Genova, Università di Roma “Sapienza”, Istituto Nazionale di Fisica Nucleare (INFN-Pisa), Istituto Nazionale di Astrofisica (INAF-Trieste and INAF-Bologna). Each node has the responsibility of coordinating its activity at the national level, monitoring the implementation and delivering of the products. ASI will review the COSMOS results every six months.



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The Danish space sector: A strategy for the future

Peter Mandix Sehestedt, Senior Consultant, Ministry for Higher Education and Science shares why the Danish space sector is important for the economy

Traditionally, the space sector has required huge investments, e.g. in human spaceflight, and has therefore been the preserve of large nations and large organisations with substantial budgets. However, due to the rapid pace of technological change, the exploitation of space is now possible by means of constellations of small and cheap satellites, which allows even small countries like Denmark to participate. The disruption of the old ecosystem is reinforced by new private launcher systems which, so far, seem to be successful in introducing new innovative technologies, e.g. re-useable rockets. These technological breakthroughs happen to coincide with the launch and implementation of 2 new global space systems, which will provide free access to high-quality positioning and data from space: Galileo, Europe's Global Navigation Satellite System (GNSS), and Copernicus, the European system for Earth observation.

Together these events explain why the space sector is becoming an ever more important international catalyst for technological development, as well as for innovation in general and is set to unlock new opportunities for businesses in the economy as a whole. GNSS has already changed the way both businesses and people navigate. The agricultural sector could be the next sector to benefit from an acceleration of the digitalisation of its production activities through the use of space data, for instance in precision farming. But public authorities will also be able to both optimise their working processes and deliver better solutions, e.g. the control and surveillance of traffic in the air or sea.

“To explore the possibility of bringing big data from space closer to the public in Denmark, the strategy recommended a study of the need for a national data hub. The study is now underway and the conclusions will be published later this year.”

The question is, which economies will be the first ones to benefit from what many call New Space?

A space strategy for Denmark

Against the backdrop of this new kind of space race, the Danish National Space Strategy was published in June 2016, as the result of the intensive work of 8 ministries. For the first time, the Danish government acknowledged the important role of space in growing the Danish economy. The Strategy was accompanied by a new study that shined a completely new light on the Danish space sector. Using OECD guidelines for the first time, the study showed that contrary to traditional thinking the Danish space sector is, in fact, 4 times bigger in terms of revenue than first anticipated, but space businesses are also predominantly located downstream in the value chain, in terms of both number of businesses and share of revenue. The report shook the old world view, which



had the public believe that the space sector is dominated by a few businesses exporting technology to be used upstream in the construction of big satellites. The report was seen by the government as evidence in support of the strategic goal of growing a downstream-oriented space sector.

“Together these events explain why the space sector is becoming an ever more important international catalyst for technological development, as well as for innovation in general and is set to unlock new opportunities for businesses in the economy as a whole.”

To achieve this goal the government for the first time provided the political framework for using part of Denmark’s yearly contribution to the European Space Agency (ESA) as a means to actively pursue a national growth agenda. This means that the Danish participation in ESA’s technological support programmes in the future will be awarded only after a national selection, and on the basis of their potential contribution to the Danish economy. On a national level, many of the more than 46 initiatives in the national strategy were targeting a perceived knowledge gap in society and hence, the need for promoting information about space in the rest of the economy. Furthermore, new funding in existing Danish innovation programmes was earmarked to the space sector and in particular, projects that focused on the new opportunities in the use of small satellites and application of free data from large Earth observation systems, such as Copernicus. To explore the possibility of bringing big data from space closer to the public in Denmark, the strategy recommended a study of the need for a national data hub. The study is now underway and the conclusions will be published later this year.

The implementation of the strategy is supported by a formal framework which was put into place in recent years. The responsibility for coordinating space activities was placed under the auspices of the Ministry of

Higher Education and Science by a royal decree on 8 May 2015. Furthermore, the Ministry of Higher Education and Science set up a space division within the Danish Agency for Science and Higher Education. Also, in spring of 2016, the Ministry set up a formalised inter-ministerial cooperation through the establishment of the Inter-Ministerial Space Committee, which is chaired by the Ministry of Higher Education and Science. The Inter-Ministerial Space Committee is composed of the Danish Ministry of Finance, the Ministry of Defence, the Ministry of Environment and Food, the Ministry of Transport and Building and the Ministry of Foreign Affairs of Denmark, which have responsibilities in areas with stakes in the space economy. Finally, the Danish Parliament adopted the Outer Space Act in May 2016.

Will the strategy be successful? In the coming years, the Ministry of Higher Education and Science, together with Statistics Denmark will be adding new questions about the use of space onto 2 existing national IT-surveys covering most of the branches of the Danish Economy, including the Danish farmers. When the first results on use of space systems in the Danish economy are published in October 2017, for the first time we will get the complete picture of the Danish space economy, as well as establishing a firm baseline for determining the actual impact of the strategy going forward. ■

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Nanoscale imaging research: Why is it useful?

The Center for Electron Nanoscopy's Professor Jakob Birkedal Wagner highlights the strides being made in nanoscale imaging research

Following a generous donation from the A. P. Møller and Chastine Mc-Kinney Møller Foundation, the Center for Electron Nanoscopy at the Technical University of Denmark (DTU Cen) was inaugurated in 2007. The center was established as a state-of-the-art electron microscopy (EM) facility with a suite of microscopes housed in a high specification building that only a handful of other labs worldwide could rival. The broad aim of the center is to ensure a balance between advanced research, teaching and training, and fostering collaborations with national and international partners. Now, a decade after the official inauguration of DTU Cen, the center employs 17 researchers (including PhD students and post docs.) as well as 7 technical and administrative staff. Over the years, the activities of the center have been expanding as DTU Cen attracts funding from both Danish and European funding agencies.

Access for academic and industrial scientists to DTU Cen's electron microscopes supports existing research and results in the creation of new research fields and in the sharing of knowledge for the development of materials, processes, technologies, techniques and instrumentation. The list below gives an idea of the broad research areas that the center is currently pursuing:

- In situ characterization of individual nanoparticles under controlled atmosphere;

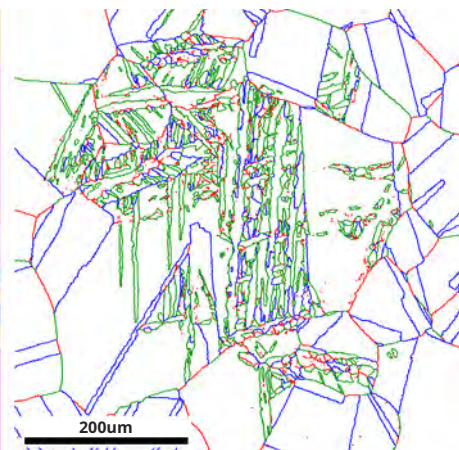
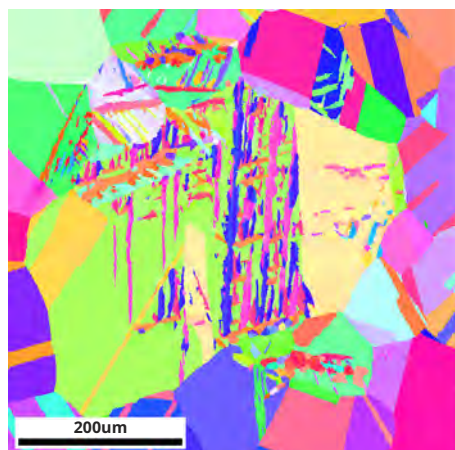


Figure 1: Combined orientation map of ferrite and austenite (left). Misorientation color coded grain boundary map (right)

- Nanostructures for Plasmonic sensing;
- Magnetic materials;
- Pore structures in minerals and soil;
- (pseudo) 1-dimensional semiconductor heterostructures for solar cells;
- Growth of 1D and 2D carbon structures;
- Grain boundary mapping and phase transitions of alloy materials.

What does EM bring to the table?

Nanotechnology has been a hot topic for more than a decade. The extraordinary properties of materials revealed when structures approach the nanometer regime calls for a better understanding of the structure-functionality relationship. Only by establishing a fundamental understanding of such relationships, is it

possible to tailor-make materials and nanostructures for properties not necessarily found in nature.

EM is a versatile tool that can be used to map out the structure and elemental composition of a material from the micrometer scale down to the atomic level. With a spatial resolution in the sub-Ångström regime, it is actually possible to image individual atoms in high-end electron microscopes.

However, even though EM can provide wonderful images of materials at the nano- and micrometer scale, the ultimate goal of EM is not to obtain aesthetically pleasing images, but to advance materials science. This means that EM has to evolve from describing to understanding materials properties.

Considering that the obtainable resolution in an electron microscope has reached well below 0.1 nm, the

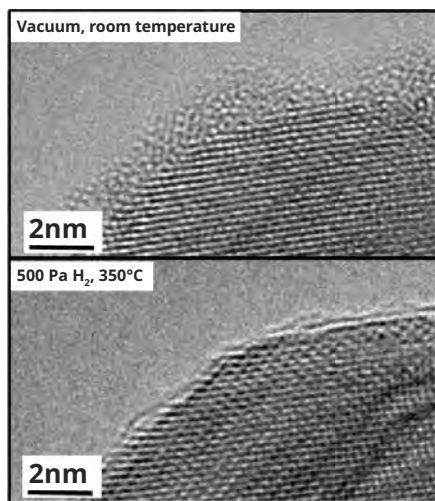


Figure 2: Palladium surface with initial oxide layer imaged in vacuum and the same surface image under reducing conditions at 350°C

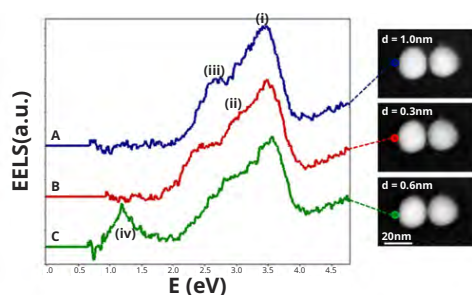


Figure 3: Examples of using electron energy-loss spectroscopy to probe the plasmonic response of Ag dimers with subnanometer gaps

challenge now lies with improving time resolution with high sensitivity. Game-changing developments in high-speed cameras and highly sensitive detectors are creating the platform for making EM an even better analysis tool, especially in so-called in situ EM studies in which the electron microscope is used as an in situ experimental laboratory. The analysis of the dynamical response to stimuli such as heat, gas and liquid exposure, electrical bias, stress, illumination, magnetic fields, etc. are all possible by using in situ EM.

Even though EM is a powerful tool for studying materials it should not be seen as a stand-alone technique, but has to be used in a complementary way with other methods. Further-

more, high-end electron microscopes are usually very specialized in order to push the limits. Thus, a centralized infrastructure like DTU Cen with a broad suite of electron microscopes and the accompanying expertise is more beneficial than having single instruments spread over a wide area. You could consider high-end EM as Formula One; you need a good car (microscope), a good driver (operator/scientist) and a comprehensive support team (technician, materials science collaborators) to achieve outstanding results. If one is missing, you have to settle for the mediocre.

Highlights from DTU Cen

The mechanical properties of materials are strongly related to grain size, grain boundary length and type. Mapping the microstructure in terms of phase and orientation in the way shown in Figure 1 before, after and (ideally) during mechanical treatment or annealing, provides invaluable insight into the relationship between macroscopic mechanical properties and the microstructure. Such insight and fundamental understanding are aids towards creating tailor-made materials for wind-turbines, aircraft parts and other materials used in harsh environments.

Chemical surface reactions, such as those taking place in catalytic processes, are highly dependent on the atomic structure of the active species. The structural aspects of the materials often change with the environment (gas, temperature, etc.). This means that in situ studies are necessary to obtain the real picture of the active material. In Figure 2, a Pd surface is viewed as synthesized and during reduction in hydrogen at elevated temperature. The native oxide layer of the particle is removed and the relevant structure of the surface is revealed.

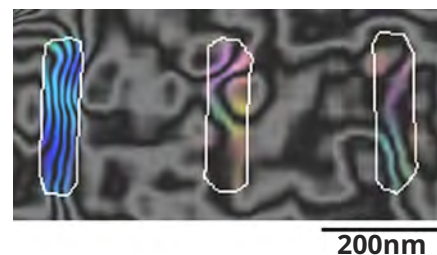


Figure 4: Magnetic induction map of three NiFe/Cu/Co thin-film PSV elements at remanence recorded using electron holography after the application of a 42.4-mT magnetic field. The left element has the parallel magnetic configuration between the two magnetic layers, while the remaining elements have the antiparallel configuration

EM also provides the possibility to map out plasmonic responses via electron energy-loss spectroscopy and magnetic fields by electron holography. Figure 3 shows an example of the spatially resolved plasmonic response probed by swift electrons of gold and silver. Electron holography allows magnetic and electric fields in materials to be studied quantitatively at the nanometer scale. Figure 4 shows in-situ magnetic reversal behaviors of individual pseudo-spin-valve thin-film elements (NiFe/ Cu/Co) after the application of a magnetic field, suggesting a variation of the switching field in the adjacent elements.

DTU Cen Center for Electron Nanoscopy

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The vast potential of European science and research

In a speech, Commissioner Moedas shares how the European Research Council has pushed the boundaries of discovery and helped to develop European science

In the past 2 years at the Commission I have had the privilege of meeting so many of the grantees and to listen to them. And the fact is that somehow they're all different. They are the best in the world but I think that what really amazed me and what differentiates them is not only that they are best. What differentiates them is their being contagious about their passions.

They are great story tellers. They have a way of communicating their project that you do not find anywhere else.

This is an amazing strength for Europe. This is an amazing strength for our collective future.

"In the next 10 years and beyond we will try to bridge the ERC to a future EIC. If we are to overcome the challenges that President Juncker spoke of, we need to reinforce the link between research and innovation. But with each keeping its own distinct identity."

The European Research Council

ERC storytellers are able to make you passionate about things that you don't fully understand. That's mind blowing. Ben Feringa and Jean Pierre Sauvage tell a story about how they created a four-wheel nano-car and how one day these nano-cars would be able to travel into your body and repair cells. You immediately become passionate about it without understanding it. How powerful is that?

This way of storytelling is contagious. This is a unique trait.

It's that unfailing belief that has made the ERC a major European success. And not just for the European project.

In fact, we can even see the ERC reach beyond planet earth!

Michael Gillon, who some of you may have heard of recently, is a perfect example of the success of the ERC. He is the lead researcher behind the SPECULOOS project and the recent discovery of the 7 new planets.

Michael, a Belgian based out of the University of Liege (those of you who have lived in Belgium will appreciate the name SPECULOOS!) is an ERC grantee. I recently had the chance to talk to him. He has an amazing story. And what he said towards the end of our conversation struck me. He said:

The European Research Council believed in our intuition. I think Europe is one of the very few places where you still believe in scientific intuition and the ERC is the real proof of that.

That is what makes the ERC exceptional: its belief in the potential of science.

Its belief in intuition. Its belief that science is at the intersection of different fields.

The problem with this story is that for several days nobody knew it was a European Scientist with European money behind it. The news was: "NASA discovered 7 earth-like Planets". So we have to be more vocal about our stories. We hesitate too much to tell our stories to the broader public.

We are shy about our science.

I am proud that the European Commission took the bold step in 2005 to propose the establishment of the European Research Council as part of the 7th Framework Programme.

At the time, there was strong opposition to this proposal



Carlos Moedas, Commissioner for Research, Science and Innovation

– including from several Member States. After 2 years of tough negotiations – and the vocal support of the scientific community – the ERC was finally agreed upon by the European Parliament and the Member States.

The ERC was a success from day one, and has gone from strength to strength ever since. For Horizon 2020, the Commission proposed a doubling of the budget for the ERC. This was – for the most part – achieved. Following the mid-term review of the EU budget, the Commission proposed an increase in funding for Horizon 2020, including for the ERC.

I am happy to announce today that the Commission plans to increase the budget for the ERC by €50m for the remaining years of Horizon 2020.

Pushing research

In 10 short years the ERC has become a powerhouse of science. It is recognised as the best in the world in the way it supports fundamental research.

But I believe its importance goes beyond science. It shows how the European Union itself can innovate. In

10 years the ERC has consistently demonstrated that it is responsive and understanding of what scientists need. Some of the simplifications that the ERC introduced have now been mainstreamed across all parts of Horizon 2020. Such as the use of lump sums for overhead costs.

As boring as it sounds to give statistics, the numbers for the first 10 years are so impressive that I can't pass them up:

ERC funded projects are responsible for 6 Nobel Prizes, 5 Wolf Prizes and 4 Field Medals.

ERC funded projects have resulted in 100,000 articles being published in scientific journals, including over 5,500 in the 1% most cited scientific journals.

That means that for the first time, Europe has surpassed the US in the number of top 1% most cited scientific publications.

So let's be vocal about it. To be European is to be proud of science.

The strong belief that the Commission and the ERC has in basic science has become contagious. Its model has been recognised as an example of best practice for national funding.

Since the creation of the ERC:

Eight Member States have set up their own national research councils inspired by the ERC model. Eleven Member States have launched funding mechanisms based on ERC funding.

In 10 years, the ERC has not only become a beacon of excellence in science. But it has kick-started a domino effect in this belief throughout Europe, and the world.

We're not just here today to talk about the past successes of the ERC. We have another task. We need to talk about where we see it going in the future.

You may know that European Commission President Juncker recently released the White Paper on the future of Europe. And in it, he took considerable care to point out the challenges we need to overcome.

Science is recognised as a central element of the future of the EU for 2 reasons:

- Because it is the best tool we have to reconnect with people. Science is about creating bridges, about collaboration about understanding others. So we need you in Europe.
- Because it is only with science that we can overcome our biggest challenges such as climate change, our ageing population and even security threats.

As a paradigm of excellence, the ERC should also act as a model for the Future of Europe.

While we are number 1 in science, this is not the case for innovation. So this is why I am working so hard to create a European Innovation Council. To create more impact from European innovation support.

If we are successful with an EIC, I believe this will increase even further the success of the ERC. The ERC Proof of Concept scheme has shown that there are many fantastic ideas for innovation that come from the ERC projects. A future EIC should accelerate the application of these ideas. And scale up the successful applications so they have a real impact on people's lives and wellbeing.

So the EIC will be a complement to the ERC, not a competitor.

In the next 10 years and beyond we will try to bridge the ERC to a future EIC. If we are to overcome the challenges that President Juncker spoke of, we need to reinforce the link between research and innovation. But with each keeping its own distinct identity.

This is very much in keeping with the 3 values I have set out for the new Framework Programme: Excellence; Openness; and Impact.

The ERC is already a beacon of excellence. It is at the forefront of open science and open to the world. And it is having tremendous impact in so many different ways.

I believe the ERC must be a key pillar in an even more ambitious Framework Programme that follows Horizon 2020. ■

This is an edited version of [a speech](#) from Commissioner Moedas.

Carlos Moedas

Commissioner for Research, Science and Innovation

European Commission

https://ec.europa.eu/commission/commissioners/2014-2019/moedas_en

www.twitter.com/Moedas

The SMiNC project: Understanding numerical cognition

Distinguished Professor Avishai Henik provides insight into the research being undertaken into numerical cognition via the ERC-supported SMiNC project

Numerical cognition is essential to many aspects of life and arithmetic abilities predict academic achievements. Acquiring a solid sense of numbers and being able to mentally manipulate numbers are at the heart of this ability. Children with poor numeracy are at a disadvantage in both academic and everyday life situations (e.g., handling money). Adults with poor numeracy are more than twice as likely to be unemployed as those who are numerically competent. Poor numeracy often means low financial proficiency, with negative consequences for economic wellbeing. However, it is also clear that studying arithmetic is not simple and is extremely difficult for those who suffer from specific learning disabilities in arithmetic, henceforth termed developmental dyscalculia (DD).

In recent years, research in numerical cognition has expanded and we have witnessed a flourishing field with research aiming to advance our knowledge, unravelling the building blocks of numerical cognition and its development. Research in the area of numerical cognition has led to a widely accepted view of the existence of innate, domain-specific, core numerical knowledge based on the ability to perceive and manipulate discrete quantities (e.g., enumeration of dots). Moreover, a deficiency in this core knowledge is thought to be the basis for arithmetic disability (i.e. DD). Many believe in the existence of 2 sys-

tems. One system represents large, approximate numerical magnitudes (i.e., the approximate number system, ANS). The second system, devoted to small sets of objects (1-4 objects), is based on the ability to simultaneously track several objects separately, and enables the precise knowledge of the number of objects. However, as is the case in many other research areas, questions and doubts regarding accepted views continuously fuel research and bring up new developments and insights.

Numerical cognition

Much of the research in the area of numerical cognition has targeted numerical abilities and accordingly, employed tasks that involved discrete variables like arrays of dots or revolved around enumeration or estimation of the number of presented dots or objects. In contrast, recent research has turned the spotlight toward non-countable, continuous variables (e.g., how much water is contained in the glass or which glass has more water?). Such research was triggered by various observations like the following: (a) Arrays of items (used to study numerosity – the number of items in an array) are always confounded by various continuous properties like area or density. It is clear that these continuous properties are naturally correlated with numerosities. (b) One such continuous property, size, seems to be a basic property of objects that infants notice early in life.

(c) Symbols that are employed in our mathematical system (e.g., 2, 5) are intimately associated with sizes and other non-countable dimensions (e.g., area, brightness). These observations and research suggested that perception of continuous properties might be important to the development of arithmetic. Accordingly, we suggest that a relatively neglected aspect of performance – the ability to perceive and evaluate sizes or amounts – might be an important foundation of numerical processing. This ability might even constitute a more primitive system that has been used throughout human evolution as the basis for the development of the number sense and numerical abilities.

We devoted effort to study these issues. Our research is carried out at the Cognitive Neuropsychology Laboratory, at Ben-Gurion University of the Negev. It has been supported by a grant from the European Research Council (ERC) for the project titled Size Matters in Numerical Cognition (SMiNC). To convey the flavour of our experimental work, let me give an example of the studies of the relationship between numbers and sizes. One of the first demonstrations of the intimate connection between numbers and sizes was the size congruity effect, or sometimes referred to as the numerical Stroop effect. In experiments designed to examine this effect, participants are presented with 2 digits that differ in both numerical



value and physical size. The pair of digits can be congruent (when the numerically larger digit is also physically larger) or incongruent (when the numerically larger digit is physically smaller). Participants are presented with such pairs of digits and are asked to decide which one is larger physically or numerically. The physical task (i.e., decide which digit is larger physically and ignore the numerical values) and the numerical task (i.e., decide which digit is larger numerically and ignore the physical sizes) are carried out in separate blocks of trials. The size congruity effect is indicated by a slower response to incongruent than to congruent trials and appears both when the physical sizes are relevant and numerical values irrelevant, and vice versa. The effect appears not only with digits but also with number words. Moreover, a similar effect appears with other non-countable dimensions like luminance. Similar effects have been found with objects (e.g., a small violin presented simultaneously with a larger banana). Importantly, we found that participants who

suffer from DD show deficiency in both the numerical size congruity effect, as well as in the object congruity effect.

What are the foundations of numerical processing?

We suggest that routines and neural structures built for size judgments were made available to other systems through evolution, allowing for the development of an exact numerical system. Non-countable representations and the ability to perceive and evaluate sizes or amounts were essential for such development. Note that this fits in with the idea put forward by Piaget that continuous spatial extent serves as the antecedent to a child's concept of discrete numbers. In order to gain a comprehensive picture of numerical cognition, there is a need to study the ability to perceive and evaluate sizes and amounts, and their relationship to the development of the numerical system.

Further Reading

Henik, A. (Ed.). (2016). *Continuous issues in numerical cognition: How many or how much*. New York, NY: Academic Press. A book

that includes chapters that discuss many of the issues raised in the current article.

Henik, A., Glikman, Y., Kallai, A., & Leibovich, T. (2017). Size perception and the foundation of numerical processing. *Current Directions in Psychological Science*, 26, 45-51.

Leibovich, T., Katzin, N., Harel, M., & Henik, A. (2017). From "sense of number" to "sense of magnitude": The role of continuous magnitudes in numerical cognition. *Behavioral & Brain Sciences*. doi:10.1017/S0140525X16000960. A review of literature on contributions of non-countable properties to numerical processing.



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Research
Council

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In situ measurements can offer insight into particulate erosion

Principal Research Scientist Tony Fry discusses using in situ measurements to accelerate the development of material solutions to particulate erosion

The efficiency of high temperature energy generation plant and aero-engines is of critical importance to OEM (original equipment manufacturer) and operators with impact on desirability and operating costs. The efficiency of plant, whether land based or on the wing deteriorates with use and service life. One of the causes of this gradual deterioration is through wear of leading edges in rotating turbo machinery caused by solid particulate erosion at elevated temperatures. This damage process can reduce the efficiency of turbines by as much as 7 to 10%, and in the case of a large power plant, can cause an additional emission of 250,000 tonnes of CO₂ over the lifetime of the plant¹. The cause and type of solid particle erosion varies across different industries and locations in plant, for instance the particles could be volcanic ash in aero-engines, fly ash in boilers, exfoliated scale in steam turbines or mineral matter in oil excavation. In all cases the performance of materials can be improved through better surface engineering and coatings, but the development of these is often restricted due to the lack of generic models, well controlled and instrumented tests and international standards.

New test facility

The National Physical Laboratory (NPL) in Teddington has been working with other national measurement institutes and research bodies across

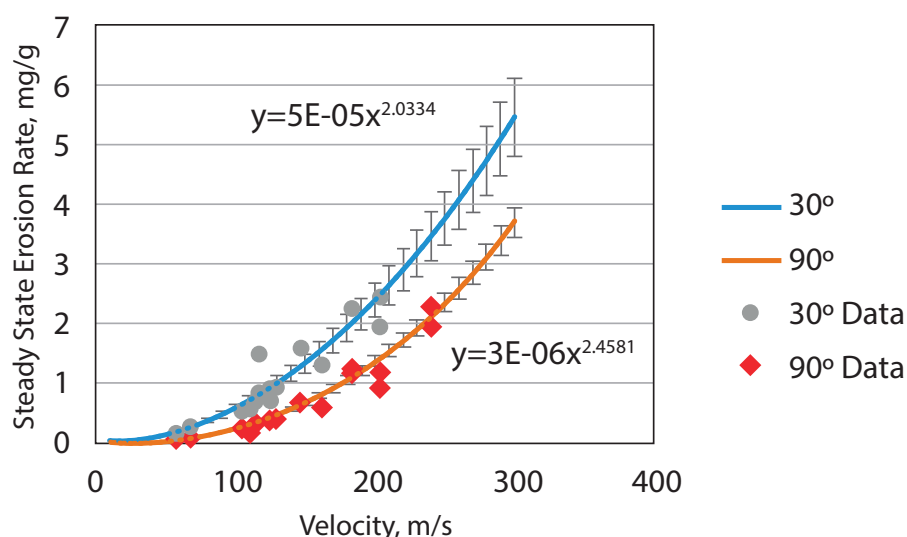


Figure 1 Erosion rate as a function of incident angle for all data collected for Nimonic 80A at 600°C by three laboratories as part of an intercomparison exercise

Europe, to design and build a new test facility. The aim of this being to produce a versatile apparatus with embedded instrumentation to monitor and control the temperature of the gas, sample and particles, to measure and control the gas velocity and to measure the mass change and erosion scar volume in situ during the test. Critically this new test facility includes in situ evaluation of the mass and volume change of the sample and provides a real time measurement of the erosion process, with the added benefit of removing the need to thermally cycle the sample for the ex situ mass and surface measurements at room temperature. This enables the erosion test to be conducted without interruption, thereby allowing the test to be completed in a matter of hours,

as opposed to a number of days. This new system has been designed to carry out experiments at temperatures up to 900°C and particle velocities up to 300 ms⁻¹.

To validate the in situ mass measurement against conventional ex situ measurements a small inter-comparison exercise was conducted as part of the METROSION project². Results from tests performed on Nimonic 80A by the 3 participating laboratories at 600°C using different stand-off distances and acceleration lengths are shown in Figure 1, which presents data collected at 2 incident angles over a range of particle velocities. The error bars represent the standard deviation in the data provided by the 3 laboratories. This shows that the

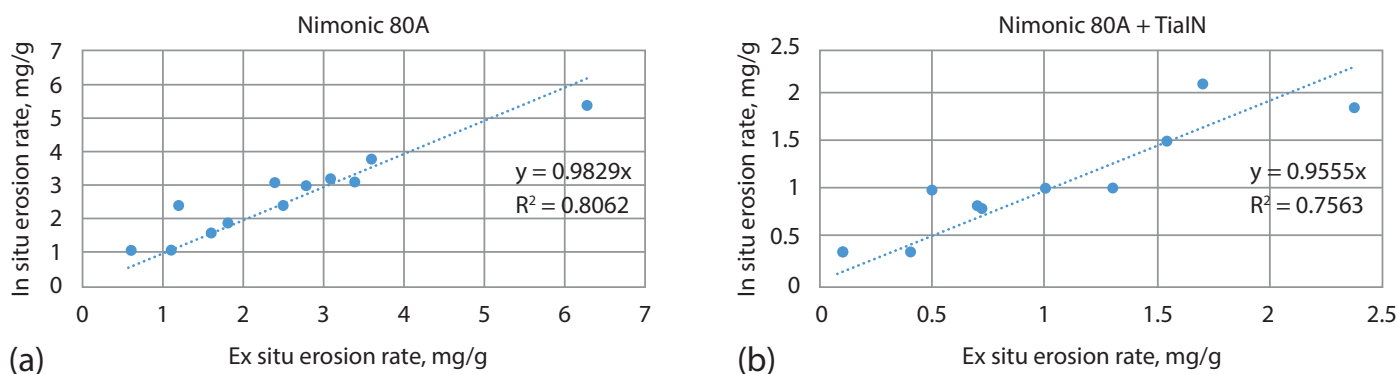


Figure 2 Comparison between the ex situ and in situ erosion rates measured for two sets of samples, (a) uncoated Nimonic 80A, (b) Nimonic 80A coated with TiAlN

erosion rate from the 3 laboratories fall on the same curve for the different test conditions, providing confidence in the data generated from the in situ measurements compared to the ex situ measurements which were conventionally made. This figure also illustrates the influence of the incident angle on the erosion rate, where the erosion rate is lower at the higher incident angle.

Further tests have been conducted to measure the erosion performance for a range of hard coatings. In each case HTSPE tests were performed at 600°C using 2 velocities of 117 and 140 ms⁻¹ with a stand-off distance of 50mm and incident angles of 30° and 90°. In situ mass measurements were made during the testing. Ex situ data were also obtained after the completion of the tests. Figure 2 shows typical results for uncoated Nimonic 80A and for samples coated with TiAlN, plotting the erosion rates obtained from in situ mass measurements, compared to those calculated from the ex situ mass measurements. For both sets of samples, the slope of the line is close to one indicating that the in situ and ex situ mass measurements agree.

In the uncoated sample, the maximum erosion rate was approximately 6mg/g. The application of a TiAlN coating to the Nimonic 80A substrate has provided protection against HTSPE, reducing the maximum erosion rate to approximately 2mg/g.

It has been demonstrated that this new mass measurement method works well and that it has many benefits over conventional methods. Not only does this new approach allow for the real time evaluation of the erosion rate during testing but it avoids additional errors from thermally cycling the sample and errors in repositioning the sample during room temperature ex situ mass measurements. This approach has the added benefit of decreasing the time needed to conduct a test, from several days to 90 minutes, which in material development provides time and cost savings.

This new erosion test facility adds to the range of tribological measurements NPL can offer industry in the assessment and measurement of material performance. For further information about this EURAMET project, or the range of surface engi-

neering tests and characterisation methods available please contact the Advanced Materials Characterisation group at NPL.

- 1 K. J. Stein, B. S. Schorr and A. R. Marder, "Erosion of thermal spray MCr-Cr-C cermet coatings," *Wear*, vol. 224, pp. 153-159, 1999.
- 2 Influence of Apparatus Design and Test Method on the High Temperature Solid Particle Erosion of Nimonic 80A. Fry, A T, et al. Albufeira, Portugal : s.n., 2016. Advance in Materials Technology for Fossil Power Plants.



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Cryogenic technologies for precision tactical and space applications

Peter Iredale, Engineering Lead at Honeywell Hymatic

Honeywell Hymatic has been at the forefront of cooling technology for infrared and sensing applications for over 50 years. Operating in some of the most demanding environments, Honeywell technology increases reliability and efficiency, whilst enabling missiles, satellites, fighting vehicles, underwater weapons and submarines to more effectively and accurately complete their missions.

Through our expertise in Joule-Thomson cryogenic coolers, linear Stirling cycle cryocoolers and compressors and extensive knowledge of long life stored energy technologies, Honeywell offers customers an integrated solution for their cooling requirements. From our dedicated cryogenic facility, we provide a bespoke manufacturing service and a responsive aftercare infrastructure to support through the lifecycle of the product.

Joule-Thomson Cryogenic Coolers and Stored Energy Gas Systems

Joule-Thomson (J-T) coolers remain the simplest, lightest and easiest technology for cryogenic cooling across a wide range of IR sensor applications, employed in numerous global missile programmes such as, Javelin, StormShadow and ASRAAM. They provide rapid, accurate cooling, within tight space envelopes.

We offer a variety of J-T coolers that can optimise gas consumption, resulting



Joule-Thomson Cryogenic Coolers and Stored Energy Gas Systems

in more efficient operation. Complementary to this are our stored energy products that provide fuel for the J-T coolers and can utilise a variety of gas species, dependant on requirement, throughout their typically extensive 25 year life cycle. These gas systems can often include various gas management ancillaries that control flow rates under varying ambient pressures (altitudes), temperatures and other complex environmental requirements often akin to tactical/airborne applications.

What this ultimately provides is a complete solution for cooling, gas supply and management of gases for the intended application regardless of the environmental complexities customers are often faced with.

Linear Stirling cycle cryocoolers

Designed for use in high duty applications for continuous use as a replacement for legacy cooling systems, the Linear Cryocooler offers a significantly



extended life and enhanced levels of performance.

Honeywell's Linear Cryocoolers incorporate unique, patented technology from the development and industrialisation of an Oxford University design concept. This patented technology, born out of the need for extremely high reliability for space applications, offers superior durability to traditional tactical Linear Cryocoolers.

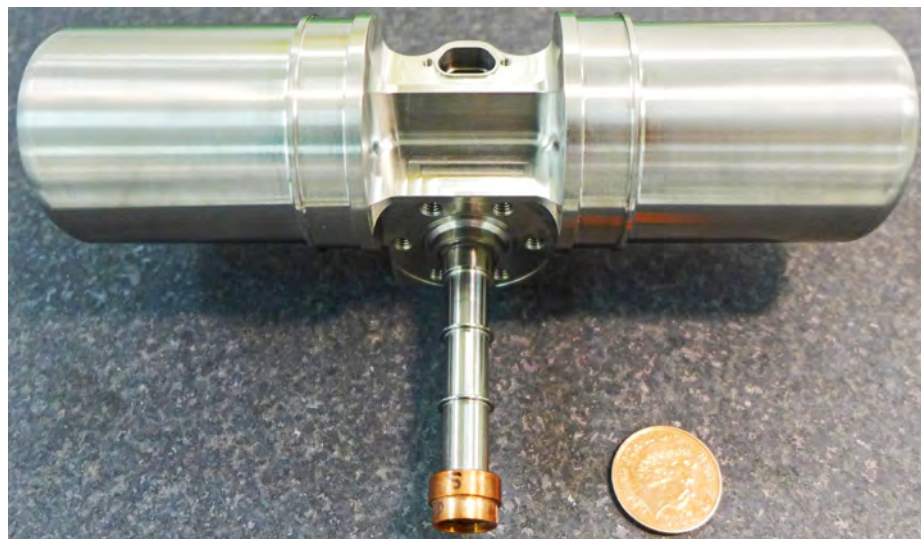
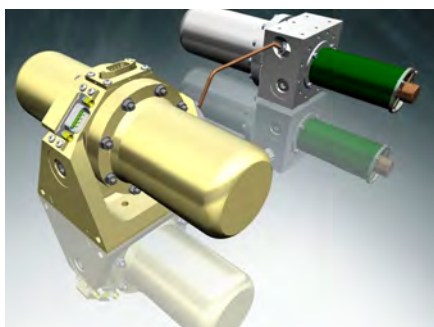
Designed to 'fit and forget' standards, the system uses a non-contact dynamic sealing of the internal working gas, coupled with a high reliability linear electric drive, which has been proven to deliver over 120,000 hours of constant, maintenance-free operation.

Due to their durability, reliability and military-grade performance, 85% of US long life flexure bearing Linear Cryocoolers in orbit on satellites today contain Honeywell Hymatic hardware. Other potential applications include:

- Extended operation cryogenic sensor cooling requirements;
- High efficiency compressors for space applications;
- High reliability/durability sensor cooling – radio isotope detection systems;
- Power generation for forward outposts.

Future developments and forging relationships

Under a General Support Technology Program (GSTP), funding from the European Space Agency (ESA), a consortium of Honeywell Hymatic, Rutherford Appleton Laboratory (RAL) and Thales Alenia Space UK are now working on the next generation of long life Linear Space Cryocoolers for Europe. Cryocoolers such as these are critical to future Earth observation missions where the need for high resolution IR sensing needs to be balanced carefully against the satellite payload size, weight and efficiency. ESA identified the need to push technology of Cryocoolers with respect to size, weight and efficiency after benchmarking US Space Cryocoolers as world leading, including those supplied by Honeywell. The program, currently at its mid-point of a 3 year schedule, promises to deliver engineering qualified units to ESA that will be market leading within Europe, with respect to low mass/size and high efficiency, whilst maintaining the long life heritage required for said applications.



Our relationship with RAL is yielding further development of products for tactical/commercial applications. The Cryogenics team at RAL has a long established heritage in the field of long life Space Cryocoolers, working with ESA and the UK Space Agency. Recently RAL have been developing a Small Scale Cryocooler for use in miniature space satellites, pushing the space envelope ever smaller. Honeywell Hymatic, seeing an opportunity with this design, has taken the technology and is applying our manufacturing techniques to ensure a version can be produced for tactical and commercial IR applications without the high costs traditionally associated with space applications. However this does present an opportunity for space applications in the respect that a Cryocooler may be taken from a standard production run, and with a minimal increase in testing and quality control, supplied to a space customer for a much reduced cost over traditional Space Cryocoolers. The key with this philosophy is sustainability of source product and their manufacturers. The space market represents very low quantities of product per annum, whereas the volumes for tactical/commercial coolers are far greater and often the technology cannot read from one

to the other. This is a dichotomy that Honeywell Hymatic is working to break with the Small Scale Cooler.

Honeywell Hymatic employs a dedicated team of specialised engineers and technicians with a combined experience of more than 300 years in cryogenic products. We continue to invest in developing leading-edge technology, working in partnership with our customers, to offer effective solutions based on our mission proven expertise.

For more information on our full product range, please visit our website: <https://Aerospace.honeywell.com/cryogenic-cooling>

To speak to one of our sales or engineering team, please feel free to contact us on the details below.

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Attracting talented researchers remains a focus of the SNSF

Open Access Government highlights how the SNSF is supporting science in Switzerland while attracting talented researchers into the field

The Swiss National Science Foundation (SNSF) was established in 1952 and is mandated by the federal government. Supporting basic sciences across all academic disciplines, the SNSF is Switzerland's key research funding organisation. The organisation finances over 3,200 projects involving 14,800 researchers each year.

The SNSF sees knowledge as the key to the future and with this research creates knowledge. The Foundation defines its ambitions and values informing its work: Quality, Independence, Reliability, and Fairness.

Recruiting talented researchers

One of the key areas of concern for the SNSF is encouraging young talent into the area of research. The SNSF supports over 4,000 doctoral students and around 2,500 postdocs through their projects and programmes, every year.

In their 2013-2016 Action Plan, the SNSF outlines the importance of ensuring the emergence of the next generation of researchers, and says:

"In Switzerland, careers in academia are filled with uncertainties which, particularly for Swiss researchers, reduce their appeal in relation to other career opportunities. Encouraging young talents to consider a career in research is therefore the uppermost priority of the SNSF.

"Supporting measures for project collaborators, redesigned mobility fellowships and doctoral programme in the humanities and social sciences are expected to create opportunities for young researchers at key stages in their careers."

The Plan says: "Switzerland is a highly successful and attractive research location with excellent research

groups working to the highest international standards, offering good infrastructure, well above-average salaries and a high-quality of life.

"The large proportion of researchers from abroad is evidence of the fact that in the international battle for the best talents, Switzerland occupies a good starting position. Both its institutions of higher education and its funding organisations are called upon to ensure optimal framework conditions so as to continue to attract the most innovative researchers, increase the number of home-grown talents willing to pursue an academic career and be able to secure Switzerland's position as a top research location in the long term."

Flexible research

Another priority area for the SNSF was to offer flexible research to scientists in their quest for excellence.

"The pace, scope and impacts of scientific discovery in research are increasing at a tremendous speed. Today, new methods of investigation and technologies building on years of basic research are enabling researchers to tackle problems and issues that are significantly more complex than those encountered only 10 years ago.

"The goal of the SNSF is to support individual performance by offering flexible funding options for all disciplines and types of research and by working to ensure good framework conditions for international co-operation and mobility, participation in national and international collaborative projects and programmes, and access to infrastructure." ■

Open Access Government
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Boosting innovation in the wood technology sector

A multidisciplinary approach is necessary to stimulate the wood technology sector, says Professor Frédéric Pichelin, of Bern University of Applied Sciences

Focusing on the sustainable use of our resources, wood is one of the best materials to develop multi-functional wood and composite materials, as well as innovative products for the timber and construction industries.

A successful product development goes through an interdisciplinary approach covering different disciplines as product design, material sciences, bonding technology or material testing.

“The wood industry is entering a new generation of production processes. Through digitalisation, machine will be connected and able to produce more complicated pieces and composite materials.”

This approach has been successfully tested in our research institute, where the extensive knowledge of our collaborators on wood and other renewable materials enables us to find innovative ways of using these materials.

Five core competencies for a successful material development

Material science and design

Developing new materials and products calls for creativity, technical know-how, and a thorough grasp of economics and ecology. Based on these competencies, our Institute develops solutions for the development of wood-based materials and, together with our business partners, put them into practice. We give

careful consideration to a holistic view of the development process from raw material, the production processes, to the finished product. In parallel, we also carry out life cycle analyses and assess the economics of products and processes.

Wood modification and surface treatments

Our team works on solutions for surface treatment and wood modification for indoor and outdoor environments. Wood anatomy and physical analyses are additional focal points of our work. Furthermore, our applied research looks at ways to develop and optimise new material technologies, coatings, and processes. For example, we developed self-cleaning coatings, UV protection systems for wooden curtain walls, and UV technology to dry coatings. Our basic research efforts are attempting to use biological ingredients to modify wood and thus provide ways to ecologically protect wood.

Bonding technology

Our institute develops and optimises synthetic and natural adhesives for load-bearing and non-load-bearing applications. Important focal points include the substitution of synthetic raw materials with natural polymers, developing low-emission adhesives, and defining the chemical and mechanical characteristics of adhesives. Thanks to our modern laboratory infrastructure, we are in a position to characterise the hardening process

of adhesives and to investigate their adhesive and cohesive characteristics. Our portfolio of projects also includes innovative connection technologies. For example, we have developed the linear friction welding of wood, an innovative connection technology without adhesives.

Analytic and chemical formulation

Our well-equipped chemistry laboratory enables us to carry out projects with an analytical and preparative orientation. The laboratory contains instruments for spectroscopy, equipment for analytical separation processes, devices for various physical and chemical measurements, and enables us to carry out and observe reactions under high pressure. Furthermore, we conduct analytical research, the characterisation of organic materials, the derivatisation of organically-based substances, the modification and functionalisation of surfaces, and the analysis and application of nanoparticles. We have also specialised in the development of LED UV and polymer systems for blue-light hardening that can be used in various applications.

Material emissions and extractives

Our activities focus on the characterisation, the development, and the application of low-emission and odor-free materials and furnishings, as well as on the resulting indoor air quality from



A welded snowboard core without any adhesive

the building construction processes. We also work on thermal insulation and the characterisation of extractives from renewable materials and their uses. Furthermore, we develop procedures for removing biocides applied to cultural assets in the 20th century. Such biocides have been found to be damaging to both health and property.

How can this research approach be transferred in a global context?

During the last few years, the Institute has been working at the international level in a challenging area: the development of bio-based resins for the production of building materials. The composite industry is using a wide range of petroleum-based resins. Depending on the type of resin, the ecological impact of the products can be seriously influenced. Especially in the field of wood-based composites, the mixing of natural fibres with synthetic resins cannot be considered

as a durable solution. The priority of further development should be led on the use of bio-based resins with a low ecological impact and when possible no influence on human health.

“A successful product development goes through an interdisciplinary approach covering different disciplines as product design, material sciences, bonding technology or material testing.”

Merging the competencies of the polymer chemists and wood-based specialists, a new generation of resins based on the use of HMF (5-hydroxymethylfurfural) has been developed. The first test has been successfully carried out at the laboratory scale, showing promising results for the production of particleboards.

More recently, one of our research groups has investigated the potential of bark extract from local European species like Norway spruce. Extracts

from Norway spruce have been used at the laboratory scale for the production of particleboard and plywood. This tannin-based resin has also been mixed with natural fibres for the production of insulating material with very high fire resistance.

Further perspectives

The wood industry is entering a new generation of production processes. Through digitalisation, machine will be connected and able to produce more complicated pieces and composite materials. One example is the use of wood compounds for the 3D printing of small and larger pieces. A fast bonding like the welding of wood will also offer new perspectives in this digital transformation.



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Horizon 2020: What full association means for Swiss research

Philipp Langer, Head of the EU Framework Programmes section, SERI, highlights Switzerland's participation in Horizon 2020 now it has full association

Up until the end of 2016, Switzerland was only partially associated with Horizon 2020, the European Union's latest framework research programme. National measures were put in place to finance Swiss project participations in areas of Horizon 2020, to which Switzerland was not associated. Since the beginning of 2017 Switzerland has become fully associated with Horizon 2020. Philipp Langer, Head of the EU Framework Programmes section at the State Secretariat for Education, Research and Innovation (SERI), looks back on the period of partial association and explains how things are likely to continue over the coming years.

What is Switzerland's official position regarding Horizon 2020?

Switzerland's official position over the last 3 years has always been the same, namely, the desire for full association to Horizon 2020. There is great satisfaction because this association to all parts of the Horizon 2020 Programme has been in place since 1 January 2017. Researchers from Switzerland can now participate in all sections of the 8th Programme generation (Horizon 2020 and the Euratom Programme), just as they could under FP6 and FP7, between 2004 and 2013. In addition, Switzerland is also able to take part as an observer when it comes to defining the programme's content and strategy.

Did the impediments of the last 3 years cause problems for higher education institutions and researchers in Switzerland?

The possibility of participating in the Horizon 2020 research framework programme is extremely important for Swiss institutions and businesses involved in research and innovation. For one thing, collaborative projects allow Swiss actors to position themselves in international networks at the cutting edge of their scientific field. Moreover, the possibility of applying for



Image: © Gaëtan Bally

Philipp Langer, State Secretariat for Education, Research and Innovation, Head EU Framework Programmes

individual funding (e.g. ERC grants) allows researchers in Switzerland to measure themselves against the world's greatest talents and is a key argument in drawing the best researchers to Swiss institutions, particularly cantonal universities, federal institutes of technology and universities of applied sciences. Obtaining such a grant brings with it prestigious recognition, which is extremely important in a researcher's career.

Over the last 3 years, Switzerland was only able to participate to a limited extent in Horizon 2020, both in terms of content and duration: researchers in Switzerland were only able to participate in a third of the Horizon 2020 as associated partners, and this was only until the end of 2016. Besides, even this partial association as of September 2014 has only been possible because Switzerland granted citizen from Croatia de facto the same treatment in terms of free movement of persons as other European countries. As of 2017, Switzerland had only 2 options: full participation as an associated country or total exclusion from the Programme. The

uncertainty that reigned over the least 3 years regarding Switzerland's partner status within Horizon 2020 diminished our country's appeal. Including Swiss partners in a given project, who were considered a risk for that project, so they were sometimes disregarded by international consortiums. The upshot was a significant drop in Swiss participation, a problematic situation as international connection is a key factor for Switzerland's standing as a scientific location.

What further possibilities are open to Switzerland with full association?

Full association status in Horizon 2020 allows Switzerland to sit as an observer on the programme's various advisory groups at European level and contribute to defining research topics and other strategic aspects. This is important for a number of reasons. On the one hand, calls for the topics of cooperative projects at European level are defined in a more top-down manner than in Switzerland, and that takes place in the advisory groups for each area covered by Horizon 2020 (health, ICT, environment, space, energy, climate, and transport). On the other, the funding available through Horizon 2020 (some €80 billion, over 7 years) is so important that each rule associated with these programmes (for example, the obligation to publish findings in Open Access journals) has a real impact on the way in which research and innovation is conducted throughout Europe.

During the period of partial association between 2014 and 2016, Switzerland was considered a third country for certain programme sections of Horizon 2020. The federal government took over the funding of Swiss elements of the projects. What will happen to these projects now that Switzerland is again fully associated?

Projects already underway that have received funding under Horizon 2020 will not be affected by the change in Switzerland's participation status: Their source of funding is assured for the full duration of the project. SERI will continue to fund projects submitted to Brussels by researchers in Switzerland and positively evaluated between 2014 and 2016. This affects around 1,000 projects with a financing volume of around 600 million Swiss francs. The last of these projects are expected to conclude in 2023. Until then, SERI has to

maintain the structures set up to implement the transitional measures.

After the uncertainty and stress surrounding Horizon 2020 between 2014 and 2016, can we now expect calmer times ahead?

The period between 2014 and 2016 was fairly work intensive. For all projects where Swiss researchers could still submit projects, but did no longer receive funding by the EU, we had to set up the whole national project funding system within a short space of time, which involved putting in place a new legal basis and creating a new IT database (the former database dated from 1993). The national funding of projects with a normal duration of 4 to 6 years, as opposed to paying a set annual contribution to Brussels, meant we had to make adjustments to the annual payment appropriations involving hundreds of millions of francs. That is still having an impact on the federal budget.

Depending on political developments between the EU and Switzerland, the future should be somewhat more ordered, yet implying double work: In addition to assuring the obligations that come with full association with the managing bodies in Brussels, SERI also has to ensure the continued project-based funding of researchers in Switzerland. Administering the 1,000 or so nationally funded projects will be particularly time consuming between 2018 and 2020, because that is when the detailed project invoices will be due. The Horizon 2020 projects are also more extensive than earlier EU projects. But it was clear from the outset that Switzerland's third country status would require the setting up of the necessary administration. ■

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Applied nanosciences for printing technologies

Applied nanosciences offer new possibilities for printing and processing, as outlined by Prof. Dr. Silvia Schintke from Heig-VD/HES-SO Switzerland

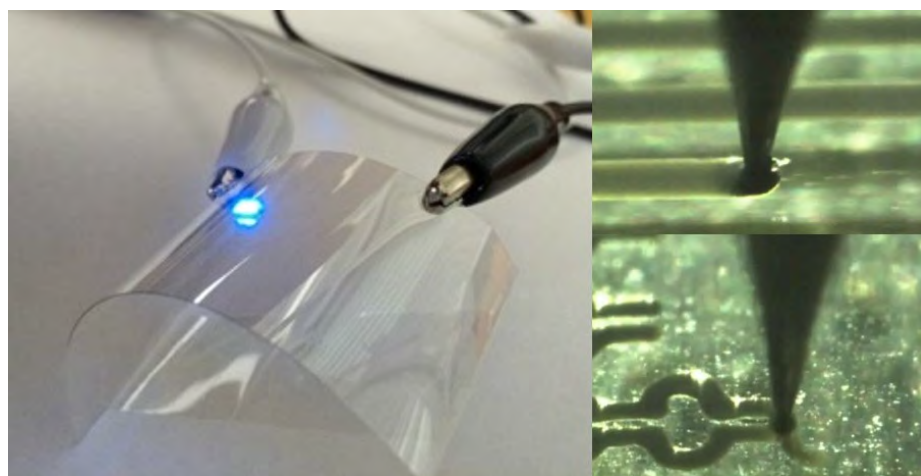
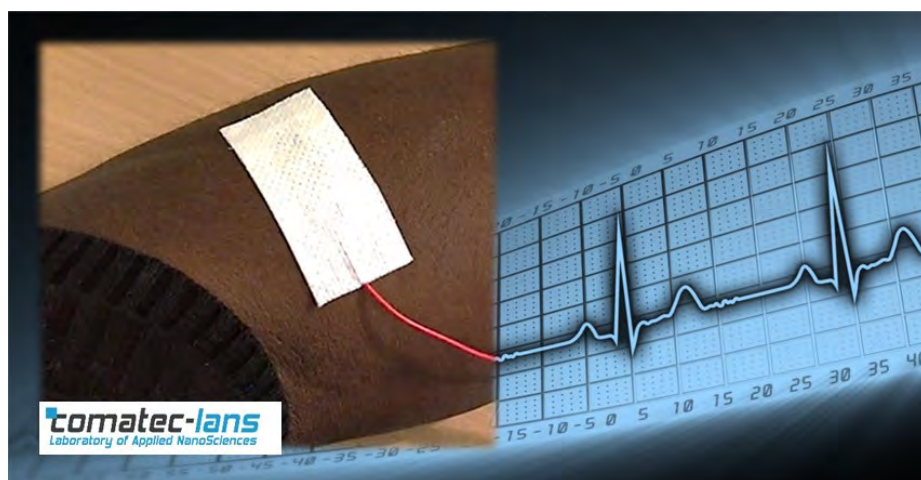
With the increasing development of 2D and 3D printing technologies, applied nanosciences, in particular functional nanocomposites and all-solution processing techniques have gained novel economic interest. For example, for industrial applications as transparent electrodes in large area printable electronics and sensor developments, for functionalised surfaces in food packaging and security tracking, as well as for the manufacturing of flexible medical electrodes.

Main R&D projects at the Laboratory of Applied NanoScience (COMATEC-LANS), of the Department of Industrial Technologies at the HEIG-VD, School of Business and Engineering Vaud of the University of Applied Sciences and Arts Western Switzerland, therefore focus on applied research and demonstrator developments based on nanocomposite materials for 2D and 3D printing and processing technologies.

Here, we present the impact of applied R&D projects of COMATEC-LANS through 3 show case examples:

Flexible biopolymer nanocomposite electrodes for Medtech applications

To eliminate the stiff and uncomfortable parts of some of today's medical electrodes was the aim of an interdisciplinary project involving engineers and scientists from the Laboratory of Applied NanoSciences (COMATEC-LANS) of HEIG-VD and network partners

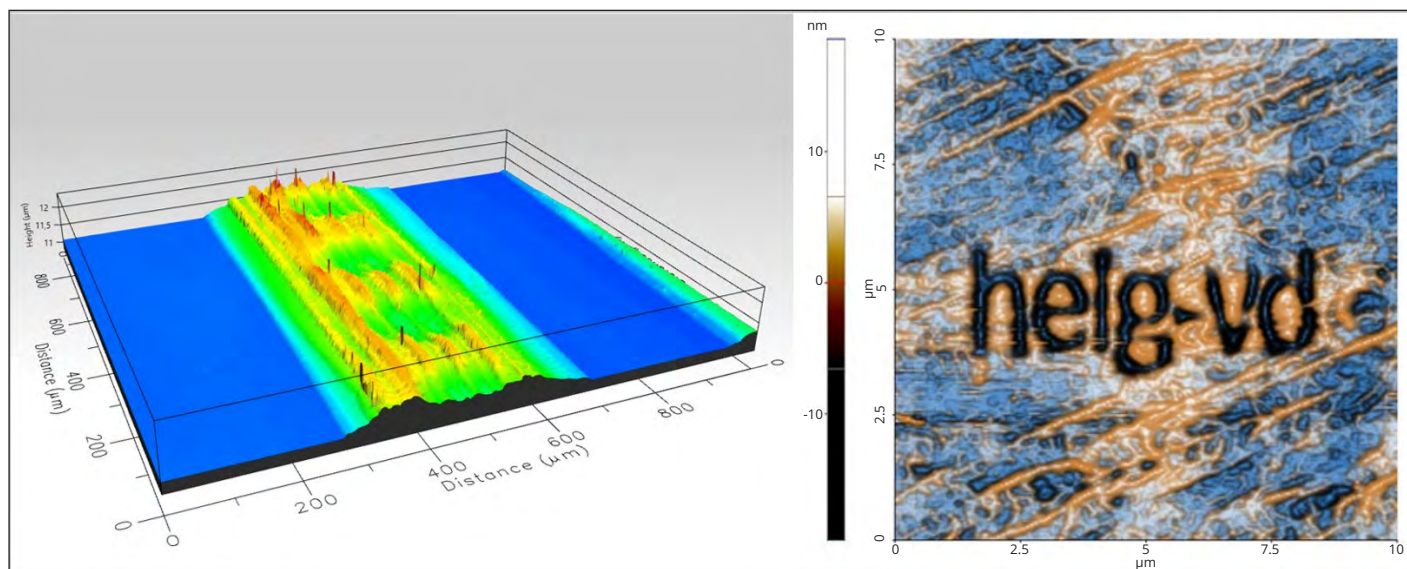


from HES-SO Wallis. The project's results are highly promising: the novel nanocomposite materials have successfully been tested for medical applications such as signal acquisition in electrocardiograms (ECG), as well as nerve stimulation (TENS). Part of the results have been published recently: in an article "Design and Characterisation of Conductive Biopolymer Nanocomposite Electrodes for Medical Applications" in the journal [*Materials Science Forum*](#) by Trans Tech Publications (2017). Furthermore, various materials

processing, printing and coating techniques are applied and developed for nanocomposite polymers at COMATEC-LANS/HEIG-VD.

Hybrid-polymers and nanocomposites for 2D and 3D electrodes and circuits

Printable polymer-nanocomposite materials for electrodes and 2D or 3D printable electrical circuits are another R&D focus of the laboratory COMATEC-LANS. One major topic concerns transparent and flexible electrodes; they are



in particular of technological relevance in photovoltaic and OLED applications, as well as for flexible displays.

The nano- and micrometerscale topography of oxide based transparent electrodes and of light management structures are studied at COMATEC-LANS/HEIG-VD in joint projects or as a service for companies from the photovoltaic sector. Polymer based transparent electrodes and sensors were e.g. investigated at COMATEC-LANS/HEIG-VD in collaboration with TU Sofia in a project supported by the scientific exchange program Sciex-NMS between Switzerland and the new EU member states. During this project a measurement technique for thin film conductivity of soft materials has been developed, as well as a printable transparent photoelectric sensor.

The developed electrical measurement technique is published in IEEE Xplore (2015) "Electrical characterisation of transparent organic conducting thin films preventing mechanical damage and preserving optical transparency". Through its design in a transmission line geometry it prevents the soft polymer film to be mechanically damaged by electrical probes and allows for the monitoring of the electrical conductiv-

ity under light exposure without probe shadowing effects. The main investigated material was PEDOT: PSS, a transparent hole conductor which is widely used in organic photovoltaics. The influence of various dopants as additives that improve the thin film conductivity and aging behaviour under UV exposure has also been studied in this context.

Nano- & microstructures and printing technologies for security tags and printable sensors

Last but not least, the COMATEC-LANS/HEIG-VD performs research and development in the field of printing and processing technologies for surface structuring and functionalisation for security tags and printable sensors. Materials and surfaces are coated or locally functionalised with molecules and/or various nanoparticles and typically studied with advanced non-contact atomic force microscopy techniques, 3D profilometry and optical spectroscopy methods in order to optimise the printing and processing techniques and to analyse advanced security tags at the nano and micrometre scale, as well as for their optical, electrical or magnetic signatures.

Recent results on "Inkjet-printing of aptamers for sensor developments"

have been presented at LOPEC, International Exhibition and Conference for the Printed Electronics Industry, 2017. Major collaborative projects of COMATEC-LANS/HEIG-VD in this field concern currently, the surface functionalisation and modifications for the development of sensors and surfaces in biomedical, environmental, food and active or smart packaging applications.

comatec-lans
Laboratory of Applied NanoSciences

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What is the importance of mechanical systems?

The University of Applied Sciences' research group discuss the challenges of mechanical systems and the benefits they bring to everyday life

Mechanical systems are hardware products – often with integrated controls – which shall simplify and improve our lives. A few examples are manufacturing machines, positioning devices, vehicles and their components, etc. Their function is closely controlled by adapted electronics & software, monitoring data can be produced by integrated sensors allowing for new function and maintenance concepts. In the age of digitalisation and networking, their development not only demands strong competences in the field of mechanical engineering itself, but also requires a holistic perspective and an interdisciplinary approach.

The Lucerne University of Applied Sciences and Arts' Competence Centre Mechanical Systems (CCMS) focus is



the development of such systems. Its areas of expertise are design, simulation, mechanics, hydraulics, robotics, automation, production and measurement engineering. Driven by the ever increasing complexity of mechanical hardware, system approaches are inevitable for development and problem solving. In this sense its technical and methodological skills in all these areas are the centre's greatest strength.

The daily research and development work of the CCMS is based on a strong collaboration with industrial partners. Located in Central Switzerland it provides the Swiss industry with application oriented solutions. In order to provide answers in an increasingly competitive environment, its research activities are focused on the future challenges. More and more projects and activities address some of the major key research areas in the context of Industry 4.0, i.e. virtual product development, additive manufacturing and automation. The following 3 examples emphasise these topics.

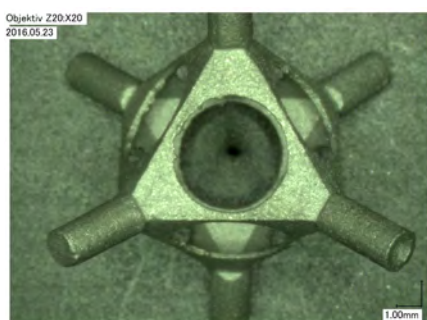
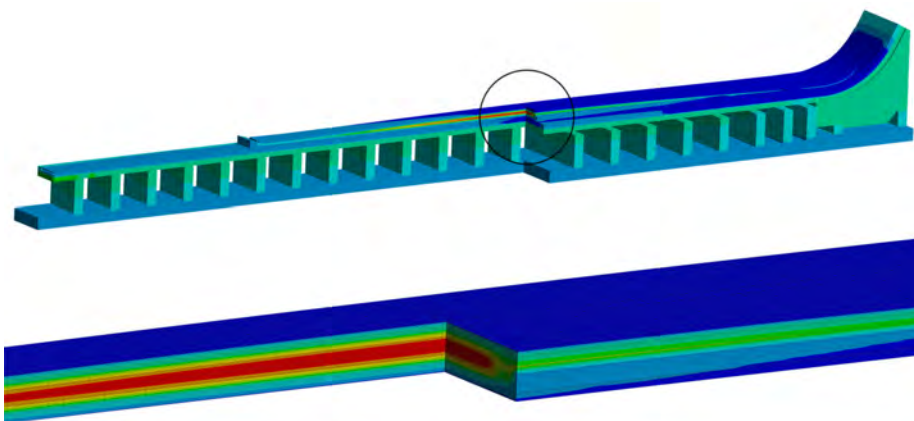
Virtual Product Development

Today the optimisation and development of new products is hardly imaginable without the use of numerical simulation methods. Even for demanding manufacturing processes, these techniques are used to optimally adjust the production parameters. The Stöckli Swiss Sports AG produces approx. 50,000 pairs of skis per year, mainly at its location in Malters, Switzerland. As a



premium manufacturer a high quality at low reject rate is required. Additionally the trend towards customised products requires an increasing degree of flexibility and short changeover times. This can only be achieved with an in-depth understanding of the physical processes occurring during production. Virtual models can provide this understanding.

Within the framework of a research project financially supported by the Commission for Technology and Innovation CTI, the CCMS developed a computer model that simulates the complete ski manufacturing process. In doing so, the individual layers of the ski are glued together in a hot-pressing process. Machine and process parameters, as well as the initial materials of the skis determine their shape and stiffness. Based on the finite



element method (FEM), the transient temperature profile is simulated during the heating and cooling phases and the residual stresses resulting from bonding are computed. The validity of the model was confirmed by measurements and extensive tests.

With such virtual models, a qualitative and even quantitative prediction of the main characteristics of a ski is possible. This is an innovation in ski development and helps to ensure the long-term competitiveness of Stöckli as an independent Swiss ski manufacturer.

Additive Manufacturing

Rapid prototyping technologies are used in student and engineering projects. Different facilities are available to generate 3D-models for analysis of early design concepts. Besides commonly used plastic fused deposition (FDM) recently activities are focusing on metal selective laser melting (SLM) for additive manufacturing. The CCMS

offers analysis and services for the complete process chain, i.e. 3D data processing, design optimisation, build process, post-processing / finishing, testing and material characterisation.

For future applications major advantages in functional integration of assemblies and structural optimisation are expected. Especially the design of variable stiffness and damping gives completely new opportunities for development of new products or components. In the context of additive manufacturing a detailed material characterisation is of great importance. Dimensional aspects of parts and surface finishing have to be taken into account – using existing and new measurement equipment at hand. A micro tensile testing device was developed with special specimen design. Further aspects of the research activities of the CCMS will consider the use and robotic assisted removal of supporting structures.

“In the age of digitalisation and networking, their development not only demands strong competences in the field of mechanical engineering itself, but also requires a holistic perspective and an interdisciplinary approach.”

Automation

A very lively field in the context of Industry 4.0 is automation and robotics. Not only are the interconnection of data from and to the robots of importance, but also the smart reaction of robots to imperfect environment (e.g. parts not placed exactly to an expected location), as well as collaboration with humans (e.g. recognition of human body parts in the path of tool or gripper). The CCMS is looking for smart ideas to tackle such problems by using visual and tactile sensing techniques and focus on their implementation into industrial robots, if possible even to upgrade available hardware and by this enabling our industrial partners on their way to smart factories.

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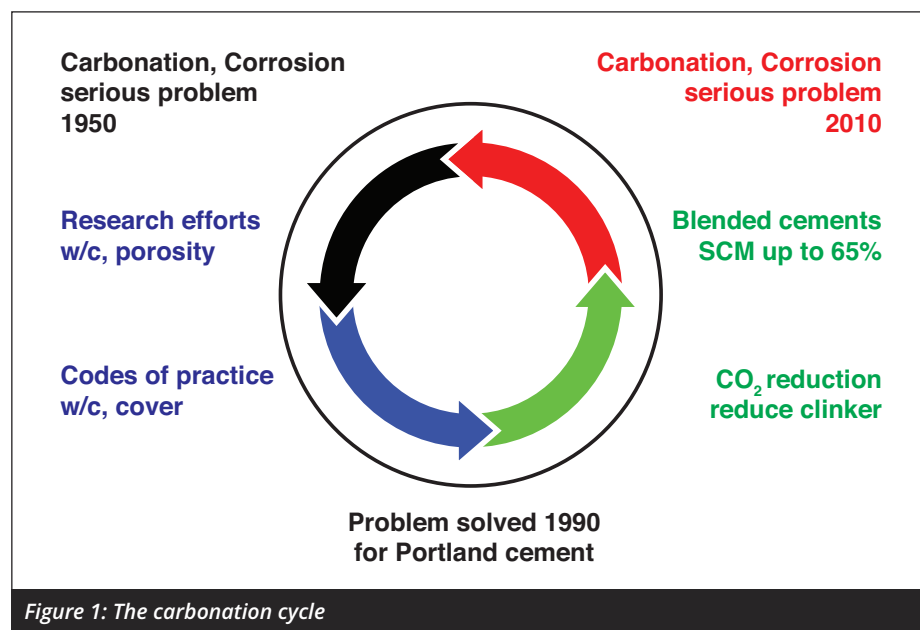
Carbonation induced corrosion of reinforced concrete revisited

The effect of corrosion on reinforced concrete must be addressed both for safety and environmental reasons, say researchers from ETH Zurich

Carbonation means the progressive neutralisation of the alkaline constituents of concrete by carbon dioxide in the air, forming mainly calcium carbonate. In this neutralised environment, reinforcing steel is no more protected by the alkaline pore solution of fresh concrete. When the carbonated surface zone reaches the depth of reinforcing steel, significant corrosion may be initiated.

“...achieving sustainable reinforced concrete structures clearly requires not only decreasing the environmental footprint of the materials at the time of their production (reducing the clinker content), but to combine this with high durability, thus enabling long and maintenance free service lives of the structures in their actual exposure environments.”

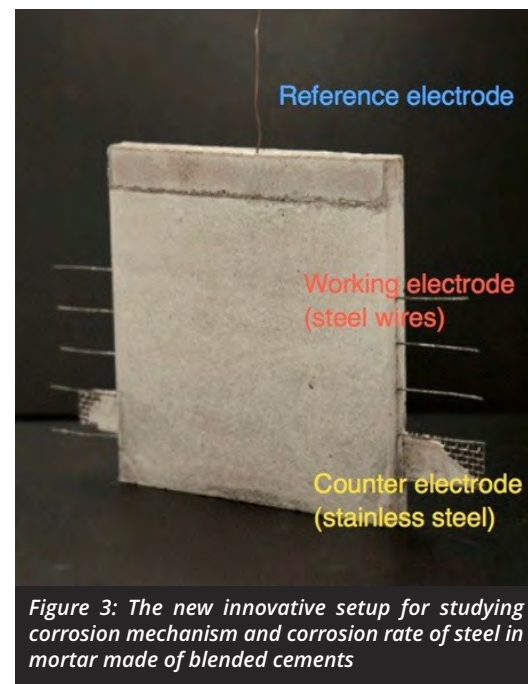
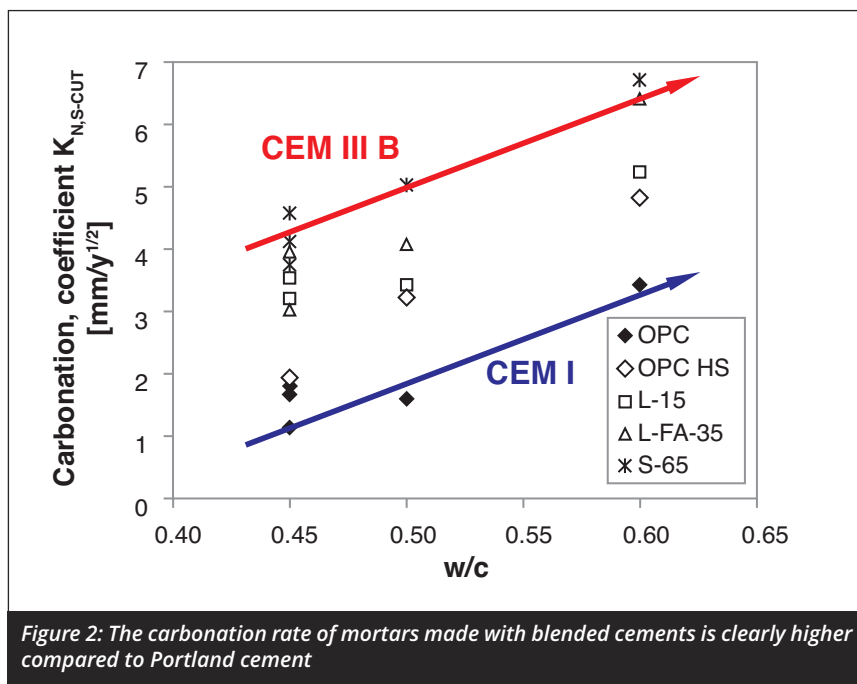
Indeed, corrosion of steel in carbonated concrete was a major concern of research and practice in the years from 1950 to 1980. The research findings lead to the requirement of dense concrete (lower w/c ratio), the control of concrete properties and to a marked increase in the cover depth (from 20 mm to 35 mm) in the codes of practice. The European standard on concrete EN 206-1 published in the year 2000 classified the risk of carbonation-induced corrosion depending on the severity of the environment (XC1 to XC4). With the minimum requirements given in the recommendations (maximum w/c ratio, minimum



cement content, minimum cover depth) the codes of practice since then give guidance for reinforced concrete made with Portland cement (CEM I) on how to avoid carbonation induced corrosion for structures with expected service life of 50 or 100 years.

The role of carbonation as a factor that contributes to the degradation of reinforced concrete is becoming increasingly important again (Figure 1) for two reasons. First, many old reinforced concrete structures that were built before modern standards were applied are ageing and have to be maintained. Secondly, the need to reduce CO₂ emissions and to obtain materials having a reduced environmental footprint, is leading to a reduction of the clinker content in the

cements. Clinker (CEM I) is substituted with supplementary cementitious materials (SCM) such as limestone, fly-ash, geopolymers etc. In the future blended cements with increasingly lower clinker content and a huge variety of supplementary cementitious materials (SCM) will be used. The introduction of non-Portlandite binders has strongly reduced the pH buffer capacity as a result of the reduction (or elimination) of the calcium hydroxide reserve considered one of the main reasons for the corrosion inhibiting nature of Portland cement systems. The carbonation rate of such modern blended cements is a factor of 2-4 higher than for Portland cement (figure 2), thus the recommendations based on the experience with Portland cement do no more guarantee the required service life.



For service life prediction of concrete structures with new, blended cements, corrosion rate data are urgently needed because the so-called “corrosion propagation stage” might be a significant part of the total service life. Literature data are scarce and refer mainly to Portland cement. To be able to collect data of corrosion rate in a reasonably short time, a new experimental set up has been designed (figure 3). The new test setup consists of small (8 x 8 cm) and thin (6 mm) cement mortar samples instrumented with a reference electrode, 5 steel wire electrodes and a stainless steel grid counter electrode. The thin sample allows rapid full carbonation (max 1 week in 4% CO₂) and rapid equilibration of environmental humidity (checked by the sample weight). Parameters that can be measured are electrical resistivity of the mortar, corrosion potential and corrosion rate (LPR measurements) of the steel wires, oxygen diffusion and consumption rate. From these data the mechanism of steel corrosion in carbonated

concrete made of different blended cements can be evaluated.

“The role of carbonation as a factor that contributes to the degradation of reinforced concrete is becoming increasingly important again for two reasons. First, many old reinforced concrete structures that were built before modern standards were applied are ageing and have to be maintained. Secondly, the need to reduce CO₂ emissions and to obtain materials having a reduced environmental footprint, is leading to a reduction of the clinker content in the cements.”

In summary, achieving sustainable reinforced concrete structures clearly requires not only decreasing the environmental footprint of the materials at the time of their production (reducing the clinker content), but to combine this with high durability, thus enabling long and maintenance free service lives of the structures in their actual exposure environments.

1 A. Leemann, P. Nygard, J. Kaufmann, R. Loser, Cement and Concrete Composites 62 (2015) 33 - 43

2 M. Stefanoni, U. Angst, B. Elsener, Innovative sample design for corrosion rate measurement in carbonated concrete, presented at 11th annual International Concrete Sustainability Conference (2016 ICSC) May 15 – 18, 2016, Washington DC (USA)

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An ambitious strategy for German research

In March, a new hi-tech strategy for German research was adopted. Open Access Government discusses the report and how it will aid innovation in the country

Germany is a country that is constantly thriving in the science and research world. Research in Germany is seen as one of the foundations of the country's future. The Federal Ministry for Education and Research is the main governing body in Germany and promotes the importance of research throughout the country. However, there are other organisations, such as the German Research Foundation, who offer funding for research programmes to all branches of science and humanities.

In Germany, education and research are seen as a Federal government policy priority. Through excellent research, Germany is able to find solutions to global problems, as well as devise strategies for sustainable growth.

High-tech strategy for German research

The Federal Cabinet recently adopted a report in the high-tech strategy, 'Progress through research and innovation'. The report, which was adopted in March, provides information on the implementation of the strategy and how it is working.

Speaking recently at the launch of the report, Federal Minister for Education and Research, Joanna Wanka outlined the importance of investing in research and innovation to maintain Germany's key position in this sector.

"Germany's strong position as the world's leading innovator and export world champion is no coincidence. It is the result of a policy that has been consistently focusing on research and innovation for more than a decade under the umbrella of the high-tech strategy," she said.

"If we want to maintain and expand this position, we must be prepared to invest even more in research and

innovation, so our goal is to increase spending on research and development to 3.5% of gross domestic product by 2025. There will still have to be two-thirds of the additional investment from the economy, which will only succeed if we are motivating more companies to generate innovation, which is why we need tax-related research funding alongside tried and tested project funding."

Over the last 10 years, the Federal government has increased its R&D expenditure by more than 60% and has an outstanding track record in research and innovation during the current electoral period. The high-tech strategy, which was launched in 2014, has 6 priority points: digital economy and society; sustainable economics and energy; innovative working environment; healthy living; intelligent mobility; and civil security.

Germany also takes pride in supporting its young scientists and aims to further encourage more young people into the world of research. A recent report indicated that from 2000 to 2014 there was a 76% increase in the number of young scientists who were employed as academic staff at universities. In 2000 the number stood at 82,400, whereas in 2014 that number rose to 145,000.

"The young academics in Germany are an indispensable part of our knowledge society, which needs highly qualified workers and a spirit of innovation, and investment in young academics is paying off, which is why the Federal government recently launched 3 initiatives in favour of young scholars. We are able to achieve a more transparent and better plannable career path," explains Federal Minister Wanka.

"We have countered developments in short-term practice with a reform of the science-time agreement, and



because reliable data such as abort and success rates, we have also reformed the Higher Education Statistics Act. Only if we are even more aware of the situation of young scientists can we promote it even more effectively.”

The report, *'The Federal Report on Young Researchers 2017'*, was published by the Federal Research Office in collaboration with the Federal Ministry for Education and Research. According to the report, young scientists are consistently supported more professionally.

The Ministry's key objectives to promote young scientists are:

- To increase the attractiveness and transparency of scientific career paths;
- Improve the transitions from the stage of scientific qualification to occupations in business and society;
- To promote the international competitiveness and mobility of young scientists;

- To aid with the career development of young academics;
- To create conditions under which scientific services of the highest possible quality can be provided.

Well-qualified scientists are key for the country and are needed for both academic work, as well as for employment in the state society and the economy. It is one of the central concerns of the Federal government to ensure the quality of training for young academics is at the highest possible level to create attractive career structures and prospects for the scientists of the future. ■

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The pursuit for new strategies in drug development

Prof. Dr. Tanja Gaich, of the University of Konstanz – Department of Chemistry discusses new strategies in drug development and the challenges involved

Finding and designing new pharmaceuticals based on small organic molecules literally constitutes the search for the needle in the haystack. The first challenge thereby is to find the specific structure with the requested biological activity among myriads ($\sim 10^{60}$) of possible organic molecules. But not enough, this molecule also needs to meet certain standards with regards to metabolic stability, bioavailability, toxicology etc. mandated by the drug agencies. In the process of evolution – over millions of years – Nature has singled out so called “privileged structures” exhibiting all kinds of biological activities and uses them for its purposes (chemical communication; chemical defense etc.). These “privileged structures” e.g. natural products are produced by organisms of the animal, as well as the plant-kingdom. Ever since mankind has taken advantage of nature by what is known today

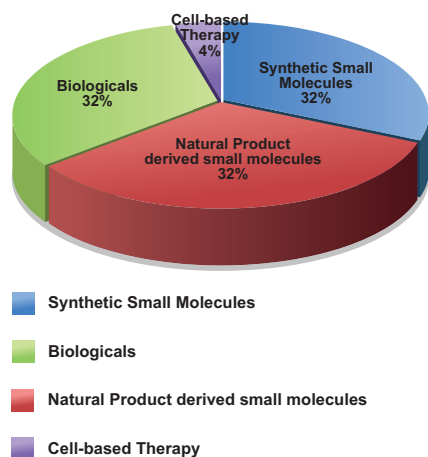


Figure 1: Percentage of natural product derived pharmaceuticals on the market

Conventional Synthesis:



Artificial Natural Product Systems Synthesis:

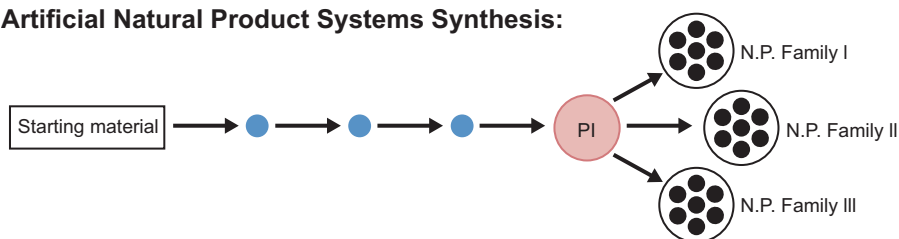


Figure 2: Comparison of strategic approaches

as “ethno or traditional medicine”. Traditionally, extracts, teas or pastes of these organisms containing these natural products have been used without the knowledge of their exact structure and mode of action. Nowadays, natural product researchers capitalise on the head-start Nature provides with these “privileged structures”, by identifying the exact molecular architecture of these natural products and understanding their mode of action, thereby enabling rational drug design. Yet, these investigations strongly depend on the actual availability and natural abundance of the investigated natural products. Extracts of organisms typically contain very low quantities (scale: mg/kg dry weight of organism) of natural products, making drug development based on isolated material from their natural producers virtually impossible. Synthetic access to natural products – independent of the natural producer – is therefore

inevitable for the development of new drugs, since exploitation of the producing organisms would threaten them with extinction.

Challenges

Since the molecular architecture of natural products is very complex, their laboratory synthesis poses a formidable challenge for synthetic organic chemists and represents the cutting edge of the science of synthesis. Consequently, natural products remain an underexplored source in pharmaceutical industry. Nevertheless, around 32% of pharmaceuticals in the market to date are based on small molecules derived from natural products (Figure 1), underscoring their vital importance in drug design. What makes the application of natural products in drug development further challenging is the fact, that synthetic access to “derivatives” is extremely laborious and very often impossible. “Derivatives” constitute small struc-

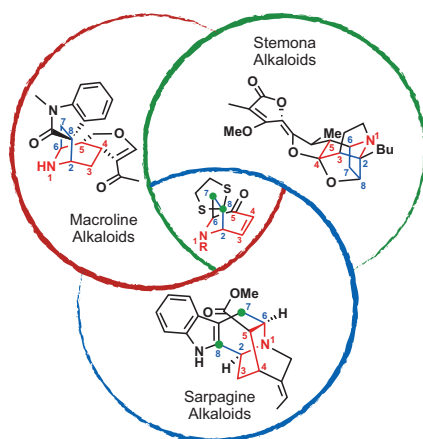


Figure 3: ANaPSy for proof of concept

tural changes introduced to the original molecular architecture by means of organic synthesis. These small changes of the original molecular structure are indispensable in drug development. Nature has designed natural products for its own purposes, which do not necessarily contain aspects of pharmacology in humans or meet the high approval standards of national drug agencies. Thus, "derivatisations" constitute an optimisation process of natural products with regard to these standards and requirements, and ultimately allow to bring the drug to the market. However, in conventional organic synthesis almost every small structural change (derivatisation) in the original molecular architecture requires a complete redesign of the synthetic route. In other words, a small change in molecular structure does not lead to an incremental change in the synthetic problem, but potentiates it. On the other hand, a big advantage of the complexity of natural product structures and opportunity for drug design, is the fact, that often "substructures" of less molecular complexity than the natural product itself already display the same biological activity. This reduces the complexity of the synthetic problem, only demanding a synthesis of a substructure of the molecule and its subsequent derivatisations.

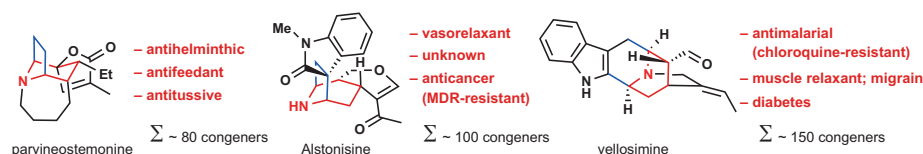


Figure 4: The pharmacological properties of molecules accessed by ANaPSy via one synthetic route

Objectives

To overcome the obstacles connected with derivatisations in conventional synthesis and embrace the opportunity of substructure synthesis, nowadays synthetic chemists develop new strategic concepts of synthesis design. An example for such a novel concept is ANaPSy (Artificial Natural Product Systems Synthesis).

ANaPSy is based on structure pattern recognition and allows to synthesise biogenetically completely unrelated natural products based on their corporate molecular architecture by a shared synthetic sequence. This sequence is upgraded every time a synthesis makes use of it hence network diversification leads to a rise in revenue. Figure 2 contrasts our strategic approach to conventional synthesis. Thereby we take advantage of common structure motifs often shared by totally different natural products. It is this shared motif that we term "privileged intermediate (PI in red Figure 2)", and which has to be identified and designed first. This is taken out by structural comparison and database searches. This intermediate is then synthesised, and diversified by means of synthetic chemistry into the respective natural products. For comparison, in conventional synthesis a target structure, which has been identified is synthesised via a specifically designed route. This route can only be used for the synthesis of this one individual molecule. Any changes made in the final structure require redesign and thus reinvestigation of the synthetic route (see Figure 2).

A specific example for such a research program is highlighted in Figure 3. Herein, 3 different natural product families with a broad range of pharmacological spectrum ranging from anti-cancer to anti-malarial activities (see Figure 4) share a common structure motif (highlighted in color in Figure 3). Up to date, the sum of chemical transformations required to synthesise 3 of these natural products (one congener per natural product family) is 69 steps. By contrast, ANaPSy will only require 33 steps. The number of synthetic steps is thus cut in half, moreover the synthetic system created for these natural products is flexible and can be used to access any other molecule sharing the common structure motif.

This strategic approach thereby creates an artificial synthetic network suitable for efficient synthesis of natural products, their derivatives, and thus will provide access to their pharmacological properties as listed in figure 4. This will enhance efficacy in drug development, which is urgently required in pharmaceutical industry.



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Understanding microbial pathogenicity requires holistic analyses

The Institute of Hygiene, Westfälische Wilhelms-Universität Münster highlights the changes in microbial pathogenicity

In many cases microbial pathogenicity cannot be predicted directly from the properties of the microorganism. Instead, often complex interactions between the environment and host, the host and microbe, and the microbe and environment have to be taken into account.

Today's view on microbial pathogenicity has profoundly changed. Pathogenicity is no longer considered a specific property of the microbe, but thought to arise from a complex and dynamic interaction with the host. Microbes may grow and multiply only in certain hosts. Likewise, a pathogen might simply exist within a host and cause no signs or symptoms of infection or elicit disease to variable degrees, ranging from mild to deadly. Accordingly, we have to shift the focus onto the host-microbe interplay as a complex and malleable phenomenon governed by the properties of both the microbe and its host environment. To avoid a microbe or host-centred view and to rather implement a holistic approach, infectious disease-related research should be cross-disciplinary and integrate traditionally separated biomedical and life science disciplines. In order to open up new therapeutic avenues to interfere with infection, we have to explore bacterial pathogenicity factors and infection pathways, but also the role of co-colonising bacteria, abiotic and bioactive factors, and pathogen and host variables.

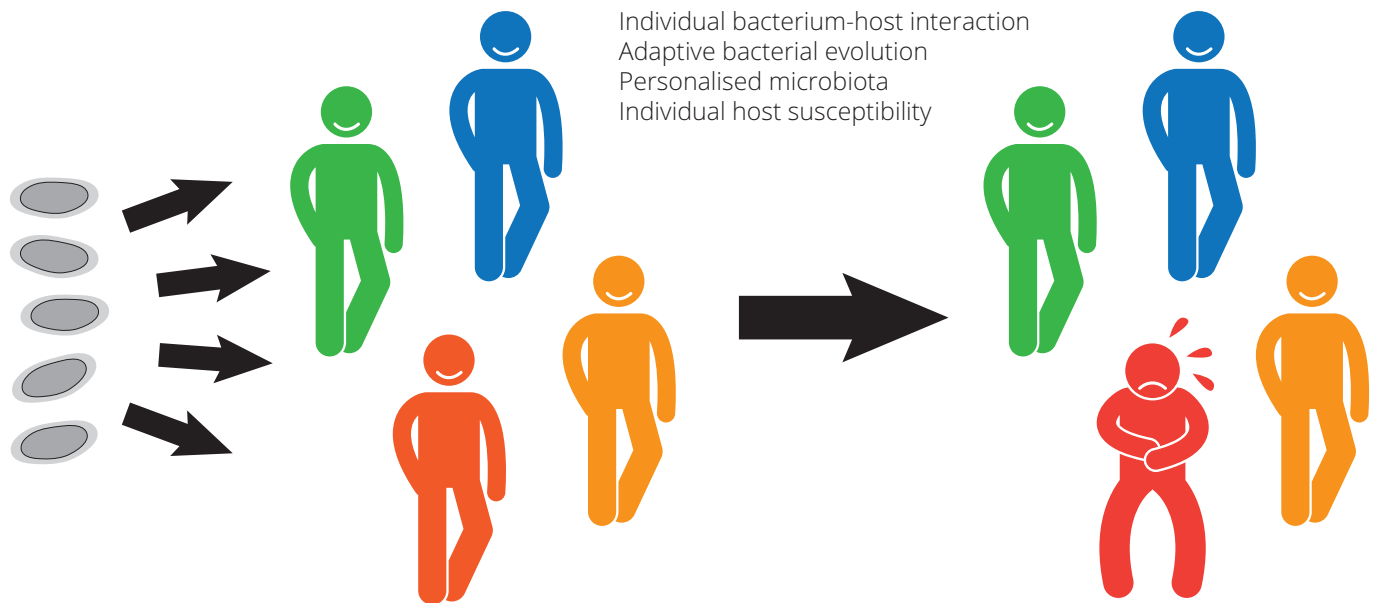
Furthermore, for many microbes, factors required for microbial pathogenicity in a normal host cannot be identified. Many pathogenicity-associated traits can be found in pathogenic, as well as in non-pathogenic variants of a species. Additionally, properties conferring pathogenicity depend as much on the host as they do on the microorganism. Recent developments in modern medicine further corroborate the fact that in many cases pathogens and non-pathogens cannot be unequivocally distinguished based on specific traits, because the introduction of broad-spectrum antimicrobials, immunosuppressive therapies, modern treatment options (including, organ transplantation and joint replacement, implantable devices and indwelling catheters), each of which alters host-microbe interactions, created conditions, in which the host became susceptible to microbes that were previously considered non-pathogenic. Consequently, many microbes previously considered non- or facultative pathogenic, such as certain *Escherichia coli* variants, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, fungi (e.g. *Aspergillus fumigatus*, *Candida albicans*), turned out to be able to cause serious disease.

Many microbes cause disease in some, but not all of those individuals who are colonised by them. This is exemplified by bacteria such as staphylococci, which are actually present in most individuals, but only

cause disease in some. There is also growing evidence from microbiome analyses, that alterations of the normal composition of the microbiota or of the balanced relationship between microbes and the host barriers, can making the host more susceptible to infection by microbes that usually do not cause disease. Pathogenicity is therefore an outcome of host-microbe interaction and is thus linked to characteristics of the host, as well as those of the colonising and infecting microbiota.

Continual research to monitor microbial pathogenicity

Despite the ongoing research activities worldwide regarding bacterial pathogenesis and the development of antibiotic resistance and pathogenicity-associated traits, the underlying evolutionary mechanisms and genetic elements in relation to the complex interactions between pathogens and their hosts are not yet well understood. We study bacterial genome plasticity and gene expression in vivo to understand bacterial interaction with their hosts during infection or colonisation which may result in differential susceptibility to infection (Figure 1). Next-generation sequencing (NGS) allows the comprehensive genome wide identification of DNA sequence alterations, such as re-arrangements, insertion/deletion as well as horizontal gene transfer events. The use of (meta-) genomic data and NGS tools facilitates the



analysis of genomic alterations in vivo as well as the analysis of bacterium-host interaction at the transcriptional level by dual transcriptome sequencing. An increased understanding of bacterial genome plasticity and gene expression in vivo will support the development of preventive, therapeutic and diagnostic strategies to specifically interfere with relevant virulence or colonisation mechanisms of pathogens in the reservoir and the infected patient.

Bacterium-host interactions drive adaptive changes in bacteria, their phenotypic diversity and genome complexity. *Escherichia coli* (*E. coli*) is a versatile pathogen, acting as a major cause of morbidity and mortality as well as a commensal, which colonises the human gastrointestinal tract within hours after birth, and typically builds a mutualistic relation. We analyse genome plasticity and gene expression in vivo and the mechanisms by which *E. coli* adapts during long-term colonisation of the urinary tract or the intestinal tract of individual human hosts. Long-term colonisation of the urinary bladder or the intestinal tract by individual *E. coli* strains is one therapeutic strategy to counteract infection by

bacterial pathogens in these niches. In addition, isolates of uropathogenic *E. coli* from different time points of a chronic urinary tract infection also allow to monitor bacterial adaptation during infection.

Comparative and functional genomic analysis of *E. coli* re-isolates from the bladder of deliberately colonised patients or re-isolates from the intestine of individuals colonised with an *E. coli* strain identified unique bacterial adaptation patterns in each person supporting the idea that, in addition to stochastic events, adaptive bacterial evolution is driven by individual host environments. Our data support the idea that hosts appear to personalise their microbiota. Furthermore, our studies of pathogenic and non-pathogenic, commensal *E. coli* isolates have identified that, rather than conventional pathogenicity factors, determinants involved in bacterial fitness, e.g. in nutrient uptake and utilisation, as well as protection against the host's immune response are advantageous as they allow rapid adaptation and growth of these strains in niches where they can cause infection. We are convinced that the combined analysis of bacterial and

host responses during infection will define promising targets for novel antimicrobial strategies. Defining a role for metabolic traits during disease and identification of novel processes underpinning this capability could allow development as potential approaches (e.g. dietary manipulation, attenuated vaccines or anti-infectives) for preventing infection.



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Reconstructing an Ancient Egyptian Microcosm in Sudan

Excavations and 3D reconstructions on Sai Island provide a glimpse into the history and culture of an Ancient Egyptian settlement, says Professor Julia Budka

The international age of the New Kingdom in Pharaonic Egypt (c. 1539-1077 BCE) resulted in the foundation of several Egyptian towns and settlements in the area known today as Upper Nubia in Sudan. Some of these are well preserved and offer the unique chance to explore domestic life in an ancient Egyptian settlement outside of Egypt proper. The most promising example of such “colonial sites” is the exceptionally well preserved town on Sai Island because of its long occupation period and its attested history as important site of the African Kingdom of Kerma. Prior to the New Kingdom, Sai was the northernmost stronghold of the Kerma Kingdom with a significant strategic role, well attested by archaeological remains.

The ERC AcrossBorders project has conducted archaeological fieldwork on Sai Island from 2013 until 2017. Archaeological excavations in the New Kingdom town and cemetery were complemented with kite aerial photography, structure from motion approaches, terrestrial 3D laser scans, geoarchaeological surveys, micromorphological soil sampling and various archaeometric analyses of diverse materials. Human remains, animal bones, botanical material, soil, plaster, sandstone and all kinds of objects are currently being assessed under the general question: Can Sai be evaluated as an Egyptian microcosm, despite its location outside of Egypt and its specific topographical, envi-



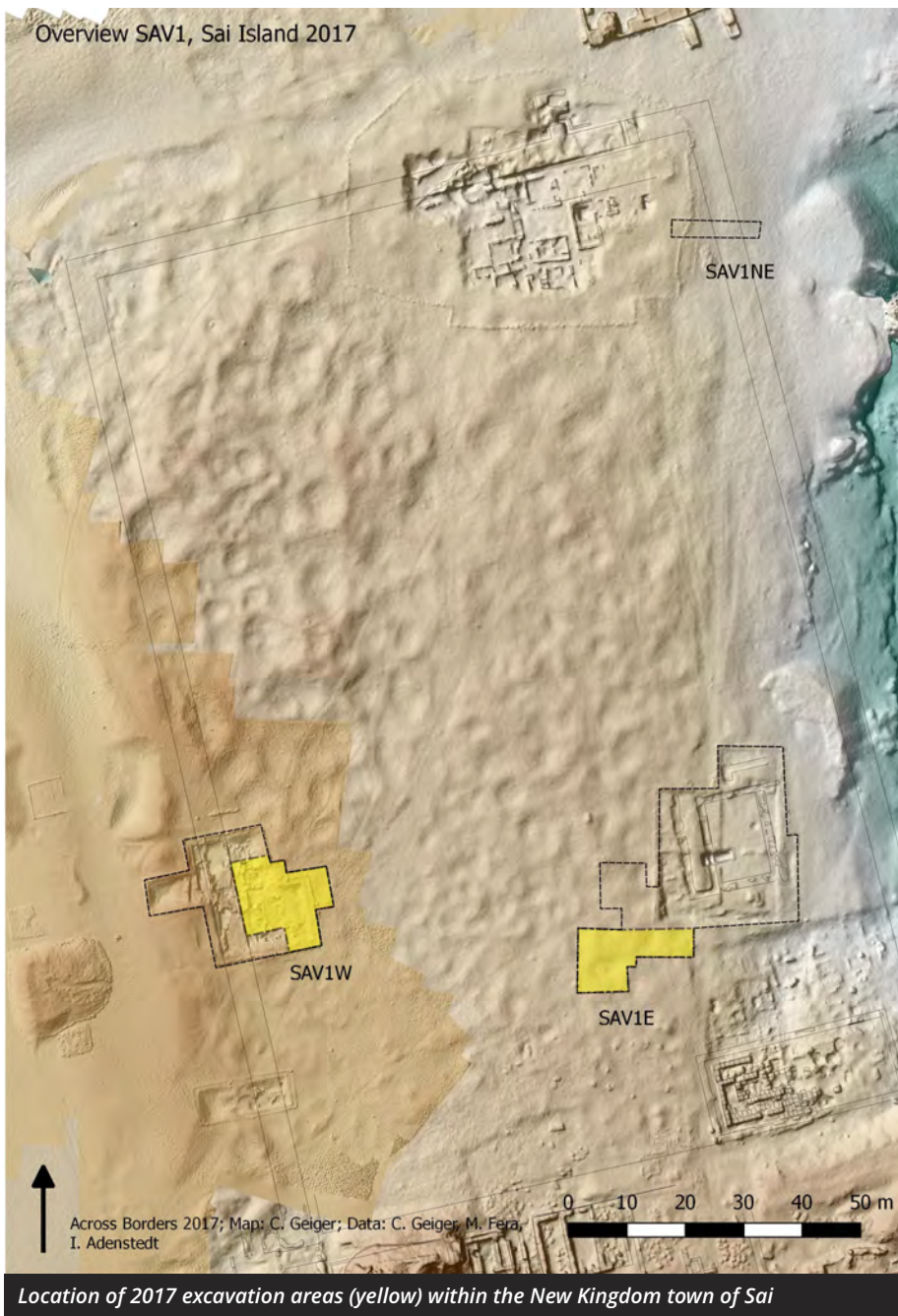
The 2017 AcrossBorders team on Sai

ronmental and cultural situation? How did the local Kerma Nubians react to foreign influences and how did the Egyptians present themselves outside of Egypt?

The town layout has been pieced together

The recent 2017 field season on Sai Island provided some answers to these general research questions, especially by new insights on the layout and function of the New Kingdom town. At sector SAV1 West, an early occupation phase, predating the town enclosure, was confirmed – supporting the reconstruction of an early Egyptian landing place on the island founded at the beginning of the New Kingdom, a period when the Kerma Kingdom was still the major rival to Pharaonic Egypt. Some new mud brick buildings of modest scale and irregular outline were excavated, providing additional data for the city map. In this respect, sector SAV1 East proved to be highly relevant. This area yielded

new material for understanding the function of the town. Large subterranean storage rooms were unearthed in rooms with schist floors, stressing the role of Sai as Egyptian administrative center. The new cellars and rooms are comparable to the southern sector of the town, excavated by a French Mission in the 1970s, and are probably related to the Egyptian stone temple close by. With our new fieldwork, the town map can be updated and fresh remarks on the internal structure are possible. Although Sai was definitely a planned Egyptian town with an orthogonal layout, AcrossBorders excavations have illustrated that within the city there are several different sectors that contrast regarding their layout. Theoretical urban planning may differ significantly from real developments within Egyptian towns like Sai – especially since the past occupants represent a potentially dynamic factor, in particular if they include both Egyptians and Nubians as it is the case for Sai.



Cooking vessels a key find

Within settlement archaeology, occupants of ancient sites may be tentatively traced by material evidence. One of the primary goals of the AcrossBorders project is reconstructing life during the New Kingdom on Sai according to the architecture and finds. For this task, the most numerous finds to be considered are thousands of potsherds. Such ceramic vessels attest to the use and function of sites and individual buildings and can also provide information on the occupants. In this respect it is remark-

able that, from the earliest strata onwards, Nubian ceramics appear at Sai side by side with imported Egyptian wares and locally wheel-made products. Since the Nubian pots are the minority, it seems safe to assume that the Egyptian style town was initially occupied by Egyptians. However, the production of hybrid pottery types illustrates that Egyptians and Nubians lived and worked side by side, combining aspects of both cultures. Although it comes as no surprise that Egyptian representation is dominant within a colonial site like Sai, a local

substratum is traceable as well. The pottery attests to individuals who identified themselves primarily as Egyptian officials and occupants of an Egyptian site, but may nevertheless have had family ties in Nubia and derive from a local group whose specific cultural identity was never completely abandoned, resulting in a very dynamic world in New Kingdom Sai.

“The most promising example of such “colonial sites” is the exceptionally well preserved town on Sai Island because of its long occupation period and its attested history as important site of the African Kingdom of Kerma.”

Currently busy with post-excavation work, the AcrossBorders project conducts a detailed assessment of architecture and material culture embedded in the environmental settings and landscape. The ongoing analysis will result in the reconstruction of aspects of daily life on a regional level, but will also include new information about the historical context of Egyptian towns set up in Nubia, thus combining research questions on the micro-level with the macro-level.



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How the Slovak Republic strengthened innovation in the EU

Peter Plavčan, Minister of Education, Science, Research and Sport shares how the Slovak Republic strengthened innovation during its EU Council Presidency

Today, research and innovation performance is a crucial determinant of competitiveness and national progress in modern societies. Moreover, innovation is important for addressing global challenges, such as climate change and sustainable development. The importance of the socio-economic effect of investments in scientific research is reflected in the international competitiveness of the state and in the living and cultural standards of the population.

However, despite the importance of innovation, many countries face difficulties in strengthening performance in this area. During the Slovak Presidency of the

Council of the European Union, we tried to use the offered opportunity to promote European science and research, and Slovakia's contribution in these areas, by showcasing sectors that we consider especially important and beneficial.

We have laid down a number of priorities in this sphere – support for young researchers, increasing the attractiveness of the scientific professions, improving the framework conditions for researchers in the European Union with regard to their effect on employment, growth, the economy and competitiveness, and intensification of relations between the EU and the European Space Agency.



Innovation brings competitiveness

It is evident that innovation is the key to ensuring the competitiveness of European states in a globalised marketplace. Innovation is the result of scientists and researchers finding new solutions to problems, both old and new. It is vital to the interests of the European Union that it provides the broadest possible support for highly qualified specialists who make up one of our most important forms of capital. It will be necessary to increase efforts to promote careers in the sciences and other beneficial professions because they are not respected enough in many cases, nor do they offer a direct career ladder.

It gives me a strong sense of satisfaction that despite often working in more difficult conditions than their colleagues abroad, Slovak researchers manage to compete with the best in the world in some areas, for example within research of materials and nanotechnology, ICT, biomedicine and biotechnology, environment, and sustainable energy, etc.

We can also be proud that our researchers and local companies are making an active contribution to

today's largest infrastructure projects such as CERN or the European x-ray free electron laser (European XFEL). I consider this another step in the right direction that Slovakia became a cooperating state of the European Space Agency a few months ago since this does not only open the way for us to participate in high-level technological research, but also has a growing influence in everyone's daily life.

In recent years, the EU's structural funds have funded the construction of a number of science parks at Slovak universities and the Slovak Academy of Sciences. They provide a good foundation and essential infrastructure for further progress. Now we face the challenge of maintaining development of these facilities and attracting the best specialists to work there. This includes young scientists at the doctoral or post-doctoral level, who often have trouble finding research opportunities in Slovakia and frequently go abroad to look for better conditions. We would be very glad if these centres were able to offer researchers interesting opportunities to enable them to stay in Slovakia as well as attracting foreign researchers.

The Slovak Academy of Sciences is also going through changes. An act to transform its institutes into public research institutions was drafted a while ago. In my view, it should be passed as soon as possible to increase the competent areas of research and development that can be explored, and to interlink the public and private sector with the aim of generating new institutional and social forms for the production, transfer and application of knowledge.

I hope that these activities that we plan to implement will not only increase the attention given to science and research here in Slovakia, but also promote our results and our potential on the European level. That is something that we would all benefit from. ■

Peter Plavčan

Minister of Education, Science, Research and Sport

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Electronics and photonics: Key enabling technologies

Slovak University of Technology's Professor Daniel Donoval highlights the scope as well as the influence of electronics and photonics in the modern world

Electronics and photonics have been identified as the key enabling technologies that have a tremendous impact on innovation in our life. Today there is no industrial or societal branch which is not armed by micro/nano-electronics and/or photonics structures, devices and smart systems. They provide various equipment, technology lines, automotive and transportation networks, with significant smart abilities enabling them to control the functional capability. They are an integral part of systems for energy harvesting, to supply autonomous communications platforms and systems, as well as systems for monitoring the quality of the environment.

The Slovak University of Technology in Bratislava (STUBA), is the oldest technical university in Slovakia. It is attended by around 15,000 students and belongs to the leading university in micro/nano-electronics and photonics education and R&D activities in the new EU member states. The Institute of Electronics and Photonics (IEP), Faculty of Electrical Engineering and Information Technology of STUBA is very active in advanced key semiconductor technologies. Its activities are ensured by complex involvement of new innovative solutions based on smart electronic, sensory and photonic systems for a bigger competitiveness, as well as for a better quality of life in a field of health, wellness, and the environment. Corresponding long-term effort brings

a lot of knowledge and experience which are immediately implemented into related curricula in electronics, particularly in master's and PhD studies, which are unique in Slovakia and serve as a platform for the international exchange of students within programmes such as ERASMUS.

Micro/nano-electronics at STUBA

The technology line for preparation of micro/nano-electronics structures is very costly, therefore we concentrate more on the measurement, characterisation and parameters evaluation, as well as on device design including 2/3D electro thermal modelling and simulation.

The IEP is mostly oriented on design, characterisation and parameters extraction of selected semiconductor structures and devices supported by 2/3D electro thermal modelling and simulation. Such simulation is important particularly for power devices where the generated heat is significant and its distribution through the chip may strongly influence device properties. We have developed numerical tools for fast electro thermal simulation with calibrated parameters of the device models for Si and GaN based structures. The results of modelling and simulation are useful not only for design and prediction of the properties of new structures, devices and systems, but also for the identification of origin and locations of defect regions. The simulated

results are compared with experimental electrical characteristics, which compared with optical and analytical characteristics provide complex view and identification of defects and critical regions on the analysed samples.

IC design uses the EUROPRACTICE services, targeted the ultra-low energy IC design on a chip, IC design for energy harvesting as well as full custom (ASIC) and semi-custom (FPGA) circuit particularly for smart systems. Chip testing, measurement, characterisation and evaluation are the integral part of our work in IC design.

In sensory IEP is involved in new types of sensors using either the metal oxides for gas sensors or sensor arrays, or sensors based on diamond and graphene nanostructures. The main focus in metal-oxide sensors is given to design, preparation and process optimisation by special surface treatment with sensors on a miniaturised heat platform and integrated read-out electronics. The results are then used in international collaboration on solutions for research grants and/or as the innovations of industrial partners, implementing them as the gas sensor arrays for measurement as a concentration of carbon like gases.

Organic electronics.

Problems of an ageing society is not only the issue of decreasing working populations, it is also the need to support the overall level of healthcare.

Organic electronics have gained tremendous research interest for applications not only in electronic devices such as organic light-emitting diodes (OLEDs), or organic solar cells, but also in the growing field of wearable sensors. Organic electronics provides flexible, low-cost, biocompatible, and roll-to-roll mass production that makes it attractive for manufacturers of wearable sensors.

Besides this fundamental research of organic materials, thin film fabrication technologies and the optoelectronic device properties, the research is also focused on sensor applications. Measuring electrocardiographic (ECG) and electromyography (EMG) bio signals, skin moisture monitoring, heart rate variability (HRV) monitoring, respirometry, etc. on a daily basis can be essential for tracking the health of patients, professional athletes, fitness trainees and professionals, and so forth.

Photonics

Photonics has been identified as a key technology with far reaching influences in communications, transportation, medicine, manufacturing, construction, computing, and defence. Photonics research at IEP has long-term experiences in optoelectronics devices design, processing and characterisation of semiconductor PIN photodiodes, LEDs, OLEDs and lasers. Present research is oriented around obtaining a new knowledge in the development of micro/nano-structures up to nanowires (1D) and nanoparticles (0D) for realisation of new optoelectronic and photonic devices based on their unique properties. The investigated structures are fabricated at IEP and within partner institutions, cooperation is based on inorganic Si-SiO₂-SiON, III-V, II-VI semiconductors, mostly GaAs, GaN, ZnO and their alloys, as well as new organic semiconductors. In

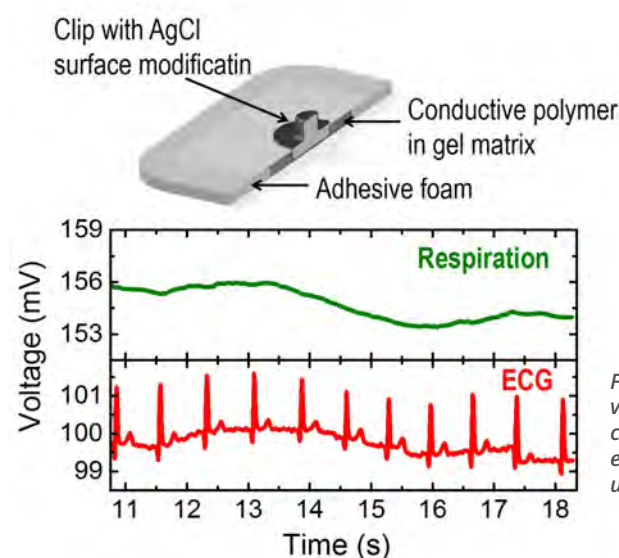


Figure 1: Simplified cross-section view of novel ECG electrode with conductive polymer gel and example of biosignals recorded using this organic electrode

the terms of recent research activities, a universal nanowire platform based on nanowires completely filled with an optically active shell layer is solved for interdisciplinary applications. Structural, electrical and optical properties of prepared micro and nanostructures are studied in the terms of heterojunction analysis, technology process optimisation and photonic crystals (PhC) of different modifications on surface or in the devices. These are applicable in all LED, OLED, photodetectors, solar cells, silicon nano photonics, and hybrid organic-inorganic photonic integrated circuits, with the orientation on enhancement of total device and system efficiency.

Industrial and International collaboration

The well-equipped laboratories, expertise and enthusiasm of institute staff ensure a successful project solution. The 10 experienced professors are supported by about 25 post-docs and PhD students. Active participation in international research projects in frameworks and ECSEL JU projects (about 10 projects), as well as about 15 national projects attract and stabilise young people. Dissemination of obtained results is ensured by their publication in scientific journals and conference proceedings. Collaboration

with companies, particularly SME, organisation of conferences, workshops and transfer of innovation technologies is another means of dissemination activities.

Based on the presented technologies and results, it is clear that IEP STUBA belongs to the leading European institutions and contributes to further development, supporting the leading role of Europe in the mentioned key enabling technologies.

Acknowledgement

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Madrid's Royal Botanic Gardens: An institution for learning

Julia Gil Hernández, Head of Protocol- Royal Botanic Garden, (CSIC), shares how the Royal Botanic Gardens in Madrid are a key centre for research

Madrid's Royal Botanic Garden opened its gates to the public at its current location in 1781. In 1939, it was assigned to the Spanish National Research Council (CSIC), and under Spanish Historical Heritage Law, it was declared a "Historic and Artistic Garden" in 1985.

After so many years, the garden still considered itself an institution of learning, research and reformation. Feeling bolstered by the change in location to further its activities, it took advantage of the situation to brighten up Madrid, placing itself in a privileged position for the capital's future urban planning programme. Nowadays, the Botanical Garden is a scientific institution, consisting of grounds where both wild and ornamental plants are cultivated. In essence it has 3 major functions: scientific research, conservation, and display & education. The site, located on Madrid's so-called 'Mile of Culture', is surrounded by the city's most prestigious art galleries, and is host to over 420,000 visitors every year.

Research at the Garden

The scientific aspect of the garden is perhaps what identifies it best and is the only aspect that has been maintained since its beginnings. It started off as an orchard dedicated to the study of medicinal and food plants. Nowadays, research at the Botanic Garden ranges from the fields of floristics (the study of plants in a given region) and plant taxonomy (awareness of the diversity and evolution of a particular group of plants), to those of ecology and conservation, etc.

All these studies also require the use of a herbarium, where dried plants, collected from natural populations, are organised methodically and labelled with data on their collection, etc. In addition, studies also use laboratories with varying levels of complexity.

The task of dissemination is also intrinsic to this type of gardens, in exhibiting a collection of living plants to the public, as in the case of recording, by properly organising and labelling, the diversity of the plant kingdom is best presented.

All of this is combined with the responsibility of protecting endangered plants in their host environments, growing them in ideal environments, safeguarding their seeds so they do not lose their ability to germinate, and studying the biology of reproduction to be able to implement recovery programmes.

The resulting interrelation between all these elements is what defines day to day activities at the Royal Botanic Garden. There are 2 sides to daily work: on one hand- and open to the public- are the 8 hectares of gardens, and on the other is the scientific and research work carried out in the Herbarium, the Archive, the Library, the research laboratories and the Germplasm Bank.

Events

The garden has a variety of areas than can be used to hold events: The Function Suite, The Bonsai House, the Plane-Tree Square, the Chestnut Square, and the Villanueva Pavilion, few of which were originally designed for their current purpose. Therefore, in many cases, a series of quite different approaches are required when it comes to the designing, assembling, and producing an event, compared with other purpose-built venues.

The garden's areas have evolved over the years within their surroundings and which, today, offer the possibility to hold events not only of an academic or scientific nature, but in fact of any nature, provided both the immediate surroundings as well as the garden's normal activities are unaffected and respected.

Each application to organise an event which reaches the Royal Botanic Garden must be mindful of these prerequisites. Appreciating the technical characteristics of the space which will be used is not enough- it is also necessary to know its constraints. The approach taken in setting up an event is influenced by many factors, from the weather to the arrival times of school visits. The greater the involvement with its surroundings, the more successful the event.

In terms of the nature of events currently organised at the garden, these can be classified as follows: in-house, private, and collaborations.

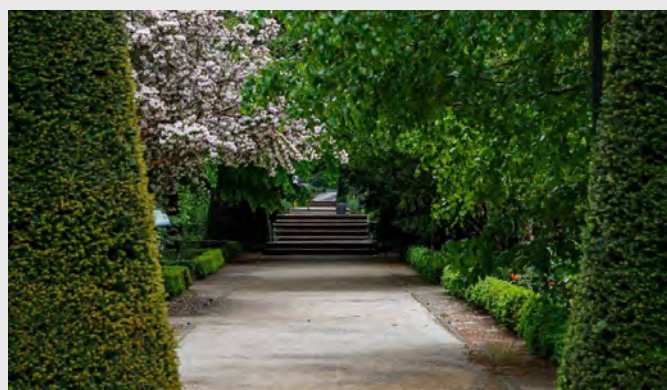
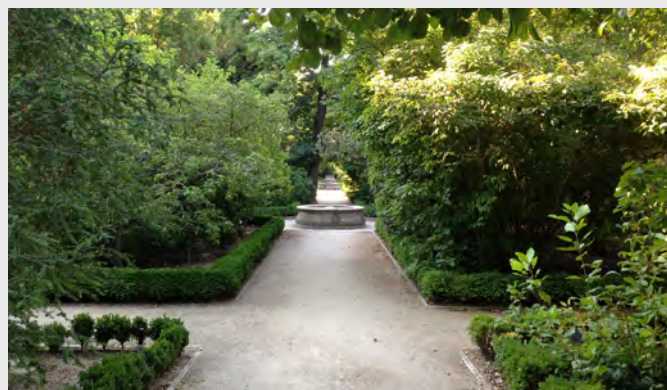
The theme of any given event can be classified as scientific, educational, cultural, social or institutional, with a clearly differentiated nuance compared with the content of a private function given that things may differ considerably, varying from marketing to commercial, and from charitable to leisure.

However, all these variables share a common characteristic in that they reflect the cultural, social and academic activity of the day.

Taking the above into account, we can appreciate that the characteristics which define the institution as a centre of investigation dedicated to the study of botany are those which, since its origins, have bestowed the centre with a special uniqueness in the celebration of events which have taken place on its premises.

One might say that the excellence in the results of the events celebrated in the Royal Botanic Garden lies in its very own *raison d'être*. The marked element of public service, its intrinsic dedication to the teaching of botany and its own natural environment have, throughout its history, permitted the centre to keep its philosophy intact.

The contents of its events have always reflected the social, scientific, political and economic context of the era, and, as one might expect, this remains so today. The rules applicable to the management of the zones and the strict compliance to regulations have been the factors that have allowed the same philosophy to be maintained since its beginnings. On most occasions this rigor has been maintained thanks to the responsibility and professionalism of its organisers.



The decision to hold an event in the Botanic Garden may produce an initial impression of limitation or inconvenience, given the venue's specifically unusual setting. Although, if treated correctly, this novelty becomes its real strength. ■

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Promoting science and higher education in Portugal

Open Access Government highlights how science and higher education in Portugal are helping to turn the country into a knowledge hub for future generations

Education and science in Portugal go hand in hand. With science steadily progressing over the last 20 years, the government in Portugal is keen to encourage research within the country further. According to the Ministry of Science, Technology and Higher Education in Portugal, internationalisation within these 3 areas has shown an unprecedented growth in recent decades. This is believed to be down to increasing numbers of students studying in Portugal, as well as researcher mobility.

The Portuguese government has acknowledged the prevailing role of higher education institutions and research centres, as places for knowledge production and sharing. Hence, by spurring innovation, they contribute towards social, cultural and economic development.

Manuel Heitor, Minister of Science, Technology and Higher Education in Portugal, (who served as Secretary of State of Science, Technology and Higher Education between 2005 and 2001) is also a Professor at Instituto Superior Técnico in Lisbon, where he directs the Centre for Innovation, Technology and Policy Research, which he founded in 1998.

On top of this, he works for the European network [step4EU](#), science, technology, education and policy for Europe, who aim “to create and promote an independent and credible international network to help improve science, technology and higher education policies and budgets across Europe”.

In June 2016, Minister Heitor [introduced a workshop at the OECD](#), whose goal was to discuss the terms of reference for an OECD review to Portugal Science, Technology and Higher Education.

A new direction for science and higher education in Portugal

In his introduction, the Minister said: “A new direction for science, technology and higher education policies is critical to strengthening countercyclical measures stimulating the necessary knowledge-driven conditions for Portugal to evolve and better use its strategic Atlantic positioning”.

He went on to argue that political actions and policies adopted over the period 2012 to 2015 caused “the level of support for attracting young researchers from abroad to work in Portugal” to be “considerably reduced”.

The Minister believes that “internationalising the knowledge base” is an essential part of this new direction for science and higher education policies. The implications of this on Portugal’s policy making are categorised by Heitor as: People, Institutions, and Incentives.

People: A human potential building program in science and technology in all areas of knowledge and including doctoral and post-doctoral fellowships, as well as strengthening the hiring of PhDs and scientific employment.

Institutions: Enhancing autonomy, promoting diversity and modernising scientific and higher education institutions should be considered as a matter of priority, to guarantee an institutional framework of international reference and to facilitate its diversification along with specialisation and the rejuvenation of the teaching staff of our institutions.

Incentives: Strengthening public and private R&D expenditure, including competitive grants for projects and R&D ideas, as well as business R&D in cooperation with scientific institutions.

The future of Portugal requires more knowledge and scientific culture, ensuring access to science and education as an inalienable right of all. More science and the systematic democratisation of access to knowledge means more equal opportunities, more social mobility and a new stimulus for entrepreneurial activities in Portugal.

Study and research in Portugal

In order to achieve this, and to internationalise science, technology and higher education, it is imperative that Portugal encourages foreign students to study and research in what is seen as a hub for creativity and innovation.

Heitor, along with Ana Mendes Godinho, the Secretary of State of Tourism, and the General Direction of Higher Education, the Foundation for Science and Technology and the Tourism of Portugal, have launched an initiative called Study and Research in Portugal. The programme illustrates the country's commitment to knowledge, creativity and innovation.

The Study and Research in Portugal website lists 10 reasons why foreign students and researchers should study in Portugal.

1 Quality learning – Portugal has 132 higher education institutions, which feature in the world's top rankings.

2 Research for the future – Portugal is the home of 307 research and development centres, who are at the forefront of exploring knowledge from social sciences to engineering or life sciences.

3 Connecting the world – 12% of Portugal's higher education students are foreign students. Thousands of foreign students and researchers of over 200 nationalities contribute to a diverse ecosystem.

4 Travelling for knowledge – Portuguese Higher Education Institutions and Research Centres understand crossing knowledge as a way of breaking down barriers for opening up to new paths to progress and modernity.

5 Knowledge for all – 35 times increased scientific production in the last 25 years, as well as 45 times the increased number of patents registered in Europe in the last 25 years.

6 Creativity and innovation – Portugal has 31,000 new start-ups a year, many of which are recognised across the world. Several of these were incubated in a stimulating higher education institution environment, in Portugal.

7 Sport and culture – Portuguese higher education institutions host hundreds of clubs and associations that foster sports, arts and cultural activities which allow you to meet people who are excited about sharing their interests.

8 Learn Portuguese – Portuguese is the fourth most spoken language, with 215 million native speakers, and 260 total speakers worldwide. As well as this, Portuguese is the official or working language of 32 international organisations.

9 People who care for you – Portugal has an open culture which connects people. For Immigrants integration, Portugal is the "2nd best country in the world, and with a population famous for openness and diversity.

10 Authentic life – On average, Portugal gets 3000 hours of sun per year, and it is the home of 850km of sandy beaches. Along with affordable living and great work-life balance, Portugal comes top in great places to live.

The Study and Research in Portugal programme urges students and researchers to be curious, learn, think Science, and choose Portugal. With 39,500 researchers currently working in Portugal, the government are keen to expand that further and grow the country into a leader of higher education and research. ■

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Why yeast is fundamental for cell death research

The Centre of Molecular and Environmental Biology outlines how yeast can clarify the regulation of cell death pathways and provide new therapeutic strategies for human diseases

Regulated cell death (RCD) is under tight genetic control, allowing a cell to trigger its own suicide. Apoptosis, the best-characterised RCD process, is crucial to eliminate damaged cells, avoid virus spreading from infected cells, and maintain tissue homeostasis. When the latter is compromised, different human pathologies often arise, such as cancer and neurodegenerative diseases. Until recently, due to a perceived beneficial role only to multicellular organisms and to the difficulty in finding orthologues of the core mammalian cell death machinery, apoptosis was thought to be confined to higher eukaryotes. However, a large body of evidence emerged in the late nineties supporting a physiological role for apoptosis, as well as other forms of RCD, in lower eukaryotes such as the baker's yeast *Saccharomyces cerevisiae*.

The added advantage of easy handling and genetic tractability, including the ectopic expression of human genes while preserving their functional role and without interference from the mammalian complex regulatory network, makes yeast a powerful and suitable model organism to approach key questions on cell death and its deregulation in humans. This fostered the field of yeast cell death, which we embraced from the early beginning, since we believed it offered great

potential to highlight molecular mechanisms underlying death processes and their regulation.

Cell death research

As a result of several years of research in this field, we identified common features between mitochondria and vacuolar/lysosomal death pathways in yeast and mammals, contributing to the recognition that RCD is highly conserved. Specifically, we found a novel process contributing to apoptotic cell death in yeast associated with the release of the vacuolar protease Pep4p, the yeast cathepsin D orthologue, and that we later validated in mammalian cells, leading to the proposal of a novel role for this protease in colorectal carcinoma. In another recent study, stemming from previous studies with yeast, we identified the plasmalemmal V-ATPase of highly metastatic cells as the molecular target of lactoferrin, which underlies its selectivity against highly metastatic cells, allowing a more rational use of this natural compound in cancer therapy.

These are 2 major breakthroughs which illustrate the potential of the yeast model to unveil novel roles of a cell death regulator and the mechanism of action of an antitumoral compound, and which fuel innovation in the design of new therapeutic strategies for diseases associated with deficient cell death mechanisms, such as cancer.

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National Science Foundation: Pioneering change in the U.S.

Open Access Government highlights the work of the National Science Foundation and reveals the importance of continued funding for research and development

Science and research are the backbone of modern day civilisation. The endeavour to pioneer change through scientific discovery is one that has existed all the way back to ancient times and shows little sign of abating.

Today, research undoubtedly has a pivotal role to play in society. Thanks to the work of scientists there are cures for diseases that once killed thousands, mobile phones are more powerful than computers were 40 years ago and cars are driving themselves.

In the U.S., the National Science Foundation (NSF) has responsibility for research progression and supports basic research. As an independent federal agency, its mission is “to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence...”

Research has a vital part to play in U.S. society. It drives the economy and enhances the security of the nation. With a budget totalling \$7.5bn during 2016, the NSF funds around 24% of all federally supported basic research carried out at high education facilities across the U.S.

Driving innovation requires solid funding

In an increasingly technological based society funding research remains vital to ensure advancement. Despite this fact the U.S. increased the overall amount of money for research during 2015, but reduced it for research and development (R&D).

According to [data published in April this year](#), R&D and R&D plant (facilities and fixed equipment) funding reached a total of \$131.4bn in 2015. The analysis, which was carried out by the National Center for Science and Engineering Statistics (NCSES), found that within the R&D total, the value of research obligations (described as orders placed, contracts awarded, and

services received) rose by 1% to \$63.6bn, but development funding dropped by 4% to \$64.9bn. There was also a 27% increase in R&D plant funding to \$2.8bn.

The report focused on the top federal agencies, among which was the NSF. The analysis revealed that the NSF's research obligations increased by 5% during 2015, reaching \$5.7bn. A total of 88% of the NSF's research obligations went towards supporting basic research.

Furthermore, the analysis found that support for all science and engineering fields was more evenly distributed by the NSF than any other agency. The data showed 21% of NSF funding was spent on environmental sciences; 18% went towards mathematics and computer science; 18% towards engineering research; 16% for physical sciences; and 12% to advance life sciences.

Support is key

This year, U.S. Congress showed its support for science and research by [announcing plans to increase federal spending](#) on R&D by 5% as part of a new fiscal 2017 budget deal. The deal will see total spending on R&D rise to \$155.8bn for the fiscal year that ends 30 September. This news will undoubtedly be welcomed by all agencies, including the NSF.

Supporting research remains imperative and organisations such as the NSF have a pivotal role to play in this. However, the U.S. government must remain focused on the bigger picture and ensure they throw their support behind an area that has the potential to change the world as we know it. ■

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Technology for proactive healthcare

Proactive healthcare is made possible through passive monitoring, which detects very early signs of health problems

The traditional reactive healthcare model is well-known. Typically, patients initiate a doctor's visit when they feel sick (sometimes very sick). Although many people seek health check-ups periodically, often health changes are not caught until they become serious health problems. This particularly affects older adults with chronic health conditions. With delayed treatment, many health problems escalate, resulting in hospitalisations. The result is that older adults and others with chronic health conditions decline, losing functionality, which in turn may lead to a loss of independence and a move to a skilled nursing facility.

Proactive healthcare using new vital signs

For over 10 years, the Center for Elder-care and Rehabilitation Technology at the University of Missouri has been investigating technology solutions that facilitate proactive healthcare, especially targeting our ageing population. We have developed an in-home sensor system that functions as a clinical decision support system for recognising early signs of illness and functional decline. The system learns a personalised model of each resident in the home and sends health alerts to clinical care coordinators when the pattern deviates, indicating a possible change in health status¹. Clinicians receiving the health alerts are trained to interpret the alerts with the help of an interactive web interface for viewing information extracted from the sensors.

The system of non-wearable environment sensors includes a bed sensor that captures heart rate, respiration rate, bed restlessness, and sleep patterns, while positioned discretely under the mattress². For couples, a sensor is positioned under each side of the bed. In-home gait analysis is accomplished with a depth sensor that extracts three-dimensional silhouettes of individuals moving through the home. Independent models of walking speed, stride time, and stride length are learnt for each resident of the home³. Passive infrared motion sensors are positioned around the home to capture room-specific motion, as well as an overall pattern of motion activity (activity density)⁴.

For each of these sensing systems, advanced machine learning

approaches are utilised to identify patterns that are tracked over time to establish typical patterns for each individual and recognise when the pattern deviates. The system of sensors and automated health alerts has been tested in several senior housing sites in the U.S. for over 5 years. Recent work is also testing the system in private homes. Examples of health changes detected automatically include urinary tract infections, respiratory infections, increasing congestive heart failure, pain post hospitalisation, depression, delirium, and low blood sugar. Studies show that the system of sensors and health alerts enables seniors to stay 1.7 years longer in independent housing, compared to a control group that did not have the technology⁵. The key is that early treatment can be offered due to



very early detection of health changes, before the health condition escalates. The effect on the older adults is improved functional ability, thereby changing the trajectory of aging.

A vision for the future

Although the in-home sensor system has been shown to work well for clinical decision support, our vision for the future extends its use in several directions. First, we envision its integration into the healthcare ecosystem that includes primary care clinics, hospitals, and electronic health records (EHRs). Health-relevant sensor data from the home should be used to inform diagnosis and treatments in clinics and hospitals. Similarly, in-home sensor data can provide useful monitoring when the patient returns home from a hospitalisation, to help track recuperation. EHRs can aid in proactively monitoring transitions into and out of the hospital. Existing EHRs should be linked to sensor databases, to provide context in the automated analysis of the sensor data. Clinicians should also be able to view new vital signs from the sensor data using electronic interfaces.

Secondly, the data from this integrated system should be accessible for data mining. A large scale implementation would facilitate the learning of new population-based models that can be tailored to individuals, especially pertinent for a variety of chronic health conditions. These models would help in the automated interpretation of tracked health trajectories to better inform health alerts. For example, imagine a system that recognises the specific trajectories of urinary tract infections or heart failure complications. We envision the existing clinical

decision support as an extended system. Currently, it prompts the care coordinator to take a closer look at an individual. An extended system would provide suggestions for possible health problems and what to do next. A validated system of this sophistication would allow its use more broadly with clinicians who may have limited experience or training.

“With delayed treatment, many health problems escalate, resulting in hospitalisations. The result is that older adults and others with chronic health conditions decline, losing functionality, which in turn may lead to a loss of independence and a move to a skilled nursing facility.”

Third, our vision extends the use to consumers and their informal caregivers for improved self-management of chronic health conditions. This especially opens significant challenges in how to convey the information for accurate and meaningful interpretation.

Our interdisciplinary team has begun to work on parts of this vision. We have developed a prototype system for linking the sensor data with an EHR, for the purpose of improving the automated health alerts by bringing in contextual information on medications and health status. The linkage also facilitates automated data mining to learn more detailed health trajectories related to specific health changes. We have begun to derive models of health trajectories for common ailments challenging older adults. Finally, we are also investigating methods to summarise the large volume of data into easy-to-interpret linguistic forms⁶. These new developments

move closer to our vision and offer the potential for significant impact in maintaining health and well-being.

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Accreditation provides certainty in uncertain times

Malcolm Hynd, External Affairs Manager, UKAS, considers how accreditation will assume greater significance for trade after the UK withdraws from the EU

In today's global marketplace, having confidence in the quality of goods and services is a vital component of international trade. This is especially pertinent given the uncertain economic and political outlook following the UK's decision to leave the EU.

Accreditation is a tool for ensuring the competence of organisations to carry out one or more specified assessment tasks. Its *raison d'être* is to provide confidence for consumers, purchasers and regulators in the goods and services they use. The United Kingdom Accreditation Service (UKAS) is the Government appointed National Accreditation Body for the UK. Its role is to check that organisations providing conformity assessment services such as certification, testing, inspection and calibration services, are meeting a required international standard of performance.

Maintaining standards

There are hundreds of standards and disciplines that can be underpinned by accreditation, with perhaps certification being the most relevant to business operation. The most commonly used are ISO 9001 for Quality Management Systems and the Environmental Management Systems standard ISO 14001. There are many other aspects of business life that can be certified, including Products, Personnel, Information Security, IT Services and Occupational Health & Safety.

Companies big and small use independent conformity assessment services either through choice (e.g. to reduce the risk of product failure) or as a consequence of legal requirements (e.g. health and safety regulations). Beyond satisfying the legal requirements in certain industry sectors, accreditation also offers market differentiation and shows credible evidence of best practice.

Lowering barriers to trade

Accreditation is a global activity that delivers certainty

in uncertain times, creating trust on a world platform. Navigating different national regulatory regimes can be a stumbling block for UK companies, especially when dealing with testing and inspection requirements. From the outset we have been instrumental in the adoption of mutual recognition agreements that provide for the international acceptance of certificates issued by UKAS and accredited organisations in over 90 different economies.

This "accredited once accepted everywhere" approach avoids unnecessary duplication of conformity assessment, saving an organisation time and money, thus making a major contribution to UK trade. It also helps to develop international trade by facilitating the acceptance of goods and services across national borders and lowering technical barriers to trade.

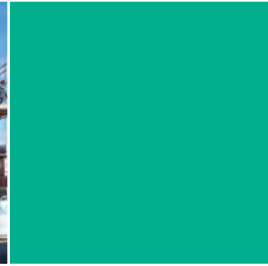
Post Brexit trade

Despite the result of the EU referendum, UKAS does not expect its international the status and the status of certificates issued by accredited organisations to change in the foreseeable future. Whilst the situation following the UK's exit from the EU will depend on the terms of any agreements negotiated, we expect the international recognition of our certificates to continue through our membership of the European co-operation of Accreditation, the International Laboratory Accreditation Co-operation and the International Accreditation Forum. Indeed, given the new trade agreements needed, accreditation is likely to assume even greater importance as we move forward to a post-Brexit world. ■

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Carbon neutrality: Phasing out coal by 2030 in Finland

Riku Huttunen, Director General, Energy Department at the Ministry of Economic Affairs and Employment shares Finland's ambition to achieve carbon neutrality

Finland's long-term goal is a carbon-neutral society. This objective will not be easy to reach, but we believe that it is possible to achieve by 2050. The challenge is particularly huge in the energy sector. Approximately 80% of all greenhouse gas emissions in Finland come from energy production and consumption, when energy used for transport is included. Much of this is due to the cold climate and long distances as is widely known.

In addition to a carbon-neutral society, Finland's energy policy focuses equally on safeguarding energy supplies under all conditions and maintaining and improving the nation's ability to compete in international markets. All these 3 goals must be kept in balance on this journey.

How to become carbon-neutral

In 2014, a Parliamentary Committee on Energy and Climate Issues published an "Energy and Climate Roadmap 2050". The roadmap focuses particularly on energy production and energy systems/infrastructures, energy consumption, other sectors, and cross-sectoral activities. In order to meet the targets set for reducing emissions, the energy system must be changed virtually emission-free by 2050. In working towards the goal of reducing greenhouse gases by 80–95%, Finland must in any case increase the use of renewable energy sources – particularly domestic bioenergy – and capitalise on the potential of increasing energy efficiency and developing cleantech solutions in all areas of industry.

The Paris Agreement on Climate Change requires that during the latter half of the century the emissions and carbon sinks must be in balance. Regarding in physical terms, this balance can be reached even sooner, by 2045, in Finland. This is when our forests would sequester all the fossil emissions generated in Finland.



Riku Huttunen

In the international context this would place Finland among the highly ambitious countries.

Meeting the 2030 Energy and Climate targets

The Finnish Government approved the National Energy and Climate Strategy to 2030 on 24 November 2016. The National Energy and Climate Strategy outlines the actions that will enable Finland to attain the targets specified in the Government Programme and adopted in the EU for 2030, and to systematically set the course for achieving an 80–95% reduction in greenhouse gas emissions by 2050.

According to the guidelines, the share of renewable energy of final energy consumption will rise to over 50% in the 2020s. The long-term goal is for the energy system to become carbon neutral and to be strongly based on renewable energy sources. In addition, the possibility to move into an economy completely based on renewably energy in 2050 has been assessed.

Finland aims to phase out the use of coal for energy during the 2020s. New power plants or replacement



investments that are based on burning coal must not be made. The complete discontinuation of using coal for energy will require strong tax steering or legally prohibiting the use of coal. During the current government term, a proposal will be prepared for an act on the transition period of discontinuing the use of coal as an energy source by 2030, taking into account aspects related to the continuity and security of energy supply and emergencies.

Measures to reduce emissions in transport involve mainly road transport, where there is the largest potential for emission reductions. The share of transport biofuels will be increased to 30%. The goal is for Finland to have a minimum total of 250,000 electric vehicles and a minimum of 50,000 gas fueled vehicles by 2030. The energy efficiency of the transport system will be improved e.g. by developing new transport services, influencing modes of travel and transport and utilising intelligent transport methods. Domestic production of advanced transport biofuels using by-products of forest industry and forest chips will increase notably.

The domestic use of imported oil will be halved during the 2020s, i.e. petrol, diesel, fuel oil as well as jet fuel and kerosene, compared to the total amount of energy in 2005. The greatest non-ETS sector reductions in emissions will be achieved in the transport sector. These operations will then directly reduce the energy use of oil. Also, measures proposed for the individual heating of buildings and for machinery are targeted to reducing the usage of oil. ■

Riku Huttunen
Director General of the Energy Department

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FinnFusion: Advancing fusion research in Finland

The FinnFusion Consortium focuses on two centres of excellence, fusion power plant analysis and remote handling, explains Dr Tuomas Tala. An essential objective of FinnFusion is the transfer of skills to industry

Fusion energy is a CO₂-free nuclear energy source with low environmental impact using ubiquitous fuels. Fusion electricity together with other energy sources could meet predicted energy supply shortages. On the basis of current research, fusion electricity using magnetically confined plasmas could be available in the second half of the century. ITER is the key facility in this strategy and the DEMO design, as well as the research and development (R&D) will benefit largely from the experience gained with ITER construction and operation.

EUROfusion Consortium is an organisation implementing the EURATOM fusion research programme in parallel to ITER construction. Finland joined the EURATOM fusion programme in 1995 when Finland became a member of the EU. Through participation in the European fusion programme the national objective was to develop critical competence networks to major European organisations involved in developing fusion energy. As a small country Finland concentrated its efforts on a small number of focus areas, plasma physics, material science, novel steel structures and remote handling. In 2004 Finland was chosen to host a remote handling laboratory, ITER Diverter Test Platform 2 (DTP2) in Tampere.

FinnFusion Consortium

During Horizon 2020, the FinnFusion Consortium was established in 2014 to replace Association Euratom-Tekes. VTT Technical Research Centre of Finland Ltd is co-ordinator in the FinnFusion Consortium and science/technology universities and private companies are also members in the consortium. FinnFusion Consortium is linked to EUROfusion Consortium via VTT. The roles of funding organisations and other key stakeholders are described in the FinnFusion organigram in Figure 1.

The FinnFusion Consortium focuses on two centres of excellence, fusion power plant analysis and remote handling explains Dr Tuomas Tala. An essential objective of FinnFusion is the transfer of skills to industry. With this position, Finland remains strong in European fusion research and will take advantage of the synergy between fusion and fission expertise and their current separate networks.

The main goal of the Power Plant Analyses and Materials and Remote Handling R&D Centres of Excellence within FinnFusion are the following:

- Foster the growth of expertise in fusion plant operation; know-how transfer to Finnish decision makers, industry involving SMEs, research units, universities and the public;

- Lead experiments in present fusion research facilities at ITER, JET (UK), ASDEX-U and W7-X (DE), DIII-D (General Atomics, US), C-Mod (MIT, US);
- Exploit the synergy between fusion and fission R&D, such as requirements and specifications for the ITER fusion plant simulator, radiation and reactor safety, the design phase of the so-called Early Neutron Source (for neutron resistant material project);
- Develop new technologies (e.g. surface processing techniques) and advanced materials (incl. steels) for fusion power plants;
- Develop systems engineering and remote handling skills. Systems engineering is a key method for upgrading all kinds of industrial activity.

The main achievements of the Finnish Fusion Programme (presently FinnFusion) in 1995 to 2016 can be summarised as follows:

Starting from scratch in 1995, the R&D program has developed to the level of about 50 ppy/a, with around 150 internationally well-networked fusion experts involved in more than 30 companies and 6 research organisations. This has enabled Finland to win ITER procurements, to learn and upgrade its competences, and to

create networks both within industry and research organisations.

After long-term investment in relevant R&D by various FinnFusion activities, Finnish companies and research organisations have gained access to several large international consortia responsible for ITER procurements.

The characteristics and future of FinnFusion

Finland is considered as a well-respected partner in the European fusion programme and therefore has committee members and leaders in many of the key positions.

The peculiar and unique feature in FinnFusion, among the other European fusion research units is the strong involvement of technology and industry in all fusion energy related activities. One example is the Diverter Test Platform 2 laboratory hosted by VTT and located in Tampere. In fact, there is knowledge and expertise on fusion technology in around 30 Finnish companies and FinnFusion is focusing more than half of its fusion research efforts on fusion technology and engineering related topics. In recent years, the fusion and fission research and existing industry around the fission infrastructure have been brought closer to each other and fruitful connections and synergy effects have been established.

The other special feature in FinnFusion is the close collaboration of all participating members, including the research laboratories, funding agencies, authorities and private companies. Therefore, as all bodies involved have a common goal in the organigram presented in Figure 1, the FinnFusion is an organisation functioning in an efficient way.

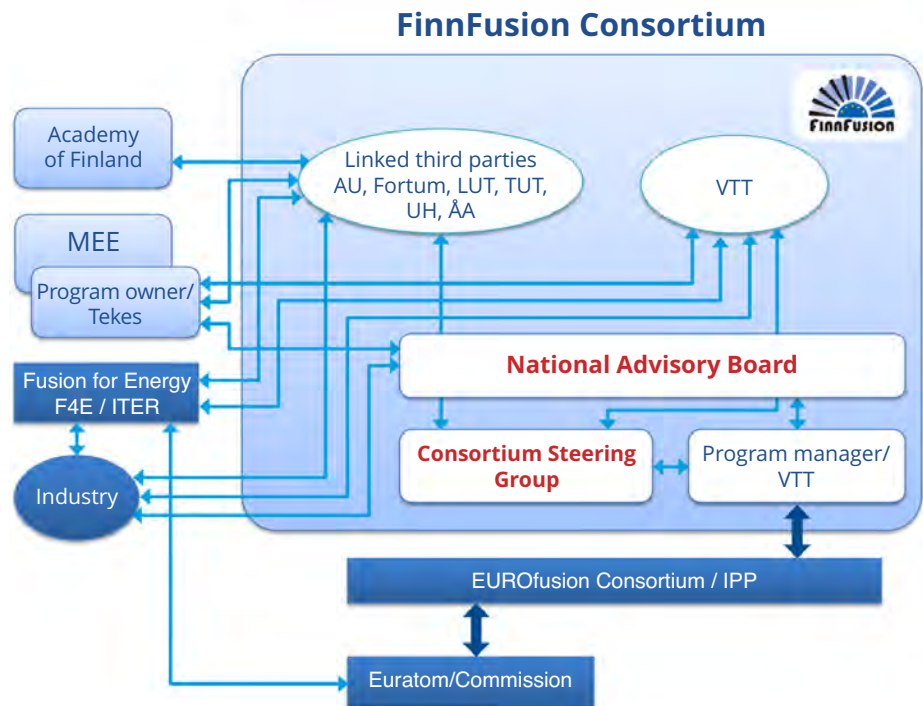


Figure 1: Organigram of the Finnish participation in the European fusion activities

ITER is a unique, and probably the most challenging scientific and technological project ever accomplished on earth. Participation of FinnFusion in a very large international programme has major scientific, technological and economic benefits. For Finnish industry and the research units, the ITER Project is an effective platform for developing expertise, networking and prestige. The level of new skills, technologies, expertise and networks are immeasurably high – FinnFusion must be proactive in exploiting all the benefits from the project. FinnFusion is well adapted to the ongoing change in the international trend from academic to project-oriented work. Strong connection to nuclear technology in line with the industrialisation of fusion is being established right now.

The future challenge is to further exploit these international networks and expertise to national benefits. In particular, the greatest challenge right

now is to find national funding to complement the EU funded projects. FinnFusion is now at an all-time high of its life cycle in terms of the number of research activities, numbers of organisations involved and the magnitude of EU level funding - the future lies in the hands of national funding bodies and authorities on which level the national funding allows FinnFusion to harness the fruits of the hard work in future.



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Is this the second coming of living labs in Europe?

Here, Seija Kulkki, of Aalto University School of Business discusses participative RDI for inclusive transformations and Europe's living labs

Since the 1990s we have witnessed a global spread of ICT, clouds and digital technologies. In the history of technological advancement of humankind, these are revolutionary technologies that have transformed – not only functionalities and efficiency of machines and devices – but also structures and processes of local and global industrial production and delivery. Moreover, these technologies have transformed the everyday life of human beings, as we have learnt from the internet, social media, intelligent traffic and digitalised welfare services that benefit from devices such as mobile phones, cars, computers, and refrigerators, in everyday use of humans. This informs us about new methods of modern human life in a digital era. The ICT, clouds and digital technologies have changed communication, information, and knowledge relations between all the economic, institutional and social actors, including individual humans. We argue that these technologies are relational and consequently structural by nature. They form a new relational infrastructure penetrating economic, social and human life.

They also carry a strong potential of changing our perception of economic, social, and human structures, processes and relations. The World Economic Forum (2016)¹ argues for the next industrial revolution that it builds on and benefits from digital plat-

forms, and deals specifically with the information and knowledge of humans. This technological development may integrate physical, digital and biological spheres of life as it builds upon, develops and integrates digital technologies with findings of social and human sciences, as well as with neuroscience, bioinformatics, medicine, science of wellbeing, health analytics and other branches of sciences wherein the human information connection may be created with globally interactive and complex digital platform technologies.

As we see, not only the economic and industrial structures, processes and relations are digitalised; the very same takes place deeply in relation to structures, processes, and relations of social and human life. Both are undergoing a strong 'technologisation'. The World Economic Forum foresees that this transformation will be unlike anything humankind has experienced before. Consequently, we argue that the issue is not only about economic or industrial efficiency and renewal; the issue is about the nature of the future of human life.

We argue, however, that Europe has an opportunity to make a major contribution to a more human-centric social and economic development – even globally; Europe has a science, research and innovation policy for solving societal challenges through RDI (research, development and inno-

vation, Horizon 2020, 3rd Pillar) in addition to science and technology (1st Pillar) and corporate RDI (2nd Pillar). By definition, Europe may be better positioned to address in a balanced way, the major societal challenges of our time, many of them caused by overemphasising the role of finance and technology driven globalisation.

Living Labs

Europe has already gained encouraging experiences of human and user centric RDI related to ICT and digitalisation. As early as 2006, during the Finnish EU Presidency and as a part of the official EU Presidency Programme, the European Network of Living Labs was launched on November 20th². By then, the European Network of Living Labs (ENoLL) included 20 actors from 16 European countries.

The strategic goal of the network was to provide open innovation ecosystems in cities and regions where firms, academia, public agencies, developer communities and citizens could collaborate in RDI for new ICT and digital services and business models.

The collaboration included experimentation, piloting, validating and scaling up technologies, services and business models within thematic domains such as media, wellbeing services, energy efficiency, intelligent traffic, rural development and climate action. The network has even experi-

mented for inclusive collaboration where forms of participative RDI with people, developer communities, social networks, academia, cities, and public agencies take an initiative and even a drivers' seat for collaboration with firms for solving societal challenges. This has even taken the human life and nature as a 'centre for orientation', leading also towards more equalitarian value and wealth creation. Locally, the network has had a positive impact on participative democracy development.

Today, the network includes over 400 open innovation ecosystems³ in cities and regions; they are internationally networked and apply means of public and citizen engagement. This is a promising start, with the knowledge and experience of human-centric participative RDI between firms, academia, cities, regions, public agencies and people. Besides this network, there are a rich set of experiences of collaborative RDI with citizens among others through smart cities, future cities and innovative regions' networks.

However, we argue for a 'second coming' of human-centric and open innovation ecosystems such as the European Network of Living Labs (ENoLL). The 'second coming' should concentrate more on inclusive structural transformations around health care and wellbeing services as a system, and around ageing populations, social media, intelligent traffic and transportation, use of renewable energy and energy efficiency, climate action, participative democracy and even public and participative governance.

However, this may imply that Europe may need to consider strengthening the institutional foundations for participative RDI and inclusive trans-

formations; there may be a need for a new European-wide development fund and organisation which promotes and scales up human-centric and inclusive RDI concerning societal challenges in cities and regions.

"Europe has already gained encouraging experiences of human and user centric RDI related to ICT and digitalisation. As early as 2006, during the Finnish EU Presidency and as a part of the official EU Presidency Programme, the European Network of Living Labs was launched on November 20th². By then, the European Network of Living Labs (ENoLL) included 20 actors from 16 European countries."

This also implies that cities and regions open their own RDI functions, and invest in related infrastructural, organisational and funding solutions. They also need to develop related skills and capabilities. Universities may reinterpret their perception and portfolio of sciences to include participative, open and citizen sciences and related innovations. This is a major change in an ongoing 'trajectory' within universities; we have seen social sciences and humanities to loose in the competition with natural sciences and technology.

However, this also means that we interpret the content of social sciences and humanities to include open and citizen science and innovations, and even large-scale experimentation for piloting and validating with citizens and other stakeholders for new solutions of societal challenges. Universities themselves may need to participate in social and economic development and learn to apply and develop participative methodologies, means of action research and

methodologies of societal challenge driven research designs and processes. Universities – perhaps with cities and regions – may even need to invest in new interactive, digital platform-based RDI infrastructures for interaction with citizens on a large scale for data collection, pattern building and even for discussion of RDI outcomes.

We may need major transfer of resources and capabilities towards human-centric, as well as city and citizen driven collaborative RDI around societal challenges. This participative and all-inclusive RDI process may imply over time a new potential as major transformative process within societies – perhaps even for public policy making. This may demonstrate how to substantiate the role and nature of human-centric participative democracy.

¹ Schwab, Klaus (2016): The Fourth Industrial Revolution; what is means, how to respond: The World Economic Forum Annual Meeting, Thursday 14, January 2016

² Press release by Finland's EU Presidency: Helsinki Manifest: Launch of the European Network of Living Labs in November 2006

³ EU: Conference on Open Innovation 2.0 in Amsterdam, May 23-24, 2016 where the number of the European Networked Living Labs as regional or city-based open innovation ecosystems was announced



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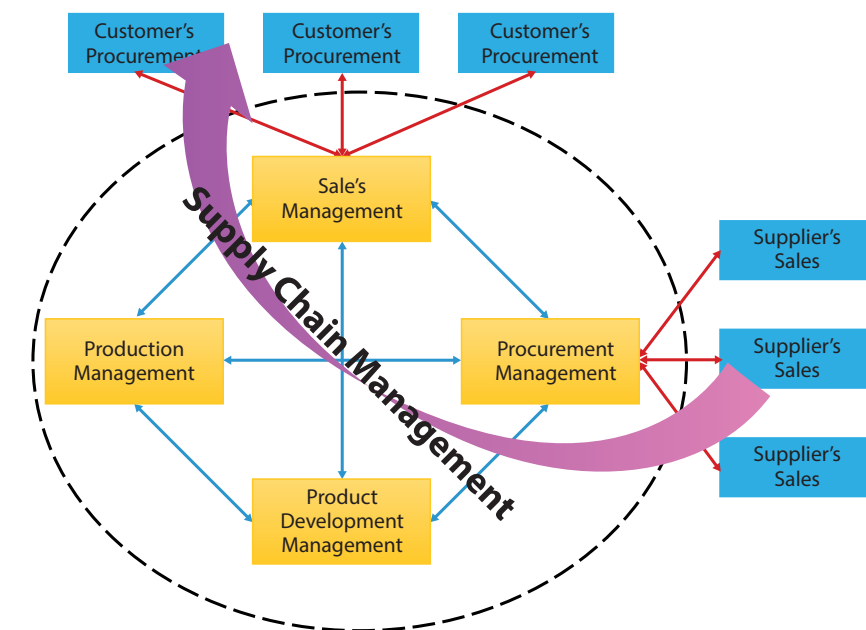
The true value of industrial management and engineering

The Business Competence and Process Management RDI-group outline how industrial management and engineering degrees could be valuable to many businesses throughout Europe

Engineering and economics combined into one very specific profession are typically referred to as industrial management and engineering (IME). This article focuses specifically on the engineering degree in industrial management. There is a huge difference between a business degree and an engineering degree in industrial management. Two very similar points of view for an IME degree are found from Germany (Wirtschaftsingenieur) and from Finland (Tuotantotalous). These degrees are very different to pure engineering degrees or pure business/economic degrees. IME graduates are engineers who have business, management, leadership and communication studies integrated to their engineering studies. A pure engineering degree includes very few business and management studies, just as pure business or economic studies include very few engineering or natural sciences studies if any at all.

Sales, procurement and production are key

When simplifying, we found that sales, procurement, production and product development are the core operations in every business or public organisation. Without sales, there is no business done or no value created in a public organisation. All organisations need customers, and sales should be recognised to be the main operation when providing products or services to a customer. Production should be understood so that all organisations



have it. From an IME point of view, kindergartens, shipyards, a logistics company, machine workshops or hospitals all perform some sort of production. They produce value for the customers. No single company or organisation can produce value from nothing. Materials, energy, tools, machines, different accessories, sub-contractors and suppliers are all needed in their production. Therefore all organisations need procurement. All organisations provide products or services. They are developed and they need to be further developed to stay competitive in future markets – to do this organisations need product development. When scrutinising an organisation's situation and environment more holistically, supply chains and value networks should be understood. These aspects and operations

are in the core of IME. Therefore, all of these subjects should be covered in IME education.

Figure 1 illustrates crucial connections between these core operations: Sales and production have to synchronise their operations; when the orders can be delivered; and which batches are the most profitable are discussed, to name a few. Sales and product development are communicating all the time, as sales are giving market information to product development and the latter one is providing product knowledge and technical support to sales. In many cases the cost of the product or service consists of 60-80% outsourced materials and other purchased items or services, it is clear that sales and procurement should coordinate their operations tightly.

Figure 1 also shows that production and product development should cooperate constantly in order to keep developed products and services feasible to produce, and lead times as short as possible. Product development is also communication with procurement in order to keep products cost effective and ensuring short lead times. Product development is also probably the most crucial operation when thinking about the cost of the final product or service. Some studies have shown that 70% of the total cost is set in product development. As procurement has to ensure that production can run smoothly, without shortages from subcontractors or materials, these 2 operations should also coordinate their activities. As in many cases, the majority of costs are generated in purchasing activities, procurement has a vital role in keeping organisation costs down. Aspects discussed above show that most of the efforts in IME education should be set to competencies including sales, procurement, production and product development.

At the Turku University of Applied Sciences, in the industrial management and engineering degree programme students have compulsory basic studies from all of the discussed subjects and they can choose 2 or 3 of these competence entities to study further. Every student also chooses which technical engineering they are focusing on. Possibilities vary from maritime engineering to bio and well-being technologies. This gives students the possibility to focus on very different competencies and positions.

The value of European trade for IME engineers

Despite the fact that all organisations should utilise IME engineers to develop their processes and operations, most

of the graduates go on to work for companies in the technology sector. When thinking about the value of European technical trade, it is easy to see the reason for this. The internal trade between the EU Member States had an annual value of over €3,063 billion in 2015. The EU's internal market mainly consisted of manufactured products. Their share was 80% of the total intra-EU goods export. Exports to regions outside the EU also consisted mainly of manufactured products. These products represented about 80% of the total annual EU exports. In 2013 the value of exported machinery, vehicles, and other manufactured goods reached €1,365 billion. Adding together the total value of technical intra-EU trade – more than €2,000 billion (80% of total trade), and more than €1,300 billion extra EU-trade – gives a total of €3,300 billion of trade. These numbers are not counting sectors other than manufacturing and they are not counting member states internal trade. It is emerging that IME engineers are hired to hospitals and other non-technology industry organisations in growing numbers. This is because IME engineers are ideal for process development and other leading positions in organisations. It is no coincidence that many Finnish publicly traded company CEO's have an M.Sc. in industrial management and engineering.

When thinking about modern, complex value networks, at least in high-tech branches, but also in every public organisation it is quite clear that they need more professionals who are capable of communicating between technology and business, as well as being able to manage these complex operations and coordinate their own. The European economy still needs many more hard-core engineers, economists and business profession-

als, but this alone is not enough. There is a tremendous need for the interfaces between these professionals and companies. At the same time, the number of interfaces is increasing exponentially when organisations are focusing on their core competencies i.e. more transactions are made, more organisations are developing their products and services and more organisations are producing their value. These trends require that more IME engineers are needed. They also need to ensure that all of the present students will have very promising career possibilities. As a conclusion, it can be stated that IME engineers are going to be the saviours of the European economy.



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Finland has embraced the fight against climate change

Editor Laura Evans outlines how Finnish Minister of Agriculture and the Environment Kimmo Tiilikainen is taking on the fight against climate change

Finland like many other countries is currently in the midst of a fight against climate change. Following on from the meeting in Paris last November, the Agreement that came into force will certainly be implemented in Finland. Minister of Agriculture and the Environment Kimmo Tiilikainen believes that the country has every opportunity to serve as a model country in climate and energy policy.

By 2050, the Finnish government aims to reduce emissions by 80 to 95% in comparison to the levels in 1990. According to their Energy and Climate Strategy, there should be 250,000 electric cars and 50,000 gas cars in use by 2030. As well as having at least a third of the road transport fuel coming from renewable sources by the same period. Finland is by no means ambitious with their climate energy goals, and is making the most of available new solutions in order to achieve them, as well as boosting employment.

"In Finland this balance can be reached sooner, in 2045 at the latest," says Minister Tiilikainen. "This is when our forests would sequester all the fossil emissions generated in Finland.

"In the international context, this would place Finland among the highly ambitious countries. Of the other countries, Sweden for example, has set similar targets."

A balancing act

The Paris Agreement means that by the latter half of the century, emissions and carbon sinks must be in balance. Ambitious Finland is in no doubt this can be achieved. With regards to forest sinks, the country is one of the top countries in the EU. Their forests generate around 30% of the annual emissions in Finland.

Due to sustainable forest management, which pro-

motes the growth of woodlands, the carbon sinks will remain high in years to come and the government is aiming for them to be back to the current level in 2035.

"About a decade ago, several paper and pulp mills were closed down in Finland," says Tiilikainen. "Now new investments and increased use of wood are bringing significant numbers of jobs and boosting our exports and national economy.

"Actions should be targeted to wood building, which sequesters carbon on a long-term basis, and new innovations. Together with the other Nordic countries, we can be the trailblazers of ambitious climate policy."

Achieving climate goals

Finland has a great commitment to sustainable development and achieving these climate goals. In 2015, the Minister placed great emphasis on water and its important role in the 2030 Sustainable Development Agenda.

"The conservation, restoration and sustainable use of biodiversity can provide solutions to a wide range of societal challenges," the Minister stressed.

Speaking in New York in 2015, Minister Tiilikainen said: "Water sustains life – it is essential for people and the planet. Therefore, water is a crucial element in the 2030 Agenda for Sustainable Development as a separate goal and as a cross-cutting issue.

"Water affects poverty eradication and is a core element in healthy lives and well-being, as well as, in gender equality and empowerment of women and girls. Water is essential within the framework of sustainable management of natural resources and with regard to our fight against climate change.



“Consequently, it is important for sustainable economic growth. In addition water has a strong security aspect.”

Declining biodiversity

In Cancun last year, the Minister stressed the need for more to be done for the well-being of biodiversity. Speaking at a High Level Luncheon Event on Biodiversity and Sustainable Development in Mexico, Tiilikainen called for a wide approach to tackle the decline of biodiversity. His address also concentrated on the role of sustainable management of commercial forests.

“The conservation, restoration and sustainable use of biodiversity can provide solutions to a wide range of societal challenges,” the Minister stressed.

“In Finland, the outlines for targets and actions concentrating the commercial forests are brought together in our National Forest Strategy 2025. It integrates all forest-related targets that come from different international, EU and national strategies and programmes.

“They cover biodiversity, sustainable development, energy and climate, as well as rural and regional policies.”

Policies such as these are integral to ensure Finland continues on its goal for sustainable economic growth. As well as fighting against climate change, the country is showing its commitment to the surrounding environment, such as biodiversity, forests and water. All three elements are key factors in Finland’s objective to be a model country with regards to climate and energy. ■

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Sustainable water treatment with Arctic attitude

Professor Riitta Keiski, Dean of the Faculty of Technology, University of Oulu talks about the importance of sustainable water treatment in Northern Finland

The Faculty of Technology at the University of Oulu combines versatile and cross-sectorial research expertise on treating arctic water and wastewater streams in a sustainable manner. The knowhow is adapted globally also to areas characterised by drought and high population densities.

Unequally dispersed freshwater reservoirs constitute 3% of the planet's water deposits. The proportion is decreasing due to climate change effect, growing needs of human populations, and frequently occurring soil and water contaminations. In the Northern hemisphere, freshwater is deposited as snow and ice layers in addition to surface and groundwater basins. Finland located in the Arctic Circle is known for the thousands of lakes and rivers which run into nearby seas, mainly the Baltic Sea and the Arctic Ocean.

Faculty of Technology, University of Oulu

The University of Oulu is located in Northern Finland where mining, steel, and the forest industry are frequent. In addition, harsh climate and delicate nature set special requirements for the water treatment. Strong industry and geographical location with a relatively short distance to the Arctic Ocean have created innovative scientific research that pushes the boundaries of the well-known. Besides steel, automation and production research, the Faculty of

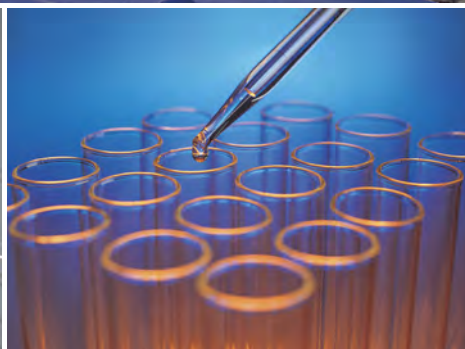
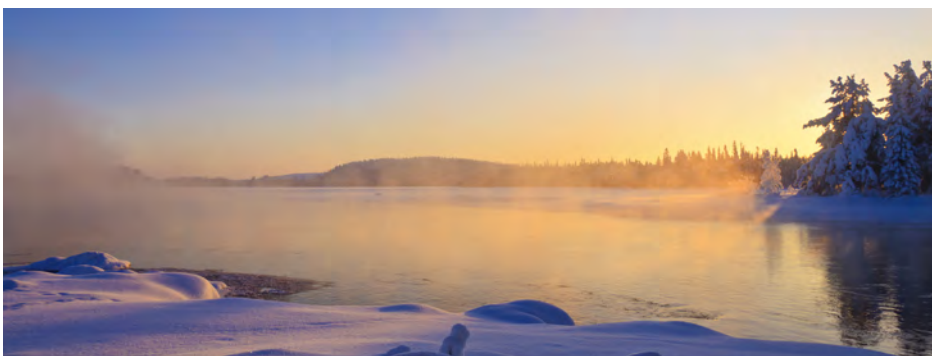
Technology is recognised for its high quality clean technologies, environmental engineering, as well as circular and bio-economy competences. Close cooperation with national and international research partners, industry and end-users have promoted a multidisciplinary approach to water research. We have gained excellent knowledge in hydrology, water resources, water and wastewater treatment, water supply, environmental engineering, modelling and management.

We work with water protection and treating on mining, forestry and peat harvesting areas, as well as water management related to industry and communities. While working on global, European and national issues we also plan, facilitate, and conduct research to help resolve regional and national water related problems. We strive for a strong societal impact. We promote technology transfer, the dissemination and application of research results to societal needs and stakeholders. Sustainability and the carbon footprint of water maintenance are researched as well.

Novel wastewater treatment techniques with low-cost green materials and the role of a system and control engineering approach, and versatile water purification techniques are among our research focus areas. One of the main ideas is to use local wastes and by-products in the development of water treatment, materials

and chemicals, and to recover and utilise valuable compounds existing in aqueous streams. This includes e.g. studies around the following timely research topics in water and wastewater treatment:

- Local bio-based adsorption materials from agricultural and forestry residues for e.g. arsenic, heavy metals, organics and pathogenic microbes' removal;
- Advanced oxidation processes, e.g. photocatalysis and wet air oxidation, for the degradation and utilisation (H₂ production) of organic pollutants in wastewaters of e.g. pharmaceutical industry and water purification plants;
- Membrane techniques including starch and micellar enhanced membrane technologies in the separation of cations and anions, e.g. heavy metals, nitrates and sulphate from e.g. mining and industrial wastewaters;
- Hybrid materials and methods for water purification, e.g. combining adsorption, photocatalysis and membranes;
- Green water treatment chemicals and materials based on functionalised celluloses, and bionanochemicals based on sawdust, bark and peat;
- Electrochemical precipitation in the treatment of water impurities; and



- Prevention of fouling of surfaces in aqueous environments, e.g. water treatment facilities, on-line sensors and heat exchanges.

The automation research in water and wastewater management includes for example:

- Operation of water distribution systems (WDS) and practical applications related to short-term management of hydrodynamic networks;
- On-line optical monitoring of processes to predict effluent quality in a full-scale wastewater treatment plant;
- Data analysis, simulation, and the development of predictive models, trend analysis and digital imaging of wastewaters in municipal and industrial environments; and
- Fast and accurate 3D laser scanning method at subsea applications such as monitoring of underwater structures.

Visions for the future

Water related research is becoming

more important due to the increasing world-wide clean water need, water pollution and tightening environmental legislation. Global scarcity of pure drinking water is a driving force in developing cheap and easy to use water purification systems. In future, sustainable, highly selective and advanced smart materials and chemicals are provided for water purification. Low cost, effective and environmental friendly materials are increasingly coming into use as water treatment technologies. Besides on-line analysis and automatic measures, as well as future applications in the digitalising world, via industrial internet-of-things and applications towards cyber-physical systems in the industry and infrastructure are needed.

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Ensuring the preservation of biodiversity in Finland

Petri Ahlroth, Director of the Natural Environment Centre, Finnish Environment Institute explains why it is important to protect biodiversity in Finland

Finnish Environment Institute SYKE is both a research institute, and a Centre for environmental expertise. SYKE forms part of Finland's national environmental administration. Natural Environment Centre is of SYKE's centers. It has mainly concentrated to work around the questions on terrestrial biodiversity and ecosystem services.

Here Director of the Natural Environment Centre, Petri Ahlroth answers Open Access Government's questions with regards to protecting biodiversity in Finland.

How important is it to protect biodiversity in Finland?

The importance of protecting biodiversity in Finland does not have major differences compared to other European countries. In the most northern areas population density is low and land use is not intensive. Also, the proportion of protected areas is high compared to Southern parts of the country. Major threats for the biodiversity in the north are climate change and the overgrazing of oversized reindeer populations.

Southern and central parts of the country are a mosaic of forest, mires and lakes. The use of forests (forestry) is very intensive, and its influence can be seen outside protected areas. Peat taking has destroyed huge areas of mires and at the same time polluted large numbers of lakes and rivers. The proportion of protected areas has been increasing slowly and large areas of forests and mires have been restored. However, current resources do not cover all needs of biodiversity (BD) protection.

Other needs on BD protection are closely related to the needs of management activities at semi-natural habitats. Changes in the agriculture and lack of pasturing animals are strongly limiting the BD of fauna and flora of open habitats. At the moment it is not easy to find enough resources for the management of open habitats.

What challenges come with protecting natural environments and endangered ecosystems?

There are almost always some conflicts of interests between BD protection and economical needs. Some of the conflicts can be also between different groups who are interested in the same resources, but have different targets, for example hunters vs birdwatchers and photographers.

How important is research for biodiversity and gaining more knowledge about how to protect our natural environment?

Biological research has originally raised almost all environmental problems to public discussions. Scientific data and evidences are often the minimum requirement for any way out from the problem. However, at the moment political decision makers are trying to ignore scientific truth. This is a new and scary phenomena of this time.

For the scientists, doing science alone is not the only way to try to have an impact on the protection of biodiversity. Scientists need to "put themselves on fire" sometimes and do some rough popularisation of their knowledge. Scientific facts also need to be told in a language that everyone can understand.

What can we learn from the natural environment in Finland in order to tackle major global problems, such as climate change?

Finland and other Nordic countries demonstrate the selfishness of people very well. Even if the standard of living is high, nothing is enough. There is this idea that, if I can get some extra benefit I will, no matter what the consequences are – which is very strong. This is a primitive feature, which rises from the evolution of man. Those who have resources have better fitness. There has never been such evolutionary pressure

which would have created the thinking of moderation. Even if we think ourselves as clever beings, we are still slaves of our primitive needs. No matter how educated people are in certain nations. This phenomenon is not only in Finland, but globally behind the ineptitude to solve the problems like climate change, biodiversity loss and pollution.

How does the work you do go towards the protection of biodiversity in Finland?

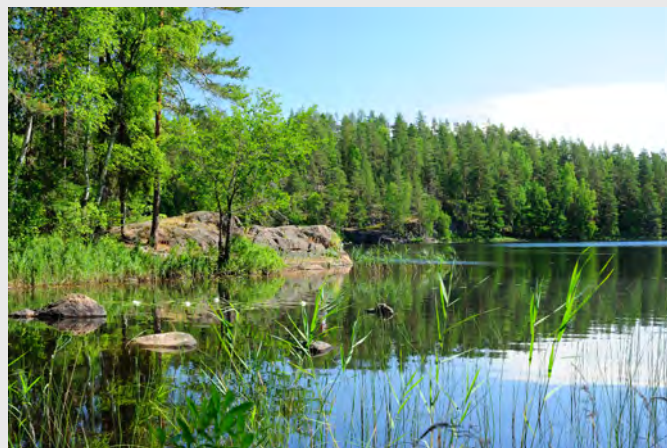
We can only do our best and try to renew our thinking to find a new solution for the ever increasing problems. One way out is to find new partners and start new types of co-operation between those new partners. Protection of BD needs to be cross-cutting through the whole of society. This can happen only if markets – investors and decision makers together – find the benefits of BD protection. We have tried to absorb learn this in Finland and some success already exists, but we are still in the very early stages of such thinking at the national scale.

How is biodiversity monitored?

Some 10 years ago the EU financed a project called (EUMON), which tried to collect all European BD monitoring together. However, this project was not carried out very well, but it may provide some useful information. In Finland monitoring data comes from 10 different resources, as well as being produced by different authorities (research institutes, NGOs, scientific societies, citizen science, etc...).

In Finland (as with most Northern European countries) species knowledge is at a very high level. The availability of literature is excellent and on social media there are several sites where people can find help for the identification. Thanks to the availability of information, it is easy for everyone to bring small pieces of information for several citizen science systems.

In Finland, the Ministry of Environment and SYKE have “light” coordination on specialist groups for the habitats and species. There are around 15 different species specialist groups and around the same number of habitats specialist groups. In each group there are around 10 specialists. These groups are mainly working on voluntary basis, but the Ministry of Environment provide some small support for the groups (meeting and some travel costs, financing for some small projects). The groups are responsible for strengthening the data



gathering and they also carry out the assessments for the red data books. The amount of work they do is amazing. For the environmental sector the financing of these groups is very cost effective.

How are natural habitats protected and monitored to gain further knowledge about them?

The legislative system behind protected areas is complicated. There are several legal “instruments” which can be used for the protection of nature. Depending on these instruments, some areas are more strictly protected than others.

One field which could be mentioned are those inventories which “Metsähallitus” (forest and park service) carries out in state owned forests. They maintain inventories and data from public protected areas. Those inventories cover several taxonomic groups and all habitat types. However, public resources for the inventories are limited and only around 4% of the species data is collected by public authorities, and 96% of species observations are based on citizen science. At the moment all resources which maintain species data together maintain around 50-70 million observations. ■

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The key to sustainable growth is in the oceans

Often seen as one of the most overstretched resources, the seas offer one of the best avenues for sustainable growth if utilised correctly

Humankind is faced with great challenges. Studies show that the rapidly growing population needs 50% more food, 45% more energy and 30% more freshwater by 2030. Diminishing land space and overexploitation of natural resources obviously lead to higher costs and increasing social conflicts.

The oceans cover more than 70% of the Earth's surface but only 4% of the nutrition comes from the marine areas. However, the production potential of fish and aquatic plants is several times that of conventional land cultivation and meat production. For the past 2 decades fish farming has been the most rapidly growing form of primary production and it has already passed the volume of beef production.

Marine areas have the potential to sustainably produce 4 times more electricity than what humankind is using

now. Currently marine renewable electricity production represents only around 0.2% of the total production. Meeting the growing need for energy is expected to lean strongly on renewable offshore solutions. We can already witness significant offshore wind power growth in Europe.

Oceans and seas will be viable responses to the global water crises. So far the main challenge in utilising these resources has been the energy cost and carbon footprint of desalination. Combining marine renewable energy production and desalination would reduce CO₂ emissions and enable the production and storage of drinking water when there is oversupply in energy.

Most of the world's megacities are located on seashore. Floating buildings may be a solution to the housing shortage and other community planning challenges in

these cities. Floating buildings are able to adapt to rising water levels, which may be important in cities that are preparing for the effects of climate change.

Industrialisation of the oceans is already taking place. However, pace of the development in coming years may surprise. The change involves great opportunities but also ecological risks. There are still huge gaps in the understanding of the impacts of human activities on the marine ecosystems and their resilience and capacity to recover. There are also e.g. deficiencies in understanding long-term impacts of waves, sea currents or ice loadings on the offshore structures. Enhancing marine knowledge requires investments in research and impact monitoring, as well as constant dialogue on the sustainability.

Blue growth powered by digitalisation

Blue growth is obviously driven by the needs on the market. However, it is strongly boosted by enabling technologies like digitalisation, artificial intelligence and robotics, as well as the advancement of telecommunications technology.

At present, the amazingly rapid development of artificial intelligence and robotics challenges almost all branches of industry. For the blue growth they mean substantial opportunities because work at sea and especially under the surface is often dangerous and costly.

In a few years nanosatellites and 5G networks will make it possible for vessels and robots – as well as people at sea – to be constantly connected to the internet. This will enable remote operations without delay and new kinds of automated and autonomous solutions, e.g. marine logistics in the future will likely be based on autonomous vessels that seamlessly connect the marine and terrestrial logistics networks.

Drivers for change are also cheaper and more miniaturised sensors that enable us to collect enormous amounts of information from the marine areas in a very short time. At the same time, artificial intelligence will enable rapid analysis of the big data produced by the sensor networks.

Blue innovations fed by collaboration and a joint vision

Grasping the opportunities in blue growth requires a

new mind-set where the sustainable growth of the marine sector is viewed as a single entity. A comprehensive perspective helps researchers perceive shared development needs. It would also motivate companies to invest in the development of blue growth solutions. A joint vision would help to understand how the different sectors could benefit from the collaboration.

The current regulatory framework has not been designed with the needs of the modern blue economy. Legislation has to safeguard the sustainability but also enable and encourage the introduction of new, even disruptive innovations. Modern ocean governance, maritime spatial planning and macro-regional strategies are key tools to reconcile environmental and industrial objectives, as well as boosting sustainable blue growth at the international level.

Opportunities for sustainable growth lie in the sea. Enhancing the multidisciplinary collaboration between sectors and strengthening the public-private partnership are key elements in creating favorable preconditions for innovations and growth.

In this respect, the government of Finland is starting a new strategy process to build national coherent and integrated maritime policy. Furthermore, the Finnish Funding Agency for Innovation has invested via the Arctic Seas Programme in establishment of autonomous shipping ecosystem.

We believe that the Baltic Sea region has excellent potential to become a world-class test area for blue growth innovations and modern ocean governance. ■

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A growth strategy for Finnish health research

Academy of Finland's Jarmo Wahlfors shares how key players have developed a growth strategy to ensure a coherent approach to Finnish health research and innovation

Finland has traditionally had strong expertise in health research and innovation. This concerns both basic and clinical research, as well as the utilisation of results in health innovations, better preventions and clinical care. The health sector has so far thrived and developed despite the fact that the public key actors (authorities like ministries, government regulatory agencies, research funders etc.), have worked without too much understanding of each other's strategies, actions and problems. This is probably the case in many other countries, too, but Finland is one of those small countries that just cannot afford undertaking crucial actions incoherently and repeatedly. Recently this has become increasingly important, since

the global competition is getting tougher and the economic situation is tight. Under these circumstances, the political decision makers are expecting profit from the public investments in health research and development (R&D).

A growth strategy for health research

To fix the incoherence problem in the Finnish health sector, 3 relevant ministries (Ministry of Employment and Economy, Ministry of Social Affairs and Health, and Ministry of Education and Culture) and 2 major government research funding organisations (Academy of Finland and Tekes, the Finnish Funding Agency for Innovation) initiated a major effort that resulted in a

common strategy. After hearing all the relevant stakeholders, the Health Sector Growth Strategy for Research and Innovation Activities was published in 2014, followed by the implementation phase, where the 3 ministries and 2 research funders continued to work on one common goal. After 2 years of intense work and following most of the strategy recommendations, a roadmap for 2016-2018 "Innovating together" was published.

Collaboration is key

The roadmap was a milestone for the Finnish health sector, not only because it revealed how successful working together can be: significant progress in the implementation and clear guidelines for the future development. Most importantly, the roadmap convinced the Finnish government about the importance of the health sector – health was adopted as one of the spearhead areas of the government programme, along with bio-economy, cleantech and digitalisation. This also involved additional investments to the health sector – government decided to invest significant amounts of money to the National Cancer Centre and the National Genome Centre, the major building blocks of the strategy.

The growth strategy is based on the idea of innovation ecosystems that evolve around the university hospitals. The cornerstone of an ecosystem is basic and clinical research carried out at universities and university hospitals, covering both the expertise and the research infrastructures. These honey pots then attract other players, especially start-ups and SMEs to utilise the system and create economical value and jobs. Since these ecosystems are as strong as their weakest link, the strategy implementation has involved a number of different actions to enhance their viability. It is important to support the interplay of the ecosystem parts, enhance the research infrastructures and adjust the legislation to enable simple use of data resources like health registries and biobanks.

Academy of Finland

From the perspective of the Academy of Finland, the major public research funding organisation, the crucial

part of the ecosystem is basic scientific research carried out at the universities, university hospitals and state research institutes. Our role in the strategy work is to nurture this cornerstone and keep the building stable. During the strategy implementation, we have deepened our cooperation with the innovation funder Tekes for joint funding actions for health R&D, initiated mapping of the university hospital research infrastructures, continued to support clinical research with a special funding instrument and initiated several new health-related research programs.

It is clear now that we have found a way to go forward. These times are challenging and we truly need to worry about the future of clinical research in Finland, but we are not alone anymore. We are now working together with our colleagues in different public sector organisations and we share the common goal: to keep these health ecosystems alive and developing, to bring well-being and economic value to Finland. It is relieving to know that our colleagues in the economy and health ministries also don't worry only about economic growth or healthcare reform (which are, of course, very important issues to the strategy), but they share our concerns about basic research and understand that the whole structure collapses if the foundation wears out. ■



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Advancing genomic epidemiology at FIMM

Director, Jaakko Kaprio shares the work that is being conducted to progress genomic epidemiology research and develop personalised medicine

The Institute for Molecular Medicine Finland (FIMM) aims to advance new fundamental understanding of the molecular, cellular and etiological basis of human diseases. We are committed to promoting translational research and the adoption of personalised medicine in health care.

FIMM was founded in 2006 as a joint research institute of several Finnish partners. As of 2017 we joined the university's new life science research centre, Helsinki Institute of Life Science, as a scientifically and financially autonomous operational unit. FIMM is located at the Meilahti medical campus in Helsinki – Finland's leading hub of academic medical research and medical care.

Cutting edge technology

To reach our mission goals, we have created a new type of research institute where we integrate molecular medicine research with cutting-edge technology platforms, and a biobanking infrastructure under one roof and focus strongly on a few scientific grand challenges. The grand challenge programmes provide an opportunity to align our research on large and complex issues and draw our researchers, technology experts and clinical collaborators together to achieve a common goal through collaboration.

FIMM is characterised first and foremost by our partnership with the flagship of

European biosciences research, the European Molecular Biology Laboratory (EMBL). As part of the [Nordic EMBL Partnership for Molecular Medicine](#), we follow the EMBL operational model and principles. This means aiming towards scientific excellence and establishing mechanisms for independent, regular scientific evaluation of research activities, scientific integrity and good scientific practice, as well as commitment to international recruitment and significant levels of staff turnover. Another important international network for us is [EU-Life](#), comprising 13 top biomedical research institutes from Europe. FIMM has been a member of this network since 2013.

There is a major global shift towards predictive, preventive, personalised, and participatory (P4) health care, anticipated to promote healthy aging and constrain healthcare costs.

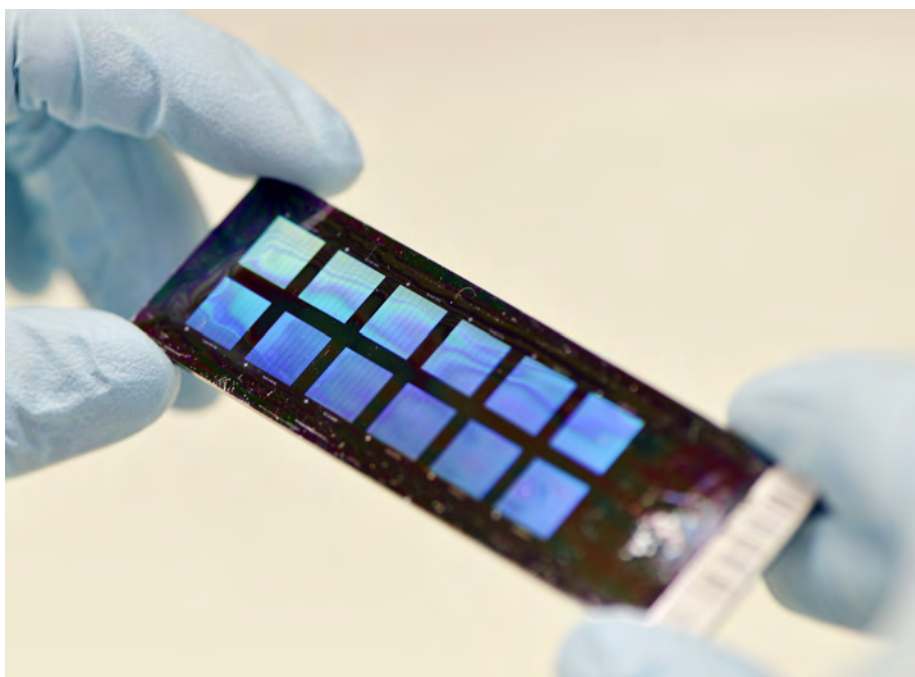
Our vision is to lead Finland into the era of P4 medicine by coordinating the integration, analysis and translation of genomic, molecular and health data in Finland and beyond.

Much of our research draws on the unique clinical and population-based samples collected from the Finnish founder population and on the close partnerships we have with our clinical and industrial collaborators. Through our high-quality science, we are uncovering the underlying causes and drivers of disease, as well as translating med-

ical molecular findings into public and individual health outcomes.

Our research focuses on two main areas: Human Genomics and Preventive Healthcare & Systems Medicine and Precision Therapeutics. We believe that an important way to achieve the best scientific results is to focus strongly on a few grand challenges in society, and for the institute to work together towards these goals.

This work requires unique resources. One such resource at FIMM is the Sequence Initiative Suomi (SISu). Due to Finland's unique population history, the Finnish gene pool is rather exceptional and thus a specific reference dataset of sequence variants in Finns is needed. SISu is a FIMM-coordinated international collaboration project aiming to build tools for genomic medicine by compiling information about the Finnish genetic variation. The freely available SISu search engine provides valuable summary data on variants from exomes of over 10,000 individuals sequenced in disease-specific and population-wide genetic studies. Other resources are the large population-based studies of general health, in particular of cardiovascular health, associated genomics and large gwas samples deposited in Finnish [Biobanks](#). Extensive register-based measures of health supplement these. The biobank data and samples are available for use not only by national and international academic



researchers, but also companies including the vibrant start-up cluster in Helsinki. These form an important part of [Helsinki Health Capital](#) alliance.

A study in human genomics

A large-scale human genomics study that utilises unique Finnish resources is the [SUPER](#) study on genetic mechanisms of psychotic disorders. It is part of the international [Stanley Global Neuropsychiatric Genomics Initiative](#). The objective of the study is to better understand the genetic and biological background of psychotic disorders in order to provide more accurate information for the development of new therapeutics. Finland is the European pilot country and the aim is to collect a minimum of 10,000 genetic samples from Finnish psychosis patients. The national study was launched in early 2016 and will continue for three years. FIMM is leading the study in collaboration with the National Institute for Health and Welfare, THL.

One practical P4 example is our Digital Health Revolution ([DHR](#)) Pilot Study.

The DHR pilot study is FIMM's first next-generation health and wellness research project and part of a national and multidisciplinary Tekes-funded strategic opening. The study combines deep and comprehensive molecular health profiling, digital wellness monitoring and personalised coaching in about 100 volunteers, with multiple assessment waves and lab visits. The main aims are to facilitate preventive health care and personalised wellness and to devise and test strategies and technologies to integrate P4 medicine into current health care systems. The two-year field work has now been completed and it was very well accepted by the participants; first results are expected later this year.

Complementary to the DHR is the cardiovascular study [GeneRISK](#). Current heart disease prediction methods based on environmental and life-style factors are insufficient, failing to detect over half the high-risk individuals. [KardioKompassi®](#) was developed by researchers at FIMM to meet the need for better and more accurate

prediction tools. This next-generation web-tool enables patients and doctors to use genomic data to predict and prevent cardiovascular disease. It uniquely combines traditional medical approaches with multiple recently discovered genetic risk factors. [KardioKompassi®](#) is currently being used in the FIMM-led population-based [GeneRISK](#)-study, with ongoing recruitment of up to 10,000 adults Finnish participants.

During our first ten years we have demonstrated that a Finnish research institute with state-of-the-art technology infrastructures can act on a high international level, in terms of recruiting staff, obtaining external funding, and, most importantly, the quality and impact of science. For further details please see our [website](#) and latest annual online report.



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Reducing the prevalence of childhood obesity in Finland

Childhood obesity can cause major health problems in later life. Open Access Government highlights how Finland is tackling the growing health challenge

Childhood obesity and health is something that has come to the forefront of policy on a global scale in recent years. Reducing rates of childhood obesity is something that requires both national and international actions. Throughout Europe the problem is prevalent; in the WHO European Region, it is estimated that 1 in 3 11-year-olds is overweight or obese.

In Finland, more than half of all adults are reported to be overweight, and 1 in 5 are obese. In adults between the ages of 25-64, 66% are overweight and 20% obese, compared to 46% of women being overweight and 19% obese. In children and young people, 10% of boys and 15% of girls in pre-school age are reported to be overweight in Finland.¹

The Ministry of Social Affairs and Health in Finland has the responsibility of promoting healthy eating and exercise across the country. According to a survey produced by the European Commission in 2000, Finland is in the top 5 countries who are satisfied with their healthcare. It reported that 88% of respondents were satisfied, compared to 41.3% – the EU average.

Juha Rehula is the Minister responsible for family and social services. Public health comes under his remit. In March along with other EU health ministers, Rehula attended an informal meeting with regards to action against children's obesity prevention, as well as action against HIV and AIDS.

At the meeting in Malta, prevention of childhood obesity was one of the key themes as part of the Malta Presidency of the EU. Officials at the meeting attached great importance to reducing childhood obesity and developing action at both a national and an EU level.

In Finland, children's obesity prevention includes a health clinic system, as well as organised day-care and school meals. Curbing obesity in childhood is important as it can help to reduce other major health problems later in life, including diabetes and cardiovascular diseases.

National Obesity Programme

The National Institute for Health and Welfare (THL) works to promote health and wellbeing throughout the country. The main goal of THL is to ensure that people in Finland live good and healthy lives.

In order to reduce the incidence of obesity throughout the nation, the THL coordinated the [National Obesity Programme](#) 2012-2018. The main targets of the programme are:

- Ensuring that fewer children and young people grow into obese adults;
- Ensuring fewer people gain weight as adults;
- Differences in obesity prevalence among population groups become smaller;
- People at risk of obesity-related conditions lose weight or do not gain any more weight.

The purpose of the National Obesity Programme is to encourage different actors from the various sectors of society to take part in the work. Key actors and partners of the programme include municipalities, health services, schools, child day care, sports, community planning, as well as employers and the food industry.

Obesity and its relation to chronic diseases

Linked to obesity are chronic diseases such as diabetes and cardiovascular diseases. In March, [the THL hosted a meeting](#) of the World Health Organization (WHO) expert network, which focusses on the risk assessment and development of the treatment of cardiovascular diseases and type 2 diabetes in primary care.

Research and specialist work on cardiovascular diseases and type 2 diabetes conducted in Finland has earned an international reputation and recognition. WHO coordinates projects that are designed to build practices in primary healthcare worldwide to detect the early risk of people developing cardiovascular diseases or type 2 diabetes, and reduce their risk through appropriate drug therapies, lifestyle advice, and support for lifestyle changes. In Finland, unlike other EU countries, this is an already established operating model that has been used in primary healthcare for decades.

“Curbing obesity in childhood can help to reduce other major health problems later in life, including diabetes and cardiovascular diseases.”

THL Research professor, Tiina Latikainen, who took part in the specialist work carried out in the WHO network, said: “In Finland, primary healthcare has played a key role in identifying, providing treatment, and monitoring long-term illnesses. For us, it is self-evident and considered the basis of cost-effective care that treatment is provided by multi-professional team, and that public health nurses and registered nurses are very much involved in the care and monitoring of patients.”

In order to reduce health problems in children, as well as preventing obesity, Finland is among the few countries in the world who offer a free school lunch. There are also a number of Finnish innovations that are also aimed at promoting healthier lifestyles, which include functional foods, products marked with the Heart Symbol, the health eating plate and non-smoking workplaces and municipalities.

1 <https://www.thl.fi/en/web/thlfi-en/research-and-expertwork/projects-and-programmes/the-national-obesity-programme-2012-2015/support-for-implementation>

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Type 1 diabetes: A serious chronic disease

University of Oulu's Professor Riitta Veijola discusses the impact of Type 1 diabetes on society and the challenges associated with tackling the disease

Type 1 diabetes (T1D) is a serious chronic disease which results from the lack of a vital hormone, insulin, which is normally secreted from the pancreas. All patients with T1D need permanent, regular insulin replacement therapy from the diagnosis. There is currently no means to cure this disease, and in the course of time there are significant risks for the development of vascular complications, as well as early death from cardiovascular disease. – Patients or their guardians are educated to inject suitable doses of insulin subcutaneously by using insulin syringes or pens, or by using an insulin pump. Typically, the treatment requires 5 to 7 daily injections or boluses from the insulin pump. The individual insulin doses need to be adjusted according to the size of the meal, the actual level of blood glucose and activities such as physical exercise. Therefore the blood glucose levels have to be carefully self-monitored by repeated fingertip measurements or using a subcutaneous sensor and continuous glucose monitor, in order to keep the blood glucose levels at the target 24 hours a day, 7 days a week. The maintenance of good metabolic control is known to markedly decrease the risk of long-term micro and macrovascular complications (retinopathy, nephropathy, neuropathy and cardiovascular disease), which are threatening to the patient when the duration of the disease increases. The patients are

also at risk of severe acute complications such as hypoglycaemia and ketoacidosis. The intensive nature of the treatment required is demanding for the patients and their families and increases the risk of psychosocial problems. All these complications have a severe adverse effect on the health and quality of life of the patients and also remarkably reduce life expectancy.

Type 1 diabetes in Europe – adverse epidemiological trends

T1D is one of the most common chronic diseases occurring in childhood and adolescence. Furthermore, the disease is also commonly diagnosed among young adults aged 15-30 years, but could actually occur at any age. The prevalence of type 1 diabetes approaches 1% among adolescents aged 15 years in the high-incidence countries in northern Europe. In Finland the incidence of type 1 diabetes is the highest in the world reaching 64.2/100 000/year in 2005 in children younger than 15 years, which is almost 5 times higher than the incidence in the 1950's. Similar trends are observed in other European countries. It is also alarming that T1D is increasingly more frequently diagnosed in young children aged 0-4 years. This trend may also increase the life-time risk of vascular complications, which are known to be associated with long disease duration and insufficient metabolic control. The reasons for the changing incidence are not known, but the fast pace of the

change implies environmental causes. Epidemiological studies have indicated that there is a slight male excess in the incidence of T1D during childhood, and a sharp increase up to 1.8 in the male to female ratio in the incidence after puberty.

“More than 50 million people in Europe are affected with diabetes, with an estimated 5 million (10%) of them having type 1 diabetes. The economic burden per case of type 1 diabetes is higher than per case of type 2 diabetes, and the difference increases with age.”

T1D clusters in families

T1D occurs more frequently in close relatives of patients with T1D than in the general population. The risk of progression to T1D by the age of 30 is 6% for siblings of diabetic children and increases to 10% by the age of 60. Several studies have reported that T1D is transmitted twice more often to the offspring of diabetic fathers than to those of diabetic mothers (6% vs 3%), the explanation for this difference remaining unclear. Familial clustering of Type 1 diabetes indicates genetic susceptibility for the disease. The strongest genetic risk factor for Type 1 diabetes is class II HLA genotype on chromosome 6. This association was found already in the early 1970's by a candidate gene approach. Class II HLA genes encode a special protein structure expressed on the surface of the human blood white cells, but the mechanisms of how



these molecules mediate the increased risk for Type 1 diabetes have remained unknown. Recent genome wide association studies (GWAS) have revealed an additional more than 50 gene regions associated with T1D. Interestingly enough, the genetic factors identified so far appear to be related to the function of the immune system. This is in contrast to the observation that susceptibility genes for type 2 diabetes (T2D) are genes, which encode proteins regulating the function of the insulin-secreting pancreatic beta-cells.

Type 1 diabetes: A high burden in society

More than 50 million people in Europe are affected with diabetes, with an estimated 5 million (10%) of them having type 1 diabetes. The economic burden per case of type 1 diabetes is higher than per case of type 2 diabetes, and the difference increases

with age. The reasons behind the high cost of treatment for type 1 diabetes are due to the fact that T1D is most often diagnosed early in life, all patients need intensive insulin therapy from diagnosis, as well as careful blood glucose monitoring to maintain good metabolic control and avoid life-threatening hyper and hypoglycaemia. In addition, good treatment requires regular contact with health care professionals, and in the paediatric age group the expertise of a multidisciplinary team including various experts (pediatrician, diabetes nurse, diabetes educator, dietician, physiotherapist and psychologist). With long disease duration the risk of vascular complications increases and emerging complications cause additional contacts with the health care system. For the patient themselves type 1 diabetes is a devastating disease, and she/he is at risk of depression, emotional stress and a feeling of discrimi-

nation. It is of vital importance for the patient that she/he receives the best possible support from health care professionals but also from their family, day care staff, peers, teachers, and the surrounding society. Families of a child with type 1 diabetes experience more anxiety and have more frequent days leave from work than the average family, and the healthy siblings may feel neglected. In day care and at school the staff has to be educated to take care of diabetes, especially in emergency situations like hypoglycaemia. In many schools personal assistants have to be hired for the young children with T1D, who need assistance with diabetes-related procedures during the schoolday. The cost of type 1 diabetes is estimated to be at least €18 billion per year in Europe. Any alleviation in this personal, societal and economical burden, such as prevention or delaying the onset of T1D in children would bring substantial



economic savings and improve the quality of life of the children and their families.

The pathogenesis of Type 1 diabetes is still unknown

The etiology and detailed pathomechanisms of type 1 diabetes are not known. – The current concept is that type 1 diabetes develops as a result of an autoimmune process, in which the immune system mediates a specific attack against the pancreatic insulin secreting beta cells, and this process finally leads to severe insulin deficiency. The development of type 1 diabetes is characterised by the presence of multiple beta-cell specific autoantibodies in the sera of the subjects, which emerge months or years before the symptoms of type 1 diabetes are present (excessive thirst and urinating, weight loss and loss of energy). In long-term prospective studies, such as The Type 1 Diabetes Prediction and

Prevention (DIPP) Study in Finland, the children at increased genetic risk are regularly followed from birth until the diagnosis of T1D. These studies have revealed that beta-cell autoantibodies most often appear very early in life, with a peak at 1-2 years of age. By combining the data from the Finnish DIPP study and other prospective studies, we have revealed that when multiple autoantibodies are persistently present the risk for progression to clinical diagnosis of T1D approaches almost 100% although the time to clinical diagnosis varies. No effective treatment to prevent type 1 diabetes or a delay of the disease process have been identified despite many clinical trials, which have mainly tested various immunological treatments. In order to develop strategies to prevent and cure T1D in the future it is vital to obtain detailed understanding on the pathogenesis of T1D. The autoimmune process, which ultimately results in insulin deficiency

and the diagnosis of type 1 diabetes, most often starts early, at the age of only 1-2 years. This discovery has led to the conclusion that possible exposure and events during the early developmental period of life are critical in the initiation of the disease process resulting in T1D and should be studied more in detail in the future.



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Accessibility for all is not an option – it's a fundamental right

European Commissioner for Employment, Social Affairs, Skills and Labour Mobility, Marianne Thyssen, explains why accessibility is important for all citizens

The European Commission's recently published Progress Report on the European Disability Strategy 2010-2020 shows that the European Union is on the right track. Ten years ago, the [UN Convention on the Rights of Persons with Disabilities](#) was adopted and ever since, the rights of people with disabilities have been gradually reinforced in all EU Member States. The rights of EU citizens have also been strengthened in cross-border situations. The 2011 Directive on the application of patients' rights in cross-border healthcare has facilitated the access to medical care for people with disabilities. Eight EU Member States are also developing a system of mutual recognition of disability statuses via the EU Disability Card, which will ensure equal access to specific benefits, mainly in the areas of culture, leisure, sport and transport. The European Commission has also recently

proposed to coordinate long-term care benefits between EU Member States.

But despite these achievements, challenges remain. As the EU population is getting older, the number of Europeans with disabilities is rising significantly, and their employment rate remains much lower than the one of people without disabilities (48.7% vs 72.5%). In addition, 30% of people with a disability are at risk of poverty or social exclusion in the EU, compared to 21.5% of people without disabilities.

Accessibility

One of the main challenges relates to accessibility. In 2020, it is expected that 1 in 5 Europeans will experience a degree of disability. Many everyday services and products have already become digital. They offer new



Marianne Thyssen, European Commissioner for Employment, Social Affairs, Skills and Labour Mobility

opportunities for people with disabilities to take part in society and in the labour market on an equal basis with others.

Indeed, technological innovation harbours a great potential of supporting social inclusion. But this will only happen if new products and services also have the necessary accessibility features. Otherwise, there is a real risk that technological innovation creates new inequalities between people.

We need to act now and we need to act together. Accessibility is not an option. It is a right and a necessary investment in our future. But it does not happen overnight: it is an ongoing process which adapts as new products, services and infrastructures are developed.

Crucially, it requires political will. The Commission has therefore put the matter at the top of its agenda. The recently adopted European [Web Accessibility Directive](#) will finally bring accessible public websites and mobile

apps. But more remains to be done and I have proposed the European [Accessibility Act](#) to step up accessibility beyond the public sector. The proposal has been identified as a priority file by the Council and the European Parliament and discussions are currently in full swing.

The Accessibility Act makes use of the full potential of our single market to trigger real change in people's lives. It sets common European accessibility requirements for key products and services, in order to step up accessibility and prevent further market fragmentation.

Take a practical example: automatic teller machines (ATMs) used in banks are regulated in some member states, for example as to their height. Did you know that a height considered accessible in France or in the UK is considered inaccessible in Austria?

This is just one example of a product where a lack of common standards is acting as a brake to the internal market. How can we encourage SMEs to invest and create jobs in the face of 28 diverging rules? Can we really expect European research centres and universities to pursue innovative solutions if they have to deal with different national and sectorial rules?

The Accessibility Act will lead to a larger market for accessible products and services at more competitive prices. That's good for business and for consumers. We can't afford to waste this opportunity to live up to our common commitment.

The commitment of national, regional and local authorities, as well as businesses and civil society organisations will be essential to achieve decisive progress. It is only by pooling our efforts that we can make the full and equal participation of people with disabilities a reality. ■

Marianne Thyssen
European Commissioner for Employment, Social Affairs, Skills and Labour Mobility

European Commission

www.ec.europa.eu/commission/commissioners/2014-2019/thyssen_en

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Evidence based health promotion at work



Health promotion in the workplace is a key priority in the 21st Century, explains Jaana Laitinen of the Finnish Institute of Occupational Health

Evidence-based health promotion at work is one of the new multidisciplinary projects that is receiving three-year funding from the Strategic Research Council at the Academy of Finland from 2016 to 2019. Criteria for funding is high-quality research that has a great societal impact. An important element of research is an active and ongoing collaboration between researchers who produce new knowledge and stakeholders and others who use it.

The workplace is one of the priority settings for health promotion

The evidence-based health promotion at work research effort focuses on

workplace health promotion (WHP), integrated with safety at work and occupational health care services.

Optimal outcomes are difficult to achieve in workplace health promotion (WHP) (Rongen et al. 2014). Good health, including healthy lifestyles, forms the basis of workers' good work ability, productivity and safety at work, and thus health promotion is important for sustaining working careers. The workplace has an influence on the physical, mental, economic, and social well-being of workers. Work-related factors such as shift work, low social support, long weekly working hours, and safety issues at work also affect employees' lifestyles. Neverthe-

less, the workplace offers an ideal setting and infrastructure to support the health promotion of larger groups (WHO, 2014).

The main approach of WHP has been the health education of individuals with a certain health risk, in order to prevent lifestyle diseases. However, these actions have not been tailored according to occupations. Obesity and unhealthy lifestyles are associated with decreased perceived work ability (Nevanperä et al. 2015b, 2015c) and sickness absence (Roos et al. 2015), as well as the adverse effect of lifestyle diseases being greater among those with physically strenuous work than among those with light work (Gould et

al. 2008). Shift work increases the risk of obesity, cardiovascular diseases and fatigue, which in turn is a risk factor for accidents.

Healthy lifestyles are the key to minimising the unhealthy effects of night shifts and are important for promoting safety at work. Some workers may be exposed to unhealthy lifestyles by having easy access to drugs or alcohol (health care, restaurants) or pastry and food (bakery and kitchen work). Thus, considering the occupational context may potentially provide meaning and motivation for healthy lifestyles, and the opportunity to develop new WHP activities. As unhealthy behaviours are too common among the working-age population and health care services resources are limited, persuasive technology might be one possibility for helping people make changes.

Furthermore, WHP focus has traditionally been on larger enterprises and companies (Goetzel et al, 2008) that have occupational health and safety plans and actors, as well as OHS. At the same time, an increasing number of people are either becoming small entrepreneurs themselves or becoming employed by one (EU-OSHA, 2015), and in most cases, the WHP practices for large companies are not feasible for small ones. Small companies often lack occupational health services (OHS) and safety organisations that could help them to implement workplace health promotion. Every sick leave and uncompleted task is directly related to lower income among micro-entrepreneurs and self-employed people (Pärnänen, Sutela 2014). In addition, as the economic growth of Finland, and also in many other countries, lies on the shoulders of micro-entrepreneurs, new ways in which to promote their health and work ability are urgently needed.

Our project will provide new ways in which to sustain the working careers of the working-age population, as well as vulnerable groups. As a general framework for health promotion we will use the principles of the Ottawa Charter for Health Promotion (WHO 1986), according to which health promotion activities include building healthy public policy, creating supportive environments, strengthening community or workplace community actions, and developing personal skills and reorienting health services. Advocating is also an important health promotion measure. Co-creation is a way in which to commit target groups to WHP and to tailor measures to suit them, as well as empowering target groups towards “agency” or advocacy.

We aim to produce evidence based WHP guidelines that will be co-created with researchers, stakeholders and actors, and peer reviewed by researchers. Together with the scientific work interaction with different stakeholders and actors is performed from the start of the project. The aim of the interaction is to co-design, co-create, review and start to implement the results and WHP guidelines. Our aim is to integrate WHP plans with organisation’s occupational safety and health plan and or with the operational plans of workplaces’ occupational health services.

About the author

Jaana Laitinen, Docent in nutrition and in public health, is specialised in the intervention studies aimed to promote healthy lifestyles and work ability. Additionally, she has studied the development of unhealthy behaviours in an epidemiological prospective study of Northern Finland in 1966 and 1986, cohort studies. She has been involved in several development projects that aimed to transfer research results into

practice though interaction with workplace actors. The most prominent has been the WHP of professional drivers – Alert behind the Wheel – which had media coverage of 38 million and improved the nutritional quality of service station restaurants.

“Good health, including healthy lifestyles, forms the basis of workers’ good work ability, productivity and safety at work, and thus health promotion is important for sustaining working careers.”

The Finnish Institute of Occupational Health is a specialist in well-being at work, which carries out research, and provides services and training. Together with our clients, we develop well-functioning work communities and support workers’ work ability. Our clients include workplaces, decision-makers, individuals, occupational health units and other organisations that strive to improve well-being at work. Our vision is well-being through work, as it is healthy, safe and meaningful work that creates well-being.



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Teachers are experts in driving social mobility

In a speech, Secretary of State for Education Justine Greening highlights how teachers are inspiring the professionals of the future

Teachers are the experts who inspire the professionals of the future. We shouldn't underestimate just how powerful that is – from architects to academics, geologists to graphic designers, technicians to translators – it is teachers who lay the foundations for the successful careers the young people who are growing up in our country today want and need.

When I visit schools I talk to children and I wonder who they're going to be. What they can be. It is teachers who, on a day-to-day basis, understand and develop that potential to enable and shape those young people to – as it were – become themselves.

Teaching deserves all the hallmarks of the other great professions – with a high bar to entry, high-quality initial training and a culture of ongoing self-improvement.

It's crucial that, like other experts, you now have a professional body with a shared commitment to ever-improving standards, disseminating evidence on what works, and driving progress for the profession as a whole.

I've been really clear that my defining goal as Education Secretary is improving social mobility across our country. So that it does not matter where you start, or where you grow up, you have the same opportunities to reach your potential.

I know that I can't do that without you – a strong profession able to make it a reality. That is why setting out my vision, I placed building the right, long-term capacity in the system as 1 of the 3 core pillars of my approach for driving social mobility through education.

This, above everything else, means investing in the people who work in our schools.

Teachers are the great drivers of social mobility in our country. We know that the single biggest in-school influence on a child's life chances is the quality of teaching they receive – in fact, over a single school year, a strong teacher can help disadvantaged young people to gain as much as a whole extra years' worth of learning, compared to those taught by a weaker one.

Great teachers are the key to making sure that people can achieve their potential irrespective of where they start in life. I know that from my own personal experience. Teachers are experts in levelling up opportunity for all our young people.

That is why we've particularly got to do more to attract the best teachers to our more challenging schools, and to reward and invest in those currently working there.

To me, education is about a child being ready and wanting to learn and a great teacher being able to engage and inspire them. Everything else is just an enabler. Across the country, teachers are doing an amazing job every single day of the week.

We have flown around the world to try to ensure we have the best, most innovative teaching that is out there – I was recently in Shanghai to observe how they teach maths. And they do it brilliantly. But it has really struck me what incredible expertise and practice there is right here on our doorstep.

Part of our challenge is unlocking that best practice, understanding why it works, and disseminating it around other schools and teachers. It is important for us to be able to do that effectively, which is why I believe the Chartered College of Teaching can be so important.

It is important that all teachers are supported with the right framework that will allow them to become the best professionals they possibly can be.

A framework of support that will allow the profession to flourish.

Strong entry into the profession

That support has to start when teachers begin their journey into the profession, with a real focus on evidence-based practice through the new ITT framework, recently developed by leading teachers and heads.

We know that initial training is just the first step. I want there to be an expectation of ongoing learning throughout a teacher's career – and the support necessary for that to happen.

A mature profession like teaching also needs high-status qualifications that reflect its standing. So I want to be really clear today about my views on qualified teacher status.

Some people have suggested that QTS might be scrapped... or replaced with some vague notion of an 'accreditation' – let me be absolutely clear: not on my watch.

Keeping and strengthening QTS is vital. This is not about removing school freedoms. But I believe that teachers should have the highest quality qualification and what I want to see is a QTS so well regarded, so strong that school leaders will naturally want all their teaching staff to have it.

QTS should be the foundation stone for the teaching profession to build on.

I want to strengthen it as a first step to ensuring that people entering teaching in the future join a profession that, as well as being truly valued, empowers them with access to the sustained high-quality training and development that every professional needs in the early stages of their career.

My aim is that from September 2019 we will introduce the newly strengthened QTS. I want to work closely with the profession.

Meaningful professional development

Of course professional development as a teacher doesn't stop once you qualify – it has to continue. The first few years are crucial for new teachers to embed learning and also to find their place in the classroom and the wider school community.

Getting this right means making sure that a new generation of teachers have the support they need, not only within their school, but from a broader profession made up of experts, with a wealth of experience, knowledge and skills.

“Great teachers are the key to making sure that people can achieve their potential irrespective of where they start in life. I know that from my own personal experience. Teachers are experts in levelling up opportunity for all our young people.”

There is a growing culture and ethos within the teaching profession of constantly seeking to improve teaching methods, use evidence, to look at research and stay ahead of the curve – just like other professions like medicine, engineering or law.

This culture of constantly pushing to do better – a hallmark of a great profession – will continue to be strengthened and embedded by teachers, with the support of the Chartered College of Teaching, as well as organisations like the Education Endowment Foundation and ResearchED.

This continued professional development also needs to happen within clear career development pathways – whether staying in the classroom as a subject expert, working elsewhere in the education system as part of a wider 'education career', or progressing into school leadership roles.

Lots of schools and multi-academy trusts are already doing this brilliantly – but I want it to become the norm throughout the system, whatever type of school you teach in, wherever you are.

I want to work with you – the profession – to make sure this happens, with a golden thread through every teacher's career from initial training and QTS through continuing professional development, especially in

those early post-QTS years, through to specialism or leadership.

We all know that for a culture of development to work, the highest quality, evidence-based CPD has to be available – particularly where it is needed, in our more challenging schools.

So, I am opening the first round of bidding for the £75m Teaching and Leadership Innovation Fund.

This first round of funding will support programmes which will have an impact in the [12 opportunity areas I recently announced](#) where we want to really galvanise social mobility to increase opportunity for young people, as well as in other areas throughout the country where it can make the biggest difference.

This fund will enable new, high-quality CPD provision to be delivered where it can make the most difference and where it's needed most.

“I especially want to see a new generation of teachers becoming part of the Chartered College of Teaching – to help safeguard and shape the profession's future. You have as much to invest and are as invested in its success as anyone.”

I believe that, as much as anything, investing in home-grown talent in these more challenging areas where we want to see educational outcomes improve, is absolutely vital. That talent will be key to supporting disadvantaged pupils and driving forward social mobility.

People are often most invested in improving the schools and pupil outcomes in their own communities.

This was something I saw within the DfE when I launched the opportunity areas. Lots of officials who had grown up in them came forward to offer help – they wanted to be involved. They know the areas like the backs of their hands, and now they are helping to champion change on the ground.

The Teaching and Leadership Innovation Fund will also help to provide new evidence of what works, to add to the growing evidence base for the teaching profession, and enable approaches that are working locally to be

scaled-up, so that teachers and leaders across the country can benefit.

I want to see us increasingly move from carrying out pilots to scaling up what works. We need to get into the phase of being able to spread that knowledge right across our school system so that all teachers and leaders, in all areas, can benefit.

I also think it's important that existing training is reviewed and reshaped – to make sure it keeps up with emerging practice and evidence.

I can confirm that the new fully revised, gold-standard national professional qualifications – developed in partnership with the teaching profession – will be implemented from September this year.

There will be new high-quality qualifications for middle and senior leaders, head teachers, and – for the first time – executive leaders. I'd like to thank the expert working group that has put so much work into this.

The qualifications build on the strong NPQ brand, with a revised content framework, to reflect the education system of today, and with an even stronger emphasis on the use of evidence and support for the pupils that need it most.

Running through all this there is a recognition that we need to be conscious of the right approach for teachers working with children with special educational needs and disabilities. Every teacher is a teacher of children with SEN and disabilities, so it is important to ensure that this is mainstreamed within our NPQs, training and best practice. I think this needs to happen as they are being developed, rather than as an afterthought so that the professionals are properly equipped to support all pupils.

I think the national professional qualifications for school leaders should have the same kudos that MBAs do in business – recognised in and outside the profession as qualifications that empower individuals with high-quality leadership and management skills.

I want to make sure that these new qualifications are available to as many people as possible – particularly in

the areas where they can make the biggest difference.

I want to support those working in challenging schools by investing in their development.

That is why I have set aside up to £10m from the Teaching and Leadership Innovation Fund to incentivise take-up of these new gold-standard NPQs for high-potential professionals working in our most challenging schools. These people are key to raising standards and driving social mobility, and I want to support them however I can.

Alongside this, I also want to do much more to attract the very best teachers and school leaders in the system to work in and transform our most challenging schools.

I think we should be looking at how can use career progression routes to make that happen and I am directing my department to explore the available options.

A self-confident profession

When I look at the profession, I believe a lot of the key building blocks are already in place.

Through organisations like the Education Endowment Foundation, evidence-based practice is really starting to take off, and the Chartered College of Teaching can be a real driver for that – collecting research and disseminating it for the benefit of the system as a whole, and connecting the teaching profession more widely.

Its establishment shows that the profession is stepping up to address the needs of today's young people and evolve to meet the challenges for future generations.

I especially want to see a new generation of teachers becoming part of the Chartered College of Teaching – to help safeguard and shape the profession's future. You have as much to invest and are as invested in its success as anyone.



Image: Simon Davis

Justine Greening, Secretary of State for Education

With evidence at the core of the way you deliver teaching for our children and young people, I believe the teaching profession can continue to assert itself as a truly high-status profession.

Teachers are the experts on teaching, and so I want to see the teaching profession leading on raising standards in schools.

To return to my core ambition as Education Secretary, I know it is great teachers and teaching that – more than anything else – can level up opportunity and drive social mobility in this country.

Great teaching transformed my life, and I want to make sure that happens for today's generation of children in our schools. ■

This is an edited version of a [speech from the Department for Education](#).

Justine Greening Secretary of State for Education

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Overcoming the talent shortage in the public sector

In these challenging times the public sector needs courageous, innovative and diverse leaders, says Martin Tucker, Chief Executive at GatenbySanderson

2017 is posed to be a big year for the public sector. Whitehall has the task of overseeing and implementing Brexit, which seems to present new challenges on an almost daily basis. The NHS is at a critical juncture, local governments are trying to establish a new way of working with Whitehall, housing demand outstrips supply by a long way and almost every other sector is on the precipice of major reform. At the same time they are facing budget cuts or reductions in revenues.

To be successful the public sector needs clear vision. It needs leaders who can guide it through a period of great change. However, feedback from industry suggests there is a significant skills shortage at a senior level. GatenbySanderson analysis of search and selection executive roles, advertised across the public

sector, suggests that opportunities increased by 5% in 2016. The analysis also suggests the number of senior roles advertised has increased each year for the past 3 years. While part of this can be explained by the trend that the average tenure of a public sector leader is getting shorter, it also highlights how the sector is looking to bring in new skills.

With the challenges the sector faces this year competition for the best talent is only going to intensify. What can public sector organisations do to help overcome the skills challenge?

Establish a clear framework for a new approach

It is clear the next generation of leaders will need more diverse skills and backgrounds, rather than fitting an established public sector mould. Our leaders must be

open to new ideas and way of working – from being open to new partnerships, to changing to more flexible work practices to accommodate preferences of an upcoming millennial workforce. Experience beyond a single sector is a way to bring new life into public organisations, and an avenue to bring in those collaborative, commercial and digital skills the sector craves.

One hurdle that public sector organisations face is their rigid structure and processes, which can be detrimental to the search process. These rigid structures can suffocate new approaches to find and assess the best people to guide an organisation through periods of change. Boards and decision makers should dare to re-think their current process – from how they identify skills gaps, job descriptions, the application and selection process, and the criteria upon which candidates are being measured. As part of this we need to re-think how we assess and develop leaders, not just through the lens of organisational objectives, but specific behaviours. This extra level of detail will help deliver a leader that is not only capable of bringing about change, but can also engage teams in the process.

Understand that change isn't always smooth sailing

New approaches need courage, however, and that requires new leaders who are brave enough to make decisions and take considered risks. Change has to be more fundamental, embedded deep into the organisation. This takes time and happens more by increments than large leaps. Those looking for more theatrical, superficial change are unlikely to cut it in the complex, challenging and highly regulated world of public services.

New approaches may not succeed the first time around. The measure of a good leader is how they learn and adapt their approach to bring about positive outcomes.

If the sector is to thrive in this period of change, we all (both as consumers of public services and those working in the sector) must applaud those who strive to improve our communities and accept that sometimes things will not go exactly to plan. Running a public sector organisation is different to managing a football team. We cannot call for the manager's head at the first sign of adversity. We must allow our leaders to learn from the challenges to create new iterations that will lead to success. Unlike the premier league, most organisations do not have multi-million pound budgets to invest; quite



*Martin Tucker,
Chief Executive*

the opposite, most need to innovate to cope with reduced levels of funding and increased demands. It's no surprise in 2017 that we are seeing an uplift in both 'transformation' roles and 'finance', as organisations need to balance the books while delivering more.

This becomes increasingly difficult in the current media landscape. While increased scrutiny in the public eye is a positive move for transparency, it can also make attracting the best talent to lead public sector organisation even more difficult. Leaders must certainly be held to account, but we must also allow room for innovation – because a new way of doing things is going to ruffle a few feathers.

Final thoughts

If we live in a brave new world, we need leaders that are capable of making brave decisions. Finding these people to lead the public sector, in what is shaping up to be an even more challenging year than the last, requires a new approach from all involved. If the search is to be successful in 2017, organisations need to be clear about the skills and behaviours they are looking for and establish a framework that facilitates introducing greater talent and diversity. We must also understand that truly great leaders do not shy away from adversity or simply give up, they iterate and the overcome the challenges. However, to do this they must be given a chance. ■

Martin Tucker Chief Executive

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Competence-oriented music lessons to improve teaching

What does the learning culture of music lessons in Switzerland look like? New research at the University of Zurich aims to investigate how lessons could be improved

Little is known about tasks as competence-based learning opportunities in music lessons. Tasks are widely discussed in public under the aspect of audits and tests, due to the introduction of educational standards and competencies. In connection with the competence-oriented teaching, especially learning tasks began to capture the attention of empirical teaching research and the improvement of teaching. Learning tasks are seen as the carrier of learning opportunities and processes. As a result of important international comparative large scale studies like PISA and TIMSS, the discussion about relevant criteria of good tasks, as well as the analysis and construction of domain-specific learning tasks increased in recent years. But these newer publications focused on learning tasks and the subject of a didactic research with a musical-didactic perspective is still missing.

Functions of learning tasks

Tasks have a ubiquitous presence in class and play a central role in the engagement of the students with the learning subject matter, learning objectives and cross-subject learning objectives. Depending on different phases of the lessons, they fulfil diverse didactic functions and appear as tasks for elaboration as well as for exercise, application or test. The design of learning tasks has a significant impact on the quality and complexity of learning process by

influencing the choice of the learning paths and strategies, on the motivation of the students, as well as on the depth of the resulting understanding and the acquired kind of knowledge. In summary, learning tasks have an effect on what and how something can be learnt. Their effectiveness depends essentially on the quality of the task design.

Competence orientation and social-constructivist approach to learning and teaching

Deep understanding as a basis for the use of knowledge and skills is an outcome expectation of the competence-oriented teaching and learning. Since TIMSS empirical teaching research shows that deep understanding of the subject matter results when characteristics of teaching quality like classroom management, supportive learning environment and cognitive activation are connected with an orientation for the depths structure of domain-specific concepts. This includes concept-specific elements of understanding, the quality of domain-specific representations and structural clarity of conceptual structures (Reusser & Pauli 2013). From a social constructivist viewpoint learning and teaching is characterised by the orientation toward domain-specific relevant knowledge and meaningful representations, as well as domain-specific ways to acquire knowledge and domain-specific ways to think and act. Therefore the development of compe-

tencies is made differently in diverse domains. For example, the concept of speed includes not the same learning and understanding in physics as in music. In summary, learning tasks have to represent the relevant core ideas, concepts and connections of a specific domain if they are aimed to foster students' deep conceptual understanding. Also, subject-didactic research on learning tasks requires as mandatory an analysis of the learning subject matter and the domain-specific core ideas.

Music education research in German-speaking countries

Music didactic in Switzerland is developed in practice and traditionally not seen as a scientific discipline. Music education research only gradually emerged since the formation of the Universities of Teacher Education and Universities of the Arts of the last decade. There are currently very few existing empirical studies in music education. Little is known about the common music teaching practice, the quality of music teaching in public schools, as well as the ideas of teachers about good practice of music teaching. The fact that about 20% of music lessons in primary schools are performed by teachers who are not qualified for music teaching (Huber & Camp 2013) is striking.

Also in further German-speaking countries with a widespread music education research, there is a lack of



empirically validated local theories on musical education and musical learning processes or a discussion about relevant criteria of the application, the function and the quality of learning tasks in music teaching (Lehmann-Wermser 2008). It exists in a diversity of didactic concepts, but still no consensus about an aesthetic and expressive musical understanding or about domain-specific core ideas and their underlying representations which have to be acquired in music lessons.

The necessity of a musical-didactic research on learning tasks

The development of suitable teaching designs, learning tasks and learning material is seen as a main duty of teachers. This is due to the shift from a learning input to a learning outcome perspective in educational governance, as well as the implementation of a new competence-based curriculum over the next few years. Also, musical-didactic research must generate basic empirical knowledge and new evidence-based didactical approaches about how teachers can plan and implement their music lessons in public schools according to a competence-based curriculum.

A planned research project wants to make a contribution in order to close this research gap. The primary objective of this video-based study is to investigate what the learning culture is looking like in music lessons at primary schools in Switzerland, but also to get first indications about how music teaching could be improved by the use of an educational reconstruction, a framework for the design and evaluation of theory-based content specific interventions. By qualitative content analysis of learning tasks, learning material and planning documents, by stimulated recall interviews with teachers and metaphor analysis of students' loud thinking during task solving, we hope to find answers to the following questions: Which tasks create teachers as competence-based learning opportunities in their music lessons? Which ideas of relevant knowledge, elements of understanding, meaningful representations and students' points of view, lead teachers in creating learning tasks and supporting the learning process of students? Which pre-understanding and thinking patterns lead students in solving learning tasks?

The generated data and answers of this first step should result in a follow up intervention study and the creation of teaching-learning settings for music education based on theoretical and empirical ideas of competence orientated good practice.

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New initiatives highlight the value of apprenticeships

James Kelly, Chief Executive of the British Security Industry Association looks at the value of apprenticeships and how they are shaping the industry

2017 is proving to be a big year for apprenticeships in the security industry, with the Fire, Emergency and Security Systems Trailblazer standard being launched ahead of crucial changes to the way the government will be funding apprenticeships in England. Apprenticeships are vital to the future of the industry and in recent years there has been a perceived skills gap in the fire and security sectors, as such, these new apprenticeships developments couldn't have come at a better time.

The new Fire, Emergency and Security Systems Trailblazer was developed after employers within the industry saw the need for better quality apprenticeships to help bridge the skills gap and ultimately improve businesses. As a result, 13 employers came together to form a Trailblazer Employer Group in order to create a uniformed standard for a fire, emergency and security systems technician. The group consisted of: Abel Alarm Co Ltd, Christie Alarm, AAI Security, CSL, Kings Security, Chubb Fire & Security, Secom, Amalgamated Ltd, Wessex Fire and Security, Banham, BDS Fire, Pointer Ltd and Stanley Security Solutions. Throughout the development of the standard, employers from within the fire and security sectors were encouraged to provide an input on what they would like to see from apprentices and the most effective ways for them to be assessed in order to ensure a high standard of training.

Trailblazer apprenticeship

The new Trailblazer is a Level 3 apprenticeship with a choice of pathways, including security, fire, fire and emergency lighting and fire and security, as well as a core module and an end assessment. All pathways will include core modules as well as units relevant to the chosen discipline in order to create well rounded, high quality engineers. There will also be an opportunity to transfer Level 2 City and Guilds to the new apprentice-



*James Kelly,
Chief Executive*

ship. Developed with the support of the BSIA, Fire Industry Association (FIA) and the Fire and Security Association (FSA), along with other industry stakeholders, the Trailblazer gained government approval last year and was officially launched in February 2017.

The development of the Trailblazer is a positive step for the fire and security industries, with the standard enhancing the skills of apprentices as they learn to design, install, commission and maintain electronic systems. Being regularly assessed throughout the Trailblazer, apprentices will develop an array of core knowledge and skills, including health and safety, electrical and electronic principles, practices and procedures, core systems, system technologies and environmental principles, along with customer service, communication and commercial awareness. With such well-rounded training, through a combination of 'on the job' training, mentoring and knowledge based learning, high quality apprentices will serve to increase the overall value of a business and secure the future of our industry.



As well as the launch of this new Trailblazer, this spring will see the way the government funds apprenticeships in England change, with employers with a pay bill of over £3m each year being required to contribute 0.5% of their payroll into their new apprenticeship levy pot. In an effort to get more businesses to invest in apprenticeships, employers will then be given an allowance of £15,000 to offset against their levy payment, which will be paid in monthly instalments through a new Digital Apprenticeship System. This allowance can be used to pay for quality apprenticeships, with the government contributing an additional 10% to the monthly funds.

This new reform will come into effect as of 1st May 2017 and hopes to increase employer demand for apprenticeships, as the employer will now have control of the content and assessment of the apprenticeship – through the Trailblazer scheme – as well as the funding available. When choosing training, however, it is important to select an apprenticeship that is delivered against an approved framework or standard with an approved training provider and assessment organisation.

Apprenticeship policy

Under the government's new apprenticeship policy, training providers must be on the Register of Apprenticeship Training Providers (RoATP) in order to be eligi-

ble to deliver apprenticeship training – either directly or as a subcontractor – to large, levy-paying employers. A full list of eligible providers was published in early March, with Skills for Security, the industry's sector skills body, making the grade. In order to be accepted onto the register, providers had to pass all elements of the application, which included due diligence checks on compliance, quality and financial health, ensuring that that the organisation has the capabilities to deliver high-quality apprenticeship training.

It is positive to see these new initiatives emerging, highlighting just how important apprenticeships are to our society. With the high quality training available, the skills of the younger generation can be enhanced and apprenticeships can provide a valuable pathway to a successful career that can benefit the apprentice, the business and the industry as whole. ■

James Kelly
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Truth and Reconciliation: What strides have been made?

How are Canadian higher education institutions responding to the truth and reconciliation commission's calls to action? Brock University's Dawn Zinga shares

In November 2016, a group of secondary students worked with individuals associated with the Mush Hole Project and the Integrating Knowledges Summit and created a youtube video called Reconciliation: A Response that offers insight into how reconciliation might be defined. It is important to note that reconciliation needs to be defined within an institutional context and part of an institute of higher education's mandate should be providing educational opportunities that push students, staff, faculty and administrators at every level to define what reconciliation means for themselves at an individual level.



The first national action of reconciliation was the apology provided on June 11, 2008 by Stephen Harper in his role as Prime Minister. Associated with the apology was the establishment of the Truth and Reconciliation Commission (TRC), which released its final report in June 2015 and issued 94 calls to action. The challenge over the past few years has been how to address these calls to action in meaningful ways that will result in positive changes. Many of the calls to action had implications for education.

How have Canadian institutions of higher education responded to the TRC's Calls to Action?

The answer to this question is not always readily apparent and the various institutions across Canada are in different points along the journey to

reconciliation. There is a lot of talking going on and some of that is translating into action. As of yet there is no unified response and Canada's systems of education do not lend themselves to one. Unlike the U.S., Canadian education is not a Federal responsibility and therefore each province and territory govern how education will be funded and provided. The only exception to this is First Nations education, which is the responsibility of the Federal government, who must negotiate with the provincial and territorial governments to either purchase education or ensure that it is provided to the provincial/territorial standard. To make things even more complicated each province or territory is responsible for how education is delivered at all levels. For example, in Ontario, elementary and secondary education

fall under the Ministry of Education but higher education falls under the Ministry of Advanced Education and Skills Development, which administers related legislation such as the Ministry of Training, Colleges and Universities Act and the Higher Education Quality Council Act. This makes it difficult to launch a unified response, which may not always be appropriate given the need to be responsive to histories and context of place.

However, there have been several instances where institutions have consulted with each other or joined together to explore the common issues. Colleges and Institutions Canada (CiCan) launched its 7 principles of indigenous protocol for Colleges and Institutes in December 2014. CiCan invited its members to

sign on to the protocol and adopt the 7 strategies. CiCan's membership represents 137 colleges, institutes, polytechnics, and cegeps across Canada. According the CiCan website, 49 institutions are signatories to the protocol. In June 2015, Universities Canada launched its Principles on Indigenous Education. Universities Canada represents 97 Canadian universities and the release of its principles indicates that "the leaders of Canada's universities" have committed to them. The 13 principles call for the following: support of opportunities for Indigenous students at all levels; student-centred strength-based approaches to student success; indigenise the curricula; recognise the importance of Indigenous education leadership and ensure representation at governance, faculty, professional and administrative levels; build welcoming and respectful learning environments with Indigenous student spaces; support dialogue between Indigenous and non-Indigenous students; accessible learning environments off-campus; partnerships and collaborations among educational and local Indigenous communities; build on successful practice and initiatives while keeping context in mind; communication strategies to promote support and services for Indigenous students; intercultural engagement between indigenous and non-indigenous members at all levels throughout the university; be mindful of the role that universities play in creating learning environments K-12 for Indigenous students. The document also called for support from various levels of government to fund initiatives related to the principles.

There are also other notable collaborations operating at various levels throughout Canada. Notable collaboration comes out of Saskatchewan.

The University of Saskatchewan hosted a National Forum, Building Reconciliation: Universities Answering the TRC's Calls to Action, which was attended by over 200 individuals including 25 Indigenous leaders and 14 presidents from higher education institutions. At the conclusion of the forum, it was announced that all 24 Saskatchewan post-secondary institutions had signed an accord committed to Indigenous education and reconciliation. In September 2016, the University of Alberta hosted the second Building Reconciliation National Forum. In May 2016 at the University of Calgary there were several sessions during the annual conference of the Canadian Society for the Study of Education that brought scholars and Deans from various institutions together to discuss the TRC and its implications for higher education.

While the University of Saskatchewan is one of the institutions leading the way in transforming talk to action through its reconciliation initiatives, other institutions are also responding in various ways to the TRC. Queen's University has established a Truth and Reconciliation task force that is examining the 3 calls to action addressed directly to post-secondary institutions as well as the broader implications of the TRC. One of Trent University's responses to the TRC has been to launch a new Indigenous Bachelor of Education degree while the University of Waterloo has a Truth and Reconciliation Hub that features truth and reconciliation projects, as well as other resources and supports. Among Lakehead University's responses is direct support of the TRC Recommendation 28 that all law students take a course focussing on Indigenous people and the law. This direct support comes in the form of weaving Indigenous content throughout the law curriculum.

The University of Toronto struck a university-wide steering committee to investigate how the university might best respond to the TRC calls to action, the report from the committee has included action items such as hiring more Indigenous faculty. Similarly, the University of Guelph has committed to hiring 5 new Indigenous faculty members and increasing graduate awards for Indigenous students. These are just a few examples of how institutions of higher education have begun to respond to the TRC.

As a white Euro-Canadian faculty member, I am well aware of the challenges and the work that lies ahead on the road to reconciliation. The challenges faced by institutions of higher learning involve how they will have the challenging conversations around how to change the institutions to reconciliation, maintain forward momentum in making those changes, and commit funding to accomplishing and supporting those changes. The question that remains is whether or not Canadian Universities will do the work to engage in reconciliation in meaningful ways.



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<https://brocku.ca/social-sciences/departments-and-centres/child-and-youth-studies>

Apprenticeship reforms: The role of training providers

Mark Dawe, Chief Executive, AELP says apprenticeship reforms can tackle poor productivity but the support of training providers is necessary to succeed

It's strange how in some public services, governments willingly contract out delivery to commercial and charitable providers knowing that they will often receive excellent value for money in return whereas in others, contracting out almost seems like an admission of failure. In the case of government funded skills programmes in the UK, the approach towards independent training providers has appeared to be almost schizophrenic even though without them the impact of these programmes would have been minimal.

“It would be tragic if ministers fail to address the weaknesses within the apprenticeship reforms because an expanded apprenticeship programme could make a huge difference to the British economy by improving workforce skills at all levels and in the key sectors identified by the government’s new industrial strategy.”

Why do you need a training provider?

The main reason why training providers are so vital is because they find ways of engaging with employers which many other institutions find difficult. They offer customised and flexible solutions to employers’ skills needs and they are very responsive to changing economic circumstances and government priorities. The Association of Employment and Learning Providers (AELP) estimates that its member providers engage with approximately 350,000 employers throughout the UK and hopefully the number is about to become larger with the start of the government’s new apprenticeship levy.

Apprenticeship reforms

Large employers in Britain will pay the levy and some of them will be offering apprenticeships for the first time in order to claim their levy payments back. The levy has potentially 2 key advantages which training



Mark Dawe, Chief Executive, AELP

providers are keen to exploit to the country’s benefit. The first relates to the need to tackle skills shortages and to address the UK’s lamentable track-record in productivity. In 2015, UK productivity was 18% below the average of the rest of the G7 countries and we lag way behind Germany, USA and France. Economic analysis mostly points to leadership and management being the historical factors behind the lag and we may be about to see the levy help rectify this weakness. When large businesses start reclaiming their levy in May 2017, many of their new apprenticeships will be used for management training. In fact we believe that half of the £3bn raised by the levy by 2020 will be used for this purpose.



Improving social mobility

However there is major concern surrounding the other potential key advantage which is that apprenticeships should continue to act as a driver for social mobility. In 2015-16, 16 to 18 year olds accounted for 131,000 apprenticeship starts (26% of the total) in England. The vast majority of these young people who complete their programme will still be in a job with the same employer 6 months later and will be on their way to a successful career. Unfortunately the UK government has just removed the current incentives for employers to take on apprentices for this youngest age group and, for a government which talks about apprenticeships as a 'ladder of opportunity', this seems really bizarre. Young people aged between 16 and 24 are also heavily reliant on smaller businesses to offer them apprenticeship opportunities across the country and yet within the next 2 years there is a real danger under the levy system that no little or no funding will be available for apprenticeships in SMEs. AELP is therefore pressing the UK government to find a guaranteed minimum budget of £1bn a year to make sure that this vital skills provision in smaller businesses continues.

It would be tragic if ministers fail to address the weaknesses within the apprenticeship reforms because an expanded apprenticeship programme could make a huge difference to the British economy by improving workforce skills at all levels, and in the key sectors identified by the government's new industrial strategy. Ministers also recognise that Brexit has underlined the need for young people to have the skills to take jobs which hitherto have been largely filled by migrant workers. Furthermore they now appreciate that they cannot overcome these challenges without the support of high quality training providers. ■

Mark Dawe Chief Executive

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European Capitals of Culture initiative benefits cities

In a speech, EU Commissioner for Culture, Tibor Navracsics shares how European Capitals of Culture are a driver for social and economic change

Let me nevertheless stress at the outset that culture can never be just a means to an economic end: culture plays too significant a role in our lives and our society to be reduced to its mere economic function. Especially today, when our communities face so many challenges threatening our Union's core values. Now more than ever we need culture to better understand each other and to cement the bonds between our countries and people.

But this does not mean that we should ignore culture's huge economic potential.

The European Capitals of Culture are a great illustration of this. They are of course above all a cultural event. Holding the title enables cities to boost cultural activity and reach new audiences. Cultural operators acquire a more international outlook.

The initiative also has a social impact, fostering cohesion and intercultural dialogue, for instance through outreach programmes.

European Capitals of Culture have also repeatedly shown what a city and its surrounding region can achieve in terms of growth and job creation by integrating culture and the arts in long-term development planning.

One of the most obvious economic effects is the increase in the number of tourists. The average increase of overnight stays upon the previous year for a European Capital of Culture is 12%. But this can rise to more than 25%, as in Pilsen in 2015 or Pecs in 2010.

In Mons, it is estimated that each euro of public money invested in the Capital of Culture programme generated between €5.5 and €6 for the local economy. A central achievement of the year have been the new



*Tibor Navracsics
Commissioner for Education, Culture, Youth and Sport*

partnerships created between the cultural sector and the local corporate sector, as well as the reinforced cooperation with the tourism sector.

Being a European Culture Capital entails a process of transformation for a city, offering increased opportunities in terms of urban development. The 2013 European Capital of Culture in Marseille was part of an investment project in new cultural infrastructure of more than €600m – which was in turn integrated into a multi-billion euro effort to revitalise the city spanning several decades. Some cities have used the title to regenerate former industrial areas and to transform them into new cultural or creative quarters. For example, in Košice 2013, the private sector and local universities

worked together to transform the industrial city, highlighting the city's creative potential.

Of course, we sometimes see cities that do not reap the full benefits of the title, often because of problems of governance, insufficient long-term planning, an absence of clear objectives, indicators, milestones and monitoring and a lack of experience in implementing an event of this scale and scope.

That is where public strategies – at all levels of territorial governance – can be of help.

To ensure a lasting positive impact, cities and their surrounding regions must embed the year's programme into their long-term development strategies.

In other words, cities – and regions – must not just look at the short-term benefits to be gained during the year itself. They need to look further to the future.

National Initiatives also play a role

That is also where national initiatives such as the Italian Capitals of Culture have a clear role to play. I know that in Italy the initiative came in the wake of the huge success of the Italian competition for the 2019 European Capital of Culture title, with a record number of 21 applicant cities (and Matera as the winner).

Similar initiatives exist in Ireland, in the UK, in Lithuania. They are extremely useful.

They can further illustrate the multi-faceted and central role culture plays in our cities and regions. And they reinforce the connection between culture, cultural heritage, tourism and socio-economic development. They also provide public authorities with an opportunity to implement an important change in the way they support culture.

They also offer a space where all levels of territorial governance work together, with a common and shared goal, beyond political differences. There is indeed a need for all public authorities to treat a European Capital of Culture or a national capital of culture as a non-partisan effort on behalf of the city.

The role of the European Commission is to foster the exchange of experience and good practices between past, present and future capitals and facilitate exchanges and peer learning between cities and regions across Europe.

We do this, for example, through an ongoing initiative funded under Creative Europe, called "Culture for cities and regions". Within this frame, we work directly with city and regional authorities, including some former European Capitals of Culture, to share experience and knowledge on culture and heritage as drivers for social inclusion, regeneration and growth. The initiative includes study visits and peer-learning activities for local authorities.

Moreover, through our various funding programmes (Creative Europe, Structural Funds), we can support capacity building, cooperation and networking of cultural operators beyond national borders.

Finally, I hope that we can use the European Year of Cultural Heritage in 2018 to reinforce partnerships between our various levels of territorial governance.

As we are just entering the New Year, I would also like to wish every success to Aarhus in Denmark and Pafos in Cyprus, the 2 European Capitals of Culture in 2017, as well as to Pistoia, the 2017 Italian Capital of Culture. I am confident that all 3 will be a great success and that they will invite us to reflect on our common European project.

This is an edited version of a speech that was given in Brussels in January and the full speech can be viewed [here](#). ■

Tibor Navracsics

Commissioner for Education, Culture, Youth and Sport

European Commission

www.ec.europa.eu/commission/commissioners/2014-2019/navracsics_en

Showcasing 100 years of Estonian art and culture

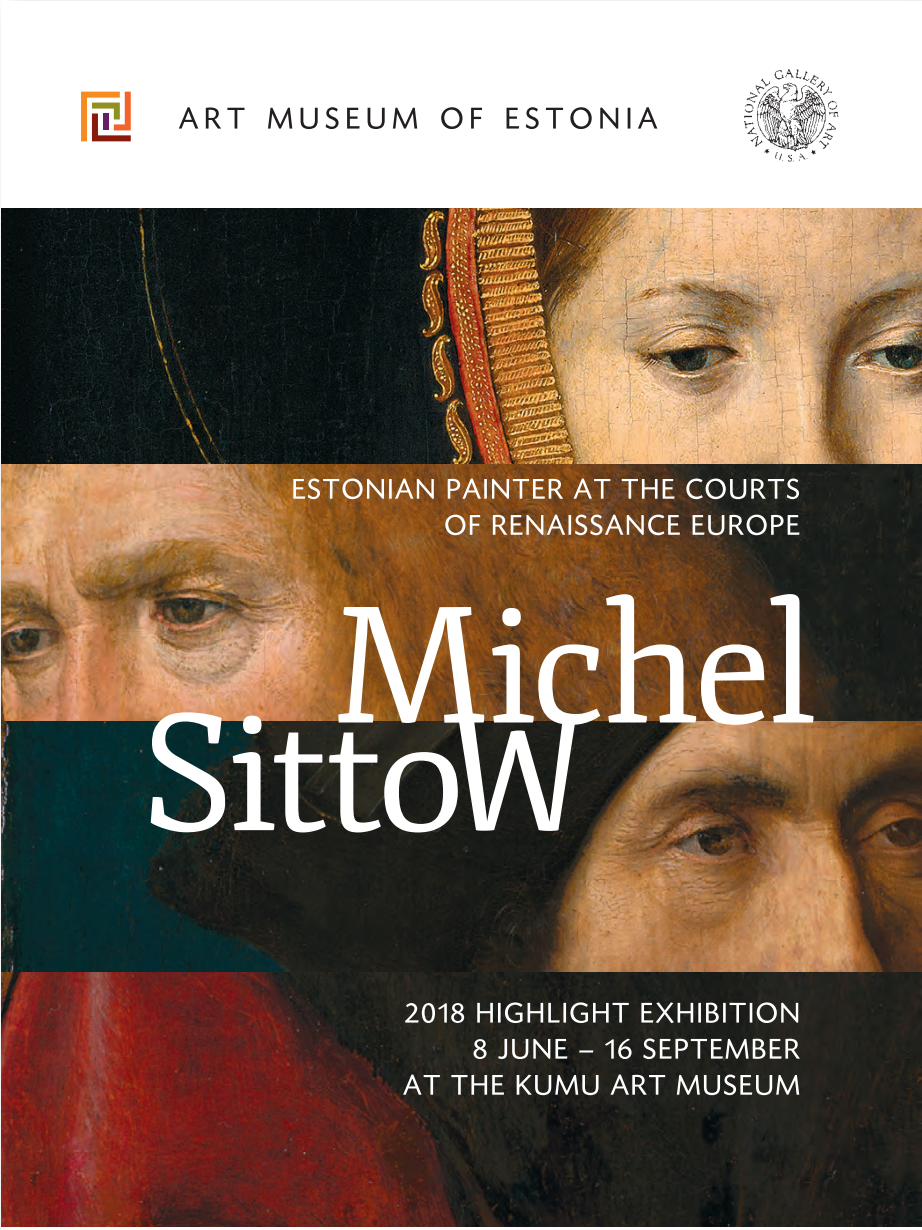
Sirje Helme, Chief Executive Officer, Art Museum of Estonia shares how Estonian art will be brought to the forefront as the nation celebrates its centennial

The Art Museum of Estonia is Estonia's largest art museum. It is comprised of 5 separate branches, which house both a local and international art legacy, from the medieval St. Nicholas' Church, where sacral art is displayed (including one of the largest northern European late-medieval winged altarpiece and the unique 15th-century Danse Macabre from Bernt Notke's workshop), to the 11-year-old modern museum building Kumu, which was named the European Museum of the Year in 2008.

The coming years of 2017 to 2019 are going to be truly special for the museum. In 2017 Estonia serves as the European Council presidency, in 2018 the Republic of Estonia celebrates its 100th anniversary, and in 2019 the Art Museum of Estonia will be 100 years old. To worthily celebrate the museum's and the state's centennials, we have decided to introduce Estonian art in other European countries.

Highlighting Estonian art and culture

Exchanging expositions and showing one's cultural heritage in other places is common in international practice, but as representatives of a small nation we have to try harder than many other countries or museums. We have many wonderful works of art, a strong historical legacy and excellent contemporary artists, who are invited to display their oeuvre all



ART MUSEUM OF ESTONIA

ESTONIAN PAINTER AT THE COURTS OF RENAISSANCE EUROPE

Michel Sittow

2018 HIGHLIGHT EXHIBITION
8 JUNE – 16 SEPTEMBER
AT THE KUMU ART MUSEUM

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For more information: kumu.ekm.ee

over the globe. Still, a lot of work needs to be done to make others aware of our culture and to keep it alive and thriving. The upcoming

events have motivated us to organise several major overview exhibitions of Estonian art in various European locations.



Sirje Helme, Chief Executive Officer

In September 2017, we will open the exhibition *Archaeology of the Screen* at the BOZAR Centre for Fine Arts in Brussels. The exhibition focuses on technological utopias that influenced our art in the 1960s and have now become significant parts of our country's success story. Digital culture does not, however, mean only progress, as it has raised some serious issues in the arts arena and in connection with our whole way of life. It is significant that the first display in our series of events is dedicated to contemporary art, particularly art that examines the technology-centred world-view.

A month later, we will open an exhibition of the oeuvre of Konrad Mägi, a great classic modernist painter from the beginning of the previous century, in Rome in the Galleria Nazionale d'Arte Moderna. Mägi's exceptional sense of colour and pantheist

approach to nature represent the connection to nature not in the sense of landscape painting, but rather in the sense of abstraction and universality. I am convinced that the nearly century-old paintings are as significant to the viewer as works that delve into our complicated current issues.

"To worthily celebrate the museum's and the state's centennials, we have decided to introduce Estonian art in other European countries."

Joint exhibitions

Estonia is not the only country celebrating 100 years of history: our neighbours Latvia and Lithuania, with whom we are linked via similar historical experiences in the 20th century, also celebrate their centennials in 2018. On this occasion, we will open a joint exhibition at the Musée d'Orsay in Paris to show our art from the beginning of 20th century, when tumultuous times of World War I, which gave rise to many a nation-state. Paris was the dream destination of all artists in those days, as it was the heart of the artistic scene of the early 20th century. The exhibition to be displayed in the newly renovated wing of the Orsay Museum in April 2018 will also be shown at the Kumu Art Museum in Tallinn in the autumn of the same year. Being geographically close, it would be great for the Baltic countries to get to know each other's art history a bit better, so the cultural overview of the past century serves as an opportunity for comparison.

Our most ambitious project will be the joint exhibition *Estonian Painter at the Courts of Renaissance Europe*, with the

National Gallery of Art in Washington, which will open in the States at the beginning of 2018, from June to September it can also be viewed at Kumu. The artist Michel Sittow, born in Tallinn in the 15th century, probably studied in Bruges under the guidance of Hans Memling, and became known for his extremely fine brushwork. Sittow received commissions from a number of important royal families. His fate and artistic talent led him to come into contact with a number of persons who have played important roles in the history of Europe and the world as a whole, such as Isabella I of Castile, Philip the Fair, Margaret of Austria, Christian II of Denmark and Charles V, Holy Roman Emperor. Working in different courts, he adopted influences from French and Spanish court art, synthesising techniques and styles of various schools. The true Renaissance travelling artist spent the last days of his life in the town of his birth, Tallinn.



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Welcome to Aarhus: The European Capital of Culture 2017

Mayor Jacob Bundsgaard explains why becoming the European Capital of Culture 2017 will bring long-term economic and social benefits to the city of Aarhus

From the perspective of Aarhus, Denmark's second-largest city, 2017 is a wildly exciting year, because this year, we are European Capital of Culture.

European Capital of Culture Aarhus 2017 is the most monumental cultural project Denmark has ever hosted, with over 400 events throughout the year.

The European Capital of Culture initiative is about transforming the arts and culture in the broadest sense into a catalyst for long-term benefits, as exemplified in Glasgow 1990, Lille 2004, Liverpool 2008 and Marseille 2013. European Capital of Culture Aarhus 2017 is a once-in-a-lifetime opportunity for Aarhus and the region. It testifies to our development into a truly European city – a city which is increasingly attractive to business, talent and tourists. Aarhus 2017 will give our citizens a sense of pride and belonging by positioning Aarhus more strongly on the European map, increasing our international visibility and profile.

This is a project of enormous scope – unified by the theme 'Let's Rethink'.

Aarhus 2017 spans the entire spectrum from great performances and exhibits – drama, concerts, dance, and literature – to major popular events and project centred on urban development, sustainability, gastronomy, architecture, nature and hygge. We have so much to offer in Denmark and so much to be proud of.

Our guests from Denmark and abroad – England, Germany, the Netherlands – in fact, from all over the world – really have something to look forward to. We are expecting millions of guests of all ages, and in fact, many of them have already started arriving. Tourists are flocking to our region as never before. Travel journalists from all over the world are reporting their



enthusiasm about what they experience in Aarhus and central Jutland. You can read about us in major international media such as Monocle and National Geographic, and in prominent international newspapers such as The New York Times, Süddeutsche Zeitung and The Independent.

In 2016, the international travel guide Lonely Planet ranked Aarhus number 2 on its list of the summer's hottest European travel destinations. Only surpassed by the Peloponnese in Greece.

It's easy to see why: the 'capital of Jutland' scores high on every conceivable parameter for travel enjoyment. Lonely Planet, which has been scouring the planet for the best travel destinations for 40 years, highlights Aarhus' hip Latin Quarter, the city's culinary scene, including several Michelin-starred restaurants, and world-class museums, such as ARoS Aarhus Art Museum, Den Gamle By (The



Mayor Jacob Bundsgaard

Old Town), and Moesgaard Museum. The travel guide also fell for the city's striking architecture.

In recent years, Aarhus has changed dramatically. Today, we are a strong national growth centre with a significant international profile, as well as a leading city of knowledge, culture and education. The city has grown substantially in size and importance, and plays a central role in the development of the entire region. And, with European Capital of Culture Aarhus 2017, we are unveiling the true magnitude of our potential.

The importance of culture

In today's world, we need to understand the concept of culture in a very broad sense. Culture is a driving force and a key to resolving many of the challenges that cities and society face, now and in the future. At the same time, culture and creativity are also an important brand, not just for our own pride in living and

working here, but also for making our region attractive to new citizens and businesses.

Fundamentally, the Capital of Culture project is about creating a city that offers a wealth of possibilities which will be available in years to come – to companies, employees, families and students. Because Aarhus offers them talent, security, quality and options. In other words, because Aarhus is a place where you can live a good life.

“In 2016, the international travel guide Lonely Planet ranked Aarhus number two on its list of the summer's hottest European travel destinations. Only surpassed by the Peloponnese in Greece.”

Our year as European Capital of Culture will leave a lasting legacy. It will change our city and our region for the better for years to come on the foundation of our core values; sustainability, diversity and democracy. Increased international visibility will attract many new and returning visitors, generating growth for our businesses, including the creative industries. But first and foremost, our European Capital of Culture year will leave us with a new self-awareness. When 2018 arrives, we will have experienced what we can truly achieve when we create something extraordinary together.

This joint experience is essential for the legacy we, as European Capital Culture Aarhus 2017, will pass on to the region and to the rest of Denmark.

We have reached a new level. We must sustain our momentum and use Aarhus 2017 – and culture in general – to drive further development. We must continue to set new ambitious goals we can achieve together. Aarhus 2017 has provided us with a catalyst and a new beginning – our work begins in earnest in 2018. ■

Jacob Bundsgaard
Mayor of Aarhus

The City of Aarhus
www.aarhus.dk

How does the pension world look in 2017?

Pensions and Lifetime Savings Association's Graham Vidler shares his expectations for the pension world in 2017 and the next generation of pensioners

Fifty is the new 40, 60 is the new 50 and everyone is worried about funding retirement, or that is what the newspapers would have you think. For most people, the reality is somewhere in between. We are living longer and people are increasingly aware that the State Pension alone will not provide them with the retirement they aspire to.

At the Pension and Lifetime Savings Association (PLSA), we represent over 1,300 employee pension schemes with more than 20 million members – some of them local government schemes. This makes us the voice of pensions and lifetime savings in Westminster, Whitehall and Brussels with our main focus being on getting more money into retirement savings, getting more value out of these savings and helping to build the confidence and understanding of savers.

What does the diverse pension's landscape look like at the moment?

Firstly, today's pensioners are better off than any previous generation. A 30% increase in average incomes over the past 15 years alone. As incomes of working age people continue to stagnate, there is now some evidence to suggest they're better off than younger people for perhaps the first time ever.

What's behind this success story?

Part of it is pensioners themselves. Increasing numbers are choosing to work past retirement age, generating extra income and making the label 'pensioner' misleading. Part of it is short-term government policy and the impact of the triple lock which has seen State Pensions rise by more than both inflation and earnings growth over the past decade. The biggest part though is the decisions employers made 50 or 60 years ago, introducing generous final salary pension schemes to large parts of British industry. Pay-outs from those



Graham Vidler, Director External Affairs

pension schemes are just about reaching their peak and many – by no means all – pensioners are reaping the benefits.

These circumstances won't be repeated again. More and more people will, we think, continue to work well into retirement. But employers across the private sector have largely closed their final salary schemes and the triple lock, as John Cridland's recent review of state pension age made clear, isn't affordable beyond this Parliament unless we want to see State Pension age rise well above 70.

What are the prospects for future generations?

In 2008, the Pensions Act introduced automatic enrolment (AE) which meant that employers must put certain staff members into a pension scheme and make contributions to this scheme. Naturally, there were caveats as – for example – a person needs to earn £10,000 per year before being automatically enrolled into a scheme and the self-employed are currently exempt. There is also the option for a person to opt-out as the idea behind the scheme was to improve a person's retirement finances but not by drastically reducing their current standard of living.

With around 7 million people enrolled into a workplace pension, low-opt out rates and high levels of compliance amongst SMEs, it is generally agreed that AE has been successful. The government has launched their Automatic Enrolment Review 2017 to review progress and determine the strategy going forward. One area that it is expected to tackle is contribution levels. Currently, the employer contributes 1% of the employee's salary and the employee contributes a further 1%. This is due to rise to 2% (employee 3%) in April 2018 and then 3% (employee 5%) in April 2019. However, while these increases are welcome, research suggests they may need to be higher.

Challenges

Our research suggests that 13.6 million workers are at risk of falling short of an adequate retirement income. Put simply, having too little saved to maintain their lifestyle into retirement. Analysis suggests that in order to meet this target, people need to contribute 12% of their salary which may be difficult for lower income earners.

Another challenge the pension system is facing is the varying expectations, advantages and approaches that the different generations have. The baby boomers (those born between 1946 and 1964) have often benefited from defined benefit pensions and significant house price growth while Generation X (those born between 1961 and 1981) has found it harder to get onto the property ladder, see increases to the State Pension age and missed out on the roll-out of AE. The millennials who may well have been enrolled into an AE scheme at the start of their career are also facing the spectre of tuition fees and the impact of the house price growth that the baby boomers are enjoying.

This is not a simple conundrum to manage but arguably the most important step is to encourage each generation to make proactive retirement provision. One issue that could undermine this essential engagement is if larger pension schemes fail or if we see similar headlines to the BHS debacle.

The UK has a long history of providing employees with a workplace pension, in fact there are 27.3 million people in the UK who are benefiting, or will benefit from a DB scheme¹. However, a combination of social, political and economic issues mean that members of schemes with the weakest employers* have just a 50:50 chance of seeing their benefits paid in full.

To tackle this issue, the PLSA launched a Defined Benefit Taskforce in March 2016. The aim was to get to the heart of the issues facing the DB system by seeking views and evidence from schemes of all sizes, as well as sponsors, regulators, government and intermediaries.

The first report – published in October 2016 – identified the scope of the problem while the second report – published in March 2017 – suggested potential solutions. Consolidation whether it be via shared services, asset pooling, a single governance structure or the creation of a superfund was mooted. The PLSA intends to publish a third report in the summer which looks at how this might work in practice.

Arguably, it is impossible to outline all the challenges facing UK pensions in just 1,000 words but fundamentally, the most important point to take from this article is that action is needed by individuals, government and employers to ensure that it can provide people with the retirement they not only want but expect. ■

* = schemes which hold 42% of liabilities of schemes in deficit

1 Occupational Pension Scheme Survey, ONS September 2016. Covers private and all public sector schemes (funded and unfunded).

Graham Vidler
Director External Affairs

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Essen: The European Green Capital 2017

Essen was granted the prestigious title of European Green Capital 2017. Lord Mayor Thomas Kufen highlights how the city became the third greenest in Germany

On June 18, 2015, the European Commission jury awarded the city of Essen the title of European Green Capital 2017. In particular, the effects of the structural change from a coal and steel city “to the third greenest city” in Germany were highlighted in the explanatory statement of the jury. This means that Essen plays a pioneering role for many cities in Europe that are now undergoing structural change.

Essen’s vision of the future is that of a prospering, sustainable, livable city that is resistant to climate change and offers its citizens a healthy environment. Essen promotes green infrastructure with high quality of air and water, parks with a great recreational value, an innovative and environmentally friendly (green) economy, integrative education and future-oriented mobility concepts. All of these aspects are part of the goals we want to achieve in the near future: a model split of 25% each by the year 2035 (25% public transport, 25% car traffic, 25% bicycle traffic, 25% pedestrian), reduction of CO₂ output by 40% by 2020, and 20,000 green jobs by 2025, to name just a few examples.

Therefore the programme of the European Green Capital 2017 will address in total 12 “green” topics, from climate change, urban transport and air quality to waste generation, water management and energy efficiency. Our aim is to trigger sustainable processes and developments that will lastingly secure the quality of life in our city, or possibly even improve it further. In doing so, we will use existing synergies with regional projects of the Ruhr Metropolis, but also with project partners at national, European and international level.

Five key themes have been developed to prepare the content of our programme for this year, each involving a multitude of events, congresses, projects and activities:



Image: © Ralph Schultze

Lord Mayor Thomas Kufen – City of Essen

- My paths: activities focusing on mobility aspects.
- My rivers: an exploration of the conversion of the Emscher system and of the project “ESSEN – New Ways to the Water”.
- My green spaces: green areas in the city, citizenship, resilience, sustainable forestry and transformation.
- My shopping: sustainable behavior in daily life.
- My future: new jobs in the green economy, innovative developments and facets of environmental education.

The various projects, actions and events proposed as part of our Green Capital year are grouped under these headings.

Through and through green

One of the milestones of the year 2017 will undoubtedly be the conversion and restoration of Emscher. The river, straightened and strapped into a concrete bed, still transports the sewage from the northern

Image: © Peter Prengel, Stadt Essen



Image: © Elke Brochhagen, Stadt Essen



Ruhr area, but from 2017 onwards this will become an underground canal, and the Emscher becomes a natural river again with clean water in a green landscape. Not only the renaturation of streams, but also the former industrial areas, can already be found in Essen in many places. The 23-hectare Krupp Park, which was built on the grounds of the former Krupp cast iron works, is impressive. In the immediate vicinity of the ThyssenKrupp company center, which has been awarded the German Sustainable Building Association for its efficient energy supply concept, the use of sustainable technologies and building materials, as well as an energy-efficient heating and cooling concept.

Even a long-cherished wish of the Essenes is fulfilled, if in the popular recreation area around Lake Baldeneysee in the south of the city bathing in the Ruhr due to the now very good water quality becomes possible. The “Neues Wege zum Wasser” (cycle paths), signposted cycle routes have been developed throughout the city, mostly on former railway routes connecting the Emscher and the Ruhr Valley with three North-South connections. In the Essen area, the “Radschnellweg Ruhr” (RS1) has already become a reality in a section that will lead more than 100 km through the metropolis.

Park and greenery in the city

About 1,600 hectares of the Essen city area are used as parks. Essen's oldest publicly accessible green area is the city garden. Today green spaces are spread over the entire city and offer visitors the opportunity to relax and make use of these green spaces which are on their doorstep.

The Grugapark Essen is one of the most beautiful and largest folk-districts in Europe, with its botanical garden, an animal park, a game and sports paradise, a health and spa offer, the numerous meadows, playgrounds and the concert arena. It originated from the Great Ruhr Garden Exhibition 1929.

Even on former industrial sites such as the Zollverein coal mine, which has been part of the UNESCO World Heritage Site since 2001, nature has recaptured vast areas, which can be discovered on the “Route of the Industries”.

The title “Green Capital of Europe 2017” puts the city of Essen in the European focus. Through the support of the European networks and EU funding, many planned measures for a viable and livable city will be even better implemented in the future.

The main focus in 2017 will be on the citizens of Essen. Our aim is to awaken the curiosity to deal with the green topics in our city, encourage residents to join in, and create the future of our city together.

Therefore our claim is: Green up your life. ■

Thomas Kufen
Lord Mayor

City of Essen
www.essen.de



Harnessing data to transform city management

Data is being used in city management to overcome many urban challenges. Here, Upendra Dharmadhikary, Vice President at Tech Mahindra explains

In the UK and around the world, Smart City initiatives are providing innovative solutions to the key urban challenges we face. From population growth to energy consumption and the protection of our natural resources, these smart technology solutions are pointing towards a future in which we can use our assets more intelligently. From Milton Keynes, to Melbourne and Jaipur, new technology is being applied to improve traffic flow, help communities optimise their fuel use and even maximise waste disposal efficiency.

The key to the success of these initiatives is data and building a bank of knowledge from the real world, based on the way humans interact with their environment. Smart analysis of information from sensors within cities is the foundation from which we can plan for future developments and now, with more data at our disposal, we are starting to see exactly how this can transform the management of our cities.

Informing decisions

The overarching vision behind Smart Cities is to harness the latest technology to make better use of finite resources, to reduce consumption and manage costs. At a time when many cities have reached saturation point with over-stretched public services as well as, road and rail infrastructures which are struggling to meet demand, they are pointing the way to a future in which cities are cleaner, greener and more cost efficient.

The first step in this road to improvement is to understand exactly how we use our assets now. To this end, sensors located across many, diverse resources in the city systems are providing valuable information on everything from water consumption to pollution levels, traffic volumes, public transport, parking and domestic energy use. New developments in low powered, low cost sensors and improvements in connectivity means that there is even more potential for this data to be



Upendra Dharmadhikary, Vice President

gathered from around cities. Thanks to the latest advancements in big data analytics, this information is now becoming the driving force for developing smart solutions to urban challenges and informing how we can make real and lasting changes to city management.

This is something we understand from first-hand experience; our own work as one of the technology partners in Milton Keynes and other smart cities globally, means we have developed a data hub which takes in information from central intelligence feeds, infrastructure networks, such as energy, public transport and water, satellite, thermal imagery and even social media, to support planning and management decision-making.

Practical resource management

Applying this in practice means we can understand how key services are operating and where savings or improvements can be made. For example, sensors and videos from roads can feedback live transport and congestion information, or pinpoint specific locations where urgent road maintenance is needed. Collecting this information centrally avoids the need for wasted,

routine journeys to be made. Similarly, smart sensors on waste bins can send alerts to a central dashboard when they're full, to maximise waste disposal efficiency as the refuse-collection trucks are sent out on more fuel-efficient routes based on which bins need to be emptied. We can manage the luminosity of street lights more efficiently to conserve energy use and even assess, more accurately, when there are flood risks in a city.

A new initiative is also now helping citizens to take charge of their energy use. An online platform in Milton Keynes enables households to organise and manage their own community energy schemes, using building data as well as satellite and thermal imagery. The objective is to encourage local businesses to develop lasting installation and maintenance capabilities and for communities to have collective bargaining power. Armed with information on their home energy performance and heat dissipation, for instance, households could join forces and even instigate crowd buying with a particular energy supplier to get volume discounts.

In the future, we can also provide information on which energy usage is cheaper at a specific point in time by measuring and analysing different sources, whether it's traditional energy going into homes and buildings, wind, solar or battery power. This has the potential to deliver more dynamic forms of energy management for households.

Harnessing data from different sources will not only inform the decisions made by local and central government, but can also give more control back to the citizens themselves. Through the intelligent analysis of data, we can improve the quality of services delivered and make real changes to the residents' quality of life. ■

Upendra Dharmadhikary Vice President

Tech Mahindra

www.techmahindra.com/theme/DAVID.html

[www.twitter.com/Tech_Mahindra](https://twitter.com/Tech_Mahindra)

Varberg takes responsibility – again

For the coastal city of Varberg, Sweden, 2015 was the year when the community united in a joint effort to take responsibility for peace and human rights – just as they did at an international peace summit held there one hundred years before. The municipality has an active role to play and views the project as an extension of the work towards its vision of developing the city of Varberg as the Swedish West Coast's creative hotspot, with the help of local residents.

As the 100th anniversary of a significant peace summit approached, here in Varberg we chose a different way to celebrate. The result was the VARBERG CALLING for Peace project, with the aim of engaging and involving residents in actively working for peace and a sustainable society. The basic idea is to draw attention to the local and international history of peace, and in doing so combine the forces of Varberg's administrative bodies, organisations, civil society and local residents to increase awareness of the important perspectives that are vital for peace and a sustainable future. It is also important to encourage participation in order to highlight issues of democracy, human rights, cultural understanding and sustainable environment, and to examine them in greater detail. Also for there to be a legacy once the project has ended, which can be built on and will provide support for future development.

Photo: Mimmi Persson



Greater awareness of the age in which we are living and a common educational perspective on our history provide the conditions for future creativity, innovation and action. We believe that the big, universal human issues can unite many, both organisations and individuals.

Thinking globally and taking into consideration situation analysis and environmental and resource perspectives cannot be restricted to municipal or national borders. VARBERG CALLING for Peace is an opportunity, therefore, for Varberg municipality to take a forward-looking, general approach to sustainable development in a project that involves local residents. Engagement on humanitarian issues and the all-pervading problems we now face in the world around us may also increase interest in important issues at local level. The project therefore represents a step towards the realisation of Varberg's plan: Vision 2025 "Swedish West Coast's creative hotspot" and a sustainable future.

Christina Josefsson

Head of the Culture and Leisure department
The City of Varberg

Come to Varberg. Share our vision.

Inspiring people to create everyday peace



**VARBERG
CALLING
for Peace**

The city's local education centre, Campus Varberg, is today the largest vocational college in the Halland region and is one of Sweden's leading providers of vocational education. The core values at Campus Varberg include knowledge, innovation and creativity, and it was not long before it became involved in the VARBERG CALLING for Peace project.

At the college's events and management course a number of students are running their own projects as part of VARBERG CALLING for Peace. Here they tell us about the solid peace work they have done, which has given them valuable experiences.

"We are studying on a three-year events and management course and during February and March we studied a course in 'project-based development work'," explains Lina Rundbom, one of the students.

"During the course, we had the opportunity to choose from a number of assignments to work on and we five chose 'VARBERG CALLING'. We had to examine and communicate the questions 'What do you stand for?' and 'How can you get strangers to talk to one another?' to the general public."

The assignment came from the two process managers for VARBERG CALLING for Peace, Malin Bellman and Jon Liinason.

"They gave us some good advice before we started. 'Don't think – just do it and see what happens!' they said. So we did. We tried out our ideas on people using quick and easy prototype tests, with the results leading to new ideas."

One of the prototype tests involved leaving a bicycle in the entrance to the city's galleria. The girls left the bicycle "right in the way" and stood a few metres away to see how people reacted. Contrary to what you might expect, most people did not seem particularly irritated. It gave some people something to talk about as they wondered why the bicycle was there. Another was the mobile "everyday peace cycle café". Loaded up with coffee and pastries, the bicycle was pushed around to various parts of the city, offering coffee and cakes for free.

They asked the people they met how we can create everyday peace. Smile at someone you don't know, pick up litter, and hold open the door for someone were some of the suggestions.

"It really doesn't need to be any more difficult than that," says Lina. "Everyone can do something. The cool thing was seeing how our own positive energy clearly spread to those people we were talking to."

Annette Wenklo

varberg

varberg.se

Integrating data lifecycles to enable circular economy in construction

PCSG Senior BIM Consultant, Steve Thompson, explains how digitalisation is opening up opportunities for a more circular economy approach

At PCSG we have for a while now been helping clients throughout the built environment to understand the potential benefits of a circular economy for construction, enabled by digital processes. With the rapid growth of digital awareness and technologies, solutions to many of the barriers to through lifecycle thinking are emerging.

“A circular economy is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.” – Ellen MacArthur Foundation.

Through the CPA's recent report on the Future for Construction Product Manufacturing, we identified the need to consider digitally connected supply chains, and to link manufacturing, design and delivery of assets with performance in use. We need to consider how to deliver mass customisation of buildings (the ability to have unique, but economic and deliverable assets), along with construction flexibility and in-use adaptability if we are to optimise the lifecycle of a building.

Construction flexibility enables the same building to be constructed in a number of ways using the same components, and also to cope with changes in user requirements during the design and delivery phase of an asset.

In-use adaptability enables the building to be re-configured or adapted, regarding layout or performance through its lifecycle. As John Turner said, “an environment is an environment by virtue of the life that it surrounds”. The way a building is used over time can change significantly as occupant requirements change, whether a complete change of use from a home to an office for example or a change driven by the invention

of new technologies, such as the invention of the refrigerator eliminating the need for a larder. By enabling a building to be reconfigured, we can potentially extend its lifecycle to maintain its suitability.

To achieve mass customisation, construction flexibility and in-use adaptability, we need to be able to share digital product information consistently all the way through the lifecycle of a project and an asset's lifecycle. To do so, and to enable a circular economy, we also need to consider the product lifecycle, and how products can be designed, manufactured and installed ready to be re-used. Re-used not necessarily at the end of their useful life, but also the useful life in the context of the wider asset.

Disparate lifecycles in construction

To achieve a circular economy in construction, the 3 disparate lifecycles of building projects, built assets and construction products have to be integrated. All of these lifecycles currently include digital processes to some degree.

A construction project delivered to Level 2 BIM – a digital twin of the physical asset – is created which then supports its management throughout the asset's operational phase.

The asset lifecycle entails the construction, maintenance, reconfiguration and eventual re-use or re-cycling of assembled products at the end of the asset's life. A range of digital tools are deployed to manage this process.

A product lifecycle includes its design and development, procurement of materials, manufacture and then delivery and installation as part of a built asset. All of these require digital processes, which are not currently typically extended through the operational

phase of an asset. Within the current fragmented construction industry, it is common for manufacturers to lose track of their products past the point of sale, leaving a significant gap in knowledge on where a product is, how it is performing in use and when it is ready for replacement or re-use. This gap can be filled using the likes of the [CPA's LEXiCON](#) to consistently define and share product information all the way through the product and asset lifecycle.

Integration and optimisation of 3 life cycles

The CPA report describes how these lifecycles can be optimised through integrating the virtual and physical environments, with the potential to deliver assets up to 40% quicker and 30% cheaper.

Benefits from a circular economy in construction through integrated data

By following the circular economy approach, each of the 3 traditional lifecycles will benefit in turn. The creators of buildings, including designers, engineers and construction firms will be able to customise designs and optimise design options eliminating the risk of value engineering and compromising the original design intent. Advanced generative design technologies such as RST are enabling fully resolved digital models to link mass customisation of buildings all the way through to the manufacture and delivery of built assets.

The financiers and owners of buildings will be able to eliminate the as-designed and as-built performance gap, achieve delivery on time and budget while reducing risk in their commercial models. The flexibility of an asset will be further enhanced, and the asset use cycle optimised, including the potential and value of reconfiguration and optimising (including potentially shortening) the lifecycle of a building.

Manufacturers will fully understand the value and performance of their products in use, enabling new business models such as leasing products or selling performance rather than product. UK PLC can benefit by reducing the need for raw materials and product imports while creating a new industry for reverse logistics of products and materials, enabled by collaborative digital platforms to share and re-sell products and identify their value and where they can best re-enter the supply chain.



Steve Thompson, PCSG Senior Consultant

Therefore, a digitally-enabled supply chain delivers products and systems to be re-used, re-distributed, re-manufactured and recycled over an asset's life. The more standard this approach becomes, the easier it will be to re-use design assets, across the UK and internationally and achieve carbon savings for one of the world's most resource-hungry industries. A recent report from the Ellen MacArthur Foundation has suggested a potential benefit for the EU of over €130bn by 2030 through a circular economy within the built environment alone, largely enabled by the digital economy. So we need to begin sharing the digital product and process data to enable this to happen and to re-think traditional supply chain and industry boundaries to start to make this happen. ■

If you would like to learn more about the digitisation of construction product data and its role in driving the circular economy, please contact Steve Thompson at enquiries@pcsg.co.uk.

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Demountable construction enables structural diversity

University of Luxembourg's Prof. Dr.-Ing. Danièle Waldmann-Diederich explains how demountable construction responds to changing structural demands

Buildings are often demolished due to a needed conversion or change of the architectural design, although the supporting structure remains completely undamaged and fully intact. This leads to huge quantities of waste which need to be discharged on mining tips. Thus, the building sector is generating a large amount of CO₂ emissions, resource consumption and waste production. Given the high resource-intensity and CO₂ emissions of the sector, new eco-construction approaches are needed.

Demountable construction

Demountable building constructions are defined as structures which allow destruction-free dis- and re-assembly responding to changing structural demands, revitalisation or removal. This could only be reached by designing modular, flexible, adaptable and upgradable structural components with detachable connections. But it is not sufficient to consider only the erection phase of the elements, they must be optimised in terms of materials ageing and energy consumption in an integrated situation within an overall building concept. The idea of developing construction systems which are demountable is not new. Although, many precast structures have been erected in the meantime, the reuse of complete structural elements is still not practiced. The advantages of reuse, with a saving of energy consumption, raw material and CO₂ emissions are obvious.

Furthermore, no waste is produced which is needed to be discharged on building rubble dump. So the question rises why the idea of demountable construction could not been pushed forward until now.

"The current research of INCEEN is driven by the aim to reduce energy and resource use throughout the entire life-cycle of buildings and their components."

The raisons are manifold. One major reason is certainly that this kind of construction needs a change in philosophy: first of all, the architect is limited in his design as he has to align to a given grid. So the development of architectural typologies and adapted constructive principles are necessary to permit the reutilisation of whole elements after one life cycle. Furthermore, these architectural principles should also allow a reuse of the building in case of conversion. Then new deconstruction methods have to be developed: e.g. renders, insulation, floor covers, screeds are fixed to the structure so that an easy disassembly is not anymore possible. Here, new techniques have to be developed which allow after the first live cycle of the building an easy disassembly and cleaning. Another major reason is certainly that after the first life cycle of a building often the information about the load bearing structure and other performance criteria is not any more available. Retracing the information

about one single load bearing element with its reinforcement position, grade, diameters, concrete cover and concrete class etc. is difficult. Often the documents of the statics and the structural design are not anymore available.

Furthermore, a condition assessment of these elements must also take place to assess the remaining load bearing capacity. Another major aspect is that no circular economy market is yet installed which would provide schemes and solutions for the deconstruction, transport, condition assessments, temporary storage and reuse of whole structural elements. Thus, the systematic integration of large quantities of elements in new buildings needs new concepts on different levels and a change in the building process without forgetting the client who must accept to invest in a new building which load bearing structure is a conglomerate of old structural elements.

All these aspects are currently addressed in research projects of the Institute of Civil Engineering and Environment (INCEEN), a sub-structure regrouping the civil engineers of the research unit of engineering sciences at the University of Luxembourg. The overarching mission of INCEEN is to solve scientific questions and to develop new scientific and technical methods for sustainable buildings. By doing so, it aims to advance the level of scientific understanding in key-



domains relevant to the next building generation, including modular construction, applying principles of the circular economy. Further INCEEN aims to catalyse interdisciplinary research collaborations in the areas of structural engineering and the environment, as well as contributing to solving sustainability challenges of the built environment sector responsible for a large amount of CO₂ emissions and resource consumption. INCEEN has strong research experience in the design of reinforced/prestressed concrete, steel and composite structures and structural health monitoring.

The current research of INCEEN is driven by the aim to reduce energy and resource use throughout the entire life-cycle of buildings and their components. By showing how buildings can be used as material and component banks, the research projects of INCEEN seeks to trigger a paradigm shift in the construction sector. The

research also analyses the possibility of business models based on loaning materials and components to customers. Therefore the applicability of monitoring systems in structural components by internal electronic chips (RFID) which are readable from outside guaranteeing a provision of all relevant information for a reconstruction or reutilisation in future reuses will be developed and tested.

To sum up, the concepts to be developed are based on the investigation of a wide spectrum of factors, taking into account different (often competing) technical, ecological and economic constraints imposed by planning, design, pre-fabrication, on-site operations, in-use consumption and emissions, as well as requirements for refurbishment and demolition/recycling at the end of a building's life-cycle. Understanding sustainable construction as an important component towards the reduction of the total

resources-related footprint of a building, it is evident that only an integrated and inter-disciplinary approach to such a multi-objective constrained optimisation problem can be successful.



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Concrete provides opportunities to achieve sustainable buildings

Concrete is increasingly recognised in the delivery of the most sustainable projects. Here, PBC Today outline the role of specifiers in this process

Concrete as a material is incredibly versatile and offers many opportunities for designers to influence the environmental, economic and social credentials of their projects, including performance credentials such as fire resistance, thermal mass, acoustic performance and flood resilience. Add this together with a reduced need for applied finishes, and concrete is increasingly recognised and utilised by design teams in the delivery of the most sustainable projects.

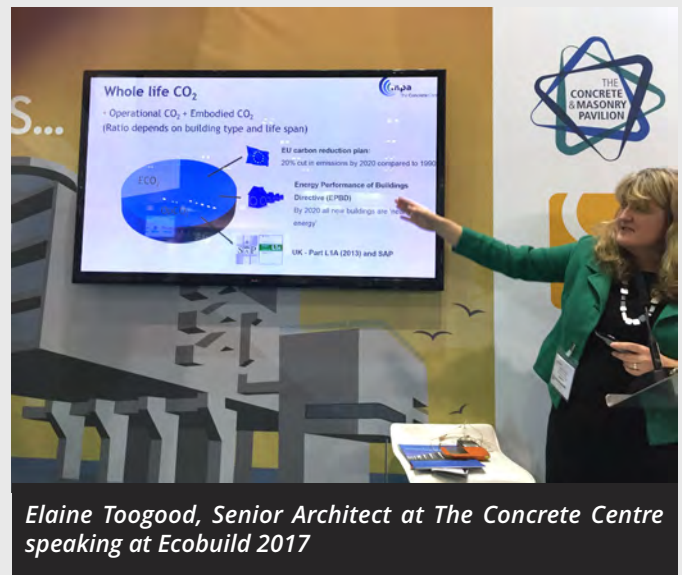
Speaking at the Ecobuild event on 7 March, Elaine Toogood – Senior Architect at The Concrete Centre presented a seminar on Sustainable Concrete and pointed out that:

“The inherent benefits of concrete mean it does not need any other treatment to make it perform, to make it fireproof. This, and many of the other performance benefits of concrete are often not discussed as sustainability benefits, and they should be.”

The whole-life performance

Sustainability is largely about getting the fabric right. Using the thermal mass of concrete within a natural ventilation strategy can reduce the amount of energy required for heating and cooling, therefore reducing the total amount of energy we use in a building. But that’s not the whole story. Examining the whole-life performance is also a key part.

Understanding the impact that different design choices have on the whole-life of a building is key. The emphasis is shifting between embodied and operational impacts, but the best answer needs to consider the lifecycle of the building’s components and materials and their contribution to minimising the overall impact over the whole-life of a building.



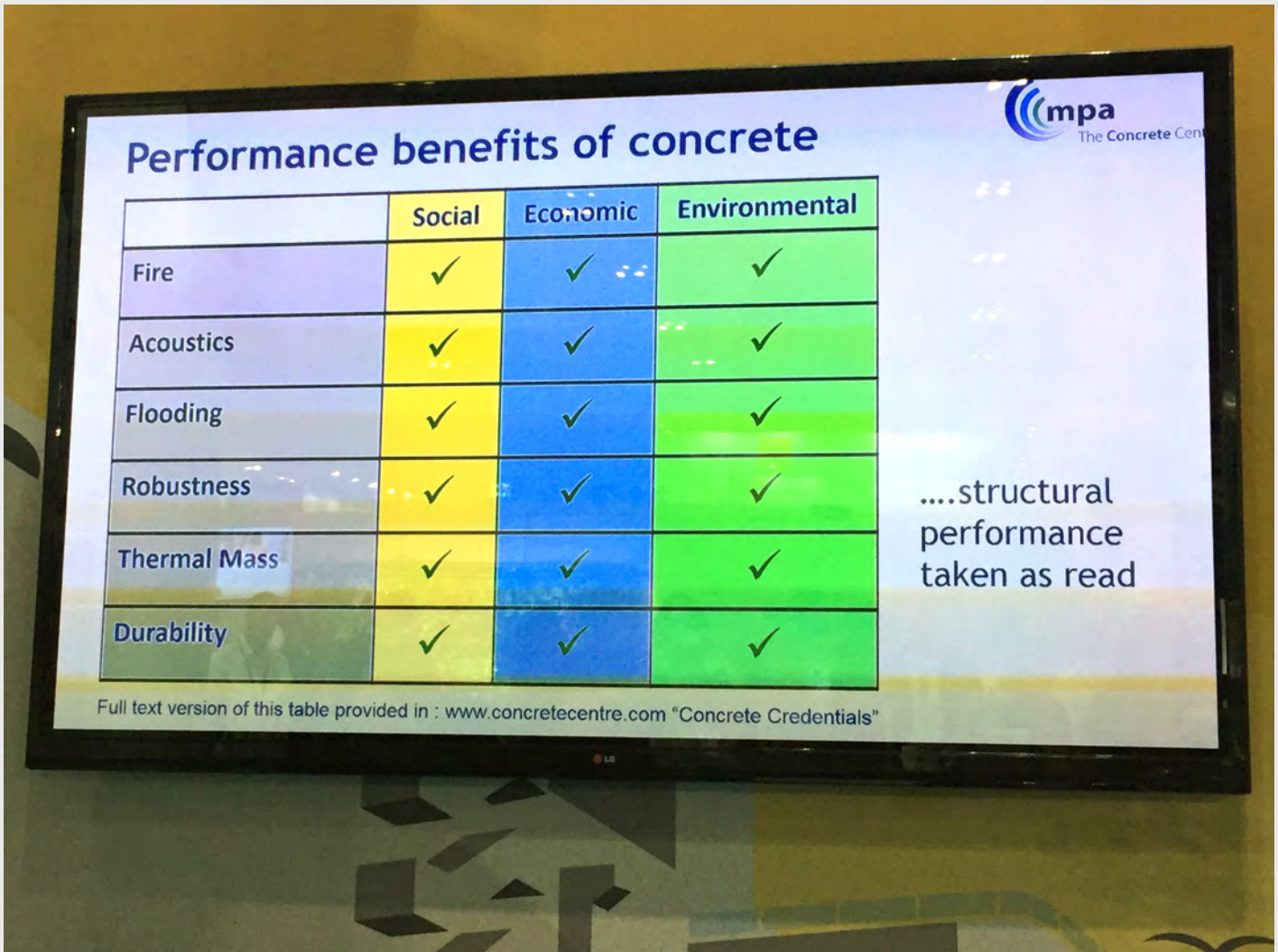
Elaine Toogood, Senior Architect at The Concrete Centre speaking at Ecobuild 2017

Concrete comes in a whole variety of forms including off-the-shelf precast products, cast in situ concrete, bespoke precast or hybrid concrete solutions. If you’re a specifier you are able to assess the manufacturers product data and going forward this is more and more likely to be in the form of an EPD (Environmental Performance Declaration). Manufacturers will provide EPDs specific to their product range and the concrete industry is developing generic EPDs that are useful at the early stages of a project.

Reducing carbon

The industry is doing an enormous amount to reduce its carbon footprint, but specifiers also have a role to play here by stipulating they want lower carbon forms of concrete. Elaine Toogood, again speaking at Ecobuild this year commented:

“We as specifiers can request concrete mixes with a lower carbon footprint, such as those using cementitious materials that include fly ash or ground granulated blast-furnace slag (GGBS).”



GGBS is a by-product recovered from the blast furnaces used in the production of iron, and fly ash is a by-product of coal-fired power stations. By using these materials, the overall greenhouse gas emissions associated with the production of concrete is reduced, and you can make serious reductions in a project's embodied carbon footprint.

New standards and guidance

At present it is common practice in Britain to use cement combinations with either fly ash or GGBS (used with Portland cement). Other cement combinations are also allowed within BS 8500 including those using silica fume and limestone.

The concrete industry is currently coordinating an investigation on the use of finely ground limestone as part of ternary or three component cements, also including fly ash or GGBS. The aim is for this to be introduced into

the concrete standard for the UK (it is already permitted in Ireland and other European countries).

There is a great deal of research going on in the background for alternative types of cements. The standard produced last year: [PAS 8820:2016 Construction materials](#) was developed allowing the use of alkali activated cements (AAC) in some concrete applications.

Recycled aggregates

In the drive to remain sustainable it is worth considering the use of recycled aggregate in the concrete specified for a project. When specifying recycled aggregate to reduce embodied carbon, it is important to check what is available locally to the site. Natural aggregates have such a low carbon footprint that a source of recycled aggregates traveling more than around 15km by road is likely to have higher embodied carbon than a local supply of natural aggregate.

Another factor when using recycled aggregates is consistency of supply. There are strict protocols for the testing of aggregates for use in concrete, and there are permitted quantities of recycled aggregate, depending upon the type as well as the strength and exposure class of the concrete being designed.

It's important to bear in mind that there are also various secondary aggregates, that are classed as a type of recycled aggregate for use in concrete. These are by-products of other industries and include china clay waste from the South West of England, often referred to as stent.

Material efficiency

Elaine went on to explain how concrete offers the opportunity for material efficiency, urging designers to use the performance benefits of concrete and optimise its use by considering low waste solutions and efficient design as a way to reduce the amount of other materials needed in the construction.

"Unlike many other materials, a concrete structure can provide a good, robust finish without the need for additional coatings or linings to provide the necessary long life performance, fire resistance or acoustic isolation necessary to meet building standards. The savings on resources to install and repair these finishes can add up to significant material savings over the lifetime of a building."

"This whole life perspective is crucial if we are to move towards a circular economy," explains Elaine. "A good approach is to design a building that can be used and then reused, extending its usable life and thereby save resources. This can add up to a low whole-life carbon solution."

Concrete is often designed to last for 100 years at no extra cost, offering plenty of opportunity for an extended service life of a building or structure. Furthermore, when the time eventually comes to demolish it, concrete can be crushed and reused.

"At the point it's crushed up, it actually starts absorbing CO₂ due to the extra surface exposed to the air. This end of life carbonation is fairly new to our understanding, but can make an impact of the whole-life carbon profile of a building."

Specify responsibly sourced concrete

Responsible sourcing for construction materials is a similar concept to Fairtrade standards for food. Elaine Toogood told the audience at Ecobuild that:

"BES 6001 is a responsible sourcing standard available for all construction materials and is the one the concrete industry has embraced. Around 90% of all concrete produced in the UK is responsibly sourced to BES 6001. This is quite an achievement, but of course facilitated by the fact that unlike most other structural materials concrete is almost always made in the UK from UK sourced materials. This is a fundamental sustainability benefit, underpinning the core social, economic and environmental credentials of concrete for use in a sustainable built environment."

Further reading is available on the Concrete Centre website including the [Whole-Life Carbon and Buildings](#) and [Specifying Sustainable Concrete](#) documents. ■



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The challenge of building a resilient food system

A changing world requires an interdisciplinary approach to research if we are to build a more resilient food system, says GFS's Evangelia Kougiumoutzi

The food security challenge is about meeting the rising demand for food in ways that are environmentally, socially and economically sustainable, whilst providing an acceptable, safe and nutritious diet for all. Currently, the global food system is under pressure with stresses like climate change, socio-economic fluctuations and emerging diseases, confining our ability to effectively use resources such as land, fresh water and energy. At the same time, a growing global population and the dietary shifts of a more affluent society are creating an ever-increasing demand for food. These tensions are likely to lead to unpredictable disruptions to food production and supply globally and in the UK, as just under half of the UK food supply is imported.¹

In the face of these stresses, new knowledge is required to identify ways to build resilience of the food system at a national and international level. Achieving this whilst ensuring food remains safe and affordable and consumer trust is maintained is a complex objective and will require joined up approaches across the varied actors of the food supply chain, as well as a combination of knowledge from different research disciplines.

Global Food Security

The [Global Food Security](#) (GFS) programme, a partnership of the UK's main public research funders, coordinates collaboration across food security research areas, by bringing together funders, researchers, policy makers and practitioners to address key issues on global food security and agriculture. As a result of GFS' activity [BBSRC](#), [NERC](#), [ESRC](#) and the [Scottish Government](#) have [committed £14.5M to support](#) interdisciplinary research to address the food system resilience challenge. The 'Resilience of the UK Food System in a Global Context' research programme aims to generate in-depth understanding of how the food system functions and how its many components interact. The



programme is designed to push researchers outside their comfort disciplinary zones. Projects will integrate natural and social sciences but also aim to drive innovation and research translation into policy and practice by involving end-users throughout the research process. The programme's main priorities focus around optimising food production systems, local and international supply chains, and influencing food choices for better health. The ambition is that research from this programme will provide the evidence base needed to underpin the UK's strategic approach to food security and will inform how we monitor, manage and mitigate short and long-term risks to food production and supply.



Through the programme's first Call for proposals, [5 interdisciplinary, collaborative research projects](#) tackling different aspects of the food system resilience have been funded. These projects vary from taking holistic approaches, developing models, food system shock scenarios or integrating knowledge across different food system actors for better adaptation to change, to more focused approaches assessing the sustainability of specific supply chains or whole industry sectors against a range of risks. A new set of proposals will be funded through the programme's 2nd call which will be announced in August this year.

The programme's research community is working closely with the programme coordinator, [Dr John Ingram](#) and his team from the Environmental Change Institute at the University of Oxford. Researchers and the Programme Coordinator will work together to facilitate knowledge exchange, build links between projects, researchers and end-users to integrate research outputs which could inform policy and practise. This way, the programme aspires to build a legacy by using the research outputs to feed into the development of a UK strategic approach to food security.

Evangelia is International Coordinator & Programme Manager for the Global Food Security programme (GFS). Before joining GFS, Evangelia worked as an Innovation Manager for GFS partners BBSRC. She holds a PhD in plant development and genetics from the University of Oxford. ■

1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/526395/foodpocketbook-2015update-26may16.pdf



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Exeter University tackles banana supply chain threat

The future of the UK's favourite fruit hangs in the balance, but researchers from Exeter University are tackling the threat to the banana supply chain

Researchers at the University of Exeter have been awarded £1.2 million to investigate the resilience of the UK's banana supply. Bananas are the most popular fruit in the world by production. More than five billion bananas are purchased in Britain each year, and the UK accounts for around 7% of the global export market. Bananas are so important to the global economy that the EU and USA have fought trade wars over them.

Now, the impacts of climate change, emerging plant diseases, and economic uncertainty threaten the banana supply chain, potentially impacting diet and nutrition in importing nations, as well as the livelihoods of producers in the developing world. The University of Exeter project brings together biologists, ecologists, economists and social scientists with the UN FAO, NGOs and businesses to address the resilience of the banana supply chain from plantation to fruit bowl.

Bananas serve as an example of a major, wholly-imported commodity to the UK. Whatever the long-term result, the immediate impact of the UK's decision to leave the EU has seen a rapid drop in the value of the pound, leading to concerns over the costs of imports to the British consumer. The Consumer Price Index, stable from 2014 to the beginning of 2016, has risen sharply since the beginning of the year.

Food price rises are of particular concern because of the impact they can have on poorer families. Consumers have benefited from food price deflation since the summer of 2014, but this could well change. Justin King, former CEO of Sainsbury's, has suggested that supermarket prices will rise by at least 5% over the next six months, as retailers eventually pass on price rises. As pointed out by Mike Coupe, Sainsbury's current chief executive, we live in a globalised world from which cheaper alternatives can be sourced. Hence, the shock of our reduced purchasing power could reverberate through our trade networks.

Global Food Security: Bananas on the agenda

Economic resilience refers to the ability of an economy to absorb sudden changes, or shocks, and quickly return to normal. Resilience of the food system has been high on the policy agenda since the global financial crisis of 2008, which doubled food prices in the space of a few weeks. Global food prices declined again at the beginning of 2016, but have since increased. The danger of rapid price fluctuations is that planning becomes difficult; either producers are impoverished by unexpectedly low revenues, or consumers are faced with expensive food.

The negative impacts of non-resilient food systems are so severe that the UK government has launched a major research initiative, the Global Food

Security programme, to tackle the issue. The programme is funding projects that bring together academics, non-governmental organisations, businesses and policymakers, to provide the knowledge and guidance needed to strengthen food supply chains against future shocks. Recognising the interconnected nature of food supply, the programme will address the resilience of the UK food system in a global context.

"Our team of ecologists, biologists, economists, and social scientists will work closely with the United Nations World Banana Forum, the UK charity Bananalink, and major retailers, to address diverse threats facing bananas. Our aim is to determine how emerging diseases and other factors like changing climate will affect banana production, and to test new methods for disease control."

My colleagues and I at the University of Exeter are fortunate in leading one of the first projects within the Global Food Security programme. We have decided to look at a food that, while being incredibly popular, bears all the signs of being highly vulnerable to production shocks: the banana.

The UK is highly dependent upon imported fruit and vegetables, which make up 80% of the market. This compares with half of cereals and one sixth of meat and dairy produce. Fruit and vegetables are a key component of a healthy diet, yet are often over-

looked in studies of global food security, where the focus is on the major grains. Reliance on imported fruit and vegetables makes the UK vulnerable to instabilities in international production and supply, so jeopardising the resilience of the UK food system.

A cheap and healthy snack

This vulnerability is epitomised by the banana, the most popular fruit in the UK by consumption, and the most important fruit in the world by production. Bananas have significant health benefits, particularly in comparison with alternative 'snack' foods, such as cereal bars containing refined sugars, salt and fat. Bananas have a low glycaemic index and contain resistant starches rather than the 'free sugars' that contribute to diabetes, obesity and tooth decay. Bananas promote a healthy gut flora and consumption is linked to reduced tooth decay in children compared with more acidic fruit like apples and citrus. The banana is a cheap, healthy snack enjoyed by millions of Britons every day.

However, scientists are increasingly concerned for the future of the banana. Recent expansion of the virulent fungal disease *Fusarium* wilt, also known as Panama Disease, has highlighted the extreme risk facing the global banana trade. Though many varieties are grown around the world for domestic consumption, the international trade relies on a single susceptible variety, Cavendish. *Fusarium* wilt destroyed the previous export variety 'Gros Michel' in the 1950s, but now there is no alternative resistant variety waiting in the wings, nor any known control for the disease.

This strain of the disease emerged in Taiwan, covering Southeast Asia in the 1990s and spreading recently to Australia, Mozambique, and the Middle East. If this new strain of wilt reaches Latin America and the Caribbean, from where the EU (and US) purchase the vast majority of bananas, the most popular fruit in the UK could disappear from supermarkets. Not only would this dramatically alter UK diets, but producers and developing economies would be impacted with potentially far reaching consequences. Other pests and diseases are also emerging, many of which also lack viable controls.

Banana supply chain particularly vulnerable

The UK retail trade increases vulnerability in the system. The Fairtrade Foundation estimates that the consumer price of bananas has halved over the past decade, while production costs have doubled. Today, the wholesale import price of bananas matches the retail price: the margin is zero. Concern over social and environmental impacts of banana production has led to a significant market for Fairtrade and Organic-certified bananas. However, UK supermarkets have been engaged in a "banana price war", resulting in prices that are insufficient to adequately support producers, and reduce investment in improved production methods, development of new varieties, and social and environmental sustainability. If bananas are to remain a key component of the UK food system, analysis of these threats and mechanisms to counter them must be developed.

Our team of ecologists, biologists,

economists, and social scientists will work closely with the United Nations World Banana Forum, the UK charity Bananalink, and major retailers, to address diverse threats facing bananas. Our aim is to determine how emerging diseases and other factors like changing climate will affect banana production, and to test new methods for disease control.

Our research will complement development of new resistant tradable varieties and fundamental disease biology ongoing around the world. We will analyse how production shocks will affect the UK market, how the UK retail sector and consumers might respond, and how those responses could feed back to producers in the developing world. Through the World Banana Forum we will work with retailers, producer groups, and other stakeholders to produce strategies to increase the resilience of the banana trade to production shocks, and secure the future of the UK's favourite fruit.



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Endocrine disrupting chemicals: From feeds to hormones

Alberto Mantovani and Chiara Frazzoli, scientists of the Italian National Health Institute, discuss the role of endocrine disrupting chemicals in feed-food chains

Foods are produced by living organisms which, in order to deliver sufficient and wholesome products, need to thrive in a healthy environment. This is one basic assumption of the European White Paper on Food Safety, issued in 2000, that sets the conceptual bases for a food safety strategy “from farm to fork”. Hence, the safety and quality of vegetable foods largely depend on the characteristics of water, soil and fertilisers; the safety and quality of foods of animal origin, in its turn, largely depends on those of feeding stuffs.



A pillar of animal husbandry, feed, or specific feed ingredients, can be also a risk factor as well as a vehicle of contaminants posing hazards to animal health and to consumer safety. Once again, endocrine disrupting chemicals (EDC) deserve a special attention because of multi-faceted potentials for exposure, pleiotropic effects and scientific uncertainties making it difficult to establish “safe” levels.

The risks associated to EDC in feeds present different scenarios. In some cases, EDC pose serious hazards to animal health and productivity, without posing significant concerns to consumer health. A major example is zearalenone, a mycotoxin (i.e., a toxic by-product of microscopic moulds) contaminating grains. Zearalenone is a potent oestrogen-active ED which, even at low concentrations can jeopardise the reproductive capacity of a

herd; pigs are especially sensitive. However, a significant hazard for animal health, zearalenone does not bio-accumulate and is readily metabolised; thus, foods of animal origin are just a minor source of zearalenone residues.

Positive endocrine-active chemicals

In some cases, endocrine-active chemicals have positive effects on animal health, but usage levels must consider the carry-over to consumers. A telling example is the supplementation with iodine of feeding stuffs. Iodine is essential for thyroid function, a key component of the endocrine network; yet, an excessive assumption can hyper-stimulate and damage thyroid. Iodine is not deposited in tissues to any large extent, but is actively excreted in milk and, to a lesser extent, in eggs. Accordingly, in 2005 the Euro-

pean Food Safety Authority (EFSA) recommended the reduction of the maximum iodine levels authorised in feeds, upon the assessment of carry-over in milk and eggs and of the potential exposure of consumers to excess iodine levels. In the meanwhile, EFSA assessed that the proposed reduction would not adversely affect animal nutrition. Upon some debate (indeed, risk managers were somewhat taken apart by an essential nutrient raising concern), the EFSA recommendation was accepted by the European Union.

The major and most evident aspect of ED presence in feeds is the environment-feed-food chain; under this respect, the EDC of top concern are those able to persist in the environment and to bio-accumulate as lipophilic compounds: dioxins and related compounds, non-dioxin-like PCB, PBDE and other brominated

flame retardants, chlorinated insecticides (DDT, hexachlorobenzene, etc.). A further addition to this list are the non-lipophylic but highly persistent perfluorinated chemicals, PFOS and PFOA, albeit the patterns of feed-food contamination have still to be characterised.

“The risks associated to EDC in feeds present different scenarios. In some cases, EDC pose serious hazards to animal health and productivity, without posing significant concerns to consumer’ health.”

Persistent and bio-accumulating EDC are ubiquitous in feeds, but general two scenarios are highly liable to exposure. First, feeds or feed ingredients of animal origin. Following the bovine spongiform encephalopathy crisis, the use of feeds of animal origin in animal production is mostly limited to aquaculture. Conventional feeds for farmed fish are largely made with fats and proteins from small fishes or marine organisms: the highly-prized salmonids (salmon, trout, etc.) are particularly high-consumers of feeds of animal origin. In practice, aquaculture feeds reproduce the “big fish eats small fish” bioaccumulation chain of wildlife ecosystems. The levels of EDC in fatty fishes and/or large fishes have created serious concerns for consumer health, in particular for the protection of the next generation, as well as jeopardizing the nutritional value of fish food. A workable solution, which was increasingly adopted in the last years, is the use of feed ingredients of vegetable origin which are definitely less liable to bioaccumulation.

Environmental influences

The other critical scenario is when feed ingredients are highly exposed to envi-

ronmental emissions: these include pastures or feeding plants harvested in polluted areas. Emission sources may be most various: fall-out from industrial or combustion processes (typical of dioxins), illicit burial of toxic waste eventually being taken by the roots of pasture plants, or contaminated water or fertilizers being spread on vegetables intended to be used as feeds. The animals most critical for consumers exposure are dairy ruminants (not just cattle, but also goats and ewes, important dairy species in Southern Europe; also water buffaloes can be locally important and should not be overlooked). Dairy ruminants live much longer than meat-producing animals, thus have more time to bio-accumulate, and use excretion in milk to reduce the body burden of lipophylic EDC. Laying hens kept on ground and allowed to forage on ground, are also definitely more exposed to pollutants than other poultry. In order to manage environmental exposures in dairy animals kept on pastures, it is important to use animal biomonitoring in order to have early and timely flags that allow actions to be taken. For example the Italian project ALERT investigates the use of a patent developed by the Istituto Superiore di Sanità, in order to monitor and assess anomalies in a simultaneous panel of biochemical parameters in milk: the daily monitoring of these biomarkers is expected to identify early signals related to the contamination of animal feed, water for drinking, or farm premises.

Overall, safe animal feed is useful to support a safe human diet in a “one health” conceptual framework, where protection of environment, farm animals and human well-being mutually support each other. Regulations and controls should be enforced and, when

appropriate, updated: however, modifications of technologies and use of validated early markers in modernised self-monitoring plans are especially effective approaches toward prevention. Based on these concepts, in sub-Saharan Africa, the network of local organisations NOODLES is boosting a prevention frame for sustainable food safety (i.e., targeted to the protection of the next generation’s health) in the context of Sustainable Development Goals. Indeed, the operationalisation of integrated and One Health prevention frames is necessary to translate scientific knowledge into global health governance mechanisms.



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Keeping pests under control requires ongoing research

Chris Bentley, Agricultural Research Service – U.S. Department of Agriculture, explains why research must continue to protect crops from pests and insects

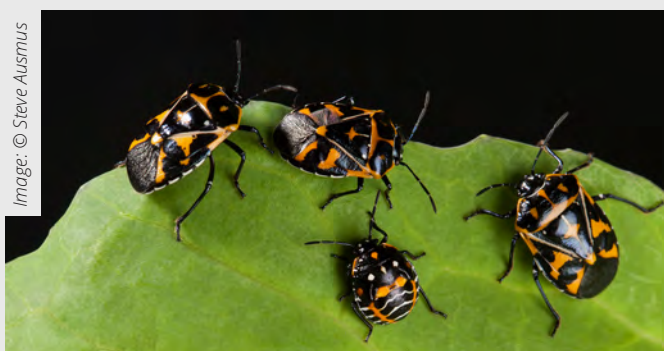
Agricultural production in the U.S. and around the world is under constant attack. One of many enemies standing at the gate: thousands of different insect species. Left unchecked, they compete for the food we eat and represent threats that could decimate our natural, agricultural, and urban landscapes. If not for today's pest control measures, insects would ruin many of the crops grown in the U.S.

Scientific research has provided a palette of measures and strategies to help farmers and ranchers, as well as gardeners, homeowners, and the general public, control these insect pests. Many of these innovative tools and techniques are the direct result of the U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS).

Thanks to ARS scientists, many large-scale insect-related problems – like screwworm infestations of livestock – are no longer on America's "need-to-worry-about" list. If not for the sterile-male insect release technique pioneered by ARS researchers Drs. Edward F. Knippling and Raymond C. Bushland more than 6 decades ago, the flesh-eating screwworm would have decimated U.S. livestock production – just as it does today for many of our Central and South American neighbours.

Unfortunately, science can't rest on past successes. That's because insects continue to invade, which researchers often learn about by comparing specimens to those maintained in the hundreds of ARS scientific collections. These collections provide a definitive resources for agricultural research to include the identification of invasive insects. Pests also evolve and are quite adept at developing countermeasures to overcome control methods designed for them. In turn, that requires ARS scientists to find newer and better approaches for controlling insects, a few of which are mentioned here.

Image: © Steve Ausmus



Clown-colored harlequin bugs are no joke – H3ARS scientists developed a synthetic version of a harlequin bug pheromone to lure the bugs to traps

Don't let the harlequin bug's red and black clown suit fool you. There is nothing funny about the way this pest can destroy a whole field of broccoli, Brussels sprouts, cauliflower, and other vegetables popular with urban and organic growers, as well as conventional farmers. ARS researchers are supercharging harlequin bug control.

It all involves a synthetic version of the insect's own aggregation pheromone to use as a lure to either trap the bug directly or make so-called "trap crops" work efficiently. Pheromones are chemicals that trigger social responses in others of the same species. In this case, when a male harlequin bug finds food, he releases a pheromone to alert others to gather and feast – much like ringing a dinner bell.

When researchers tested a synthetic version of the pheromone on plants under conditions similar to farm fields, harlequin bugs – old and young, male and female – came crawling and flying from many yards away.

The technique allows growers to make trap crops – a lower-value alternative grown to lure pests away from higher-value crops – even more attractive.

Protecting cotton from stink bugs

Forget for a minute about the invasive brown marmorated stink bug that has become such a common pest in homes, backyards, and farms in recent years. Cotton growers in the U.S. are concerned about native stink bugs that have attacked cotton and other crops for decades.

ARS scientists have found environmentally friendly alternatives to insecticides for the 3 native stink bugs – namely, green (*Chinavia hilaris*), southern green (*Nezara viridula*), and brown (*Euschistus servus*) stink bugs – that continue to threaten U.S. cotton.

Thanks to ARS research, growers are now planting trap crops such as grain sorghum to lure stink bugs away from cotton. They're using pheromone-baited traps to capture and kill stink bugs, and are planting nectar-producing plants – such as milkweed and buckwheat – to feed the stink bugs' native enemy, a parasitoid wasp.

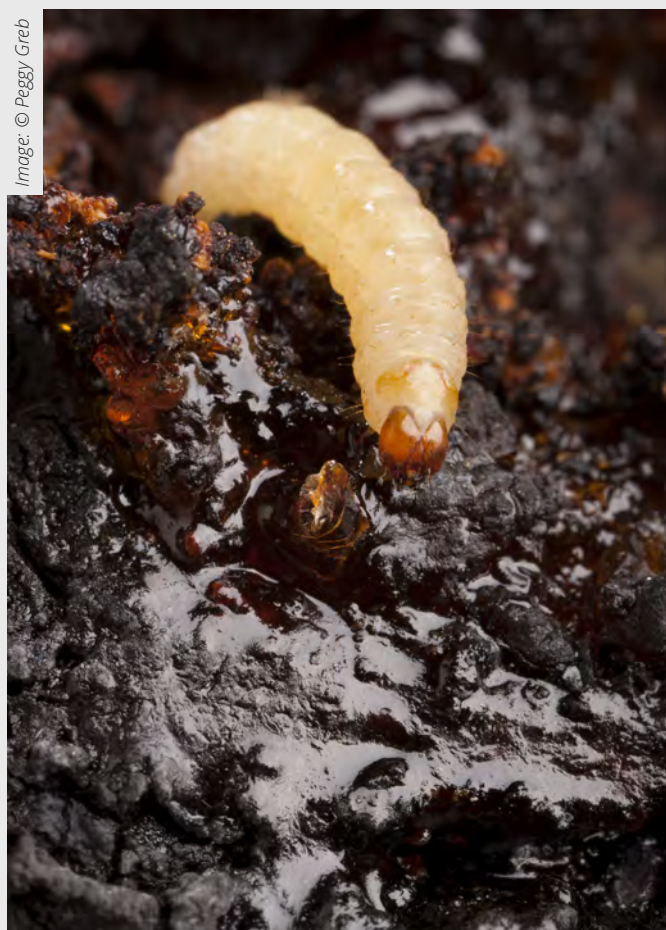
Applying beneficial nematodes to peach trees

Peach growers are facing a formidable insect foe: the lesser Peachtree borer, a native insect first reported in 1868 in Pennsylvania. ARS scientists have developed sustainable and cost-effective ways to combat this destructive pest.

Enter *Steinernema carpocapsae*, a tiny beneficial roundworm (or nematode) that can protect peach and other stone fruit trees by attacking borer pests. They are "beneficial" in that they control insect pests in an environmentally friendly way. But the sun's ultraviolet rays and heat can dry and kill the roundworms after they've been applied. To survive the sun's rays and do their job, these nematodes need protection.

ARS entomologists developed a way to protect the nematodes by using the type of "fire gel" that prevents the spread of fire in residential and commercial structures. In tests, they first sprayed nematodes onto tree limbs infested with lesser Peachtree borers and then applied the fire gel over them.

An initial drawback to that approach was overcome when one application (containing both nematode and protective gel) was developed. The treatment has proven as effective as the standard chemical approach



A lesser peachtree borer larva on a damaged peach tree

to combating the problem. These are but a few examples of the many ways ARS researchers across the country are working to stay one step ahead of insects – all while tackling other issues that affect the productivity and wellbeing of our agricultural and natural resources.

As the sterile-male insect release technique mentioned earlier illustrates, a good piece of innovation can go a long, long way. This will become especially important as the world population swells to an estimated 8.5 billion by 2030. Fortunately, the spirit of scientific and technological excellence of ARS pioneers like Dr. Knipling and Dr. Bushland continues to burn brightly in today's ARS researchers. ■

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Climate change in the Polar regions is a global problem

Vidar Helgesen, Norwegian Minister of Climate and Environment, explains how the government is helping to address climate change in the Polar regions

Norway is the only nation with possessions both in the Arctic and in the Antarctic. The two regions differ widely, but there are also many similarities. Cooperation in polar management and research will be increasingly important in the years to come, and Norway will do its best to contribute.

The northern part of the globe has always been part of Norwegian identity. Seamen and hunters have explored and exploited the seas northwards toward the ice and pole. Their experience provided the basis for Norwegians to venture into the southern Polar Regions. Famous polar explorers like Roald Amundsen and Fridtjof Nansen were pioneers.

The Arctic has warmed substantially quicker than the rest of the world. We see widespread changes in physical and ecological systems. Over the last decades the sea ice thickness and extent, land ice volume, and spring snow cover have decreased. Near-surface permafrost has continued to warm. People and societies in the north see and feel these changes.

Addressing a global challenge

Climate change in the Arctic is a global problem. The feedbacks are increasing global sea levels, affecting global climate and precipitation patterns in southern latitudes.

Over the past couple of decades, significant warming was registered in some parts of Antarctica. On March 24, 2015, a temperature of 17.5° C was measured at Esperanza Station on the Antarctic Peninsula, the highest temperature ever observed on the Antarctic continent.

Most species inhabiting the Southern Ocean are likely to be sensitive to climate change. Growth of microalgae, the base of the food web, depends critically on sea-ice



Image: © Bjørn H Stuedal

Vidar Helgesen, Norwegian Minister of Climate and Environment

cover. Predicted sea-ice reduction will have cascading effects. Organisms living in the ice, krill, fish, penguins, seals, and whales will need to find new habitats or feeding grounds. However, thresholds of climatic conditions for population or community collapse are largely unknown.

Ocean acidification is an additional stressor. The Southern Ocean contains more CO₂ than other oceans because cooler water absorbs more CO₂ than warmer water. Thus, the impacts of ocean acidification will appear here first. We need more knowledge to understand the impacts of climate change and ocean acidification in Antarctica.



Norway's research and monitoring activities in the Antarctic aims to provide such knowledge. Utilising and building on our bipolar opportunities gives Norway a unique opportunity to contribute to an extensive knowledge exchange between the Arctic and Antarctica.

Climate change together with increased human activity makes it wise to monitor developments and evaluate the consequences of such activity against the goal of conserving the Antarctic environment.

Safeguarding polar environments

The Norwegian Government will work to ensure that the unique natural and cultural environmental values in the Antarctic are safeguarded and impacted as little as possible by local activity. We will impose stringent environmental requirements on all Norwegian activity in the Antarctic.

We will as well work to ensure that Norway can make a significant contribution towards increasing environmental knowledge as a basis for environmental management. With our research station Troll in Dronning

Maud Land and our new icebreaker research vessel Kronprins Haakon we can now strengthen Norwegian research in Antarctica.

Troll stands on bare ground 1270 m above sea level on the Jutulsessen nunatak, entirely surrounded by the vast Antarctic ice cap. Kronprins Haakon is one of the world's most advanced research vessels. Programmes on marine and terrestrial biology, glaciology and physics are run. Meteorological observations and measurements of radiation, including UV radiation, are undertaken.

I am proud of Norwegian polar traditions and will do my best to ensure continued research of high quality in both the Arctic and the Antarctic. ■

Vidar Helgesen

Minister of Climate and Environment

Norwegian Ministry of Climate and Environment

www.regjeringen.no/no/dep/kld/id668/

Assessing climate change in the Arctic

Norwegian Polar Institute's Director Jan-Gunnar Winther highlights the challenges associated with climate change in the Arctic and its global impact

It is a fact that no region of the planet is experiencing more dramatic climate change than the Arctic. In recent years, this has resulted in melting glaciers, rapid ecosystem changes, diminishing sea ice, and changes in the atmospheric circulation and ocean properties. Ocean temperatures are increasing due to global warming. The Arctic is undergoing changes unknown to have occurred during the last 1,450 years (Intergovernmental Panel on Climate Change (IPCC), 2013). Climate models project that the most pronounced warming in the future will happen in the Arctic. In a business-as-usual scenario for greenhouse gas emissions, temperatures may increase by 8 to 10 degrees Celsius. Even in IPCC's most aggressive scenario for cutting greenhouse gas emissions, the Arctic will warm with several degrees and in turn fundamentally change this region as we know it today.

Global impact

The Earth's regions are connected by circulation in the atmospheric, ocean, climate and weather patterns. Arctic climate change therefore has profound global consequences and affects global conditions such as sea level rise, ocean acidification, permafrost thawing (which releases potent greenhouse gases) and changing weather patterns, such as the monsoon. Arctic climate change is therefore arguably relevant to the weather and climate in regions distantly located from the Arctic.



Photo: Alison Bailey/Norwegian Polar Institute

The lipid-rich zooplankton Calanus Glacialis is an important source of nutrition for seabirds and fish in the Arctic

Although the development is disturbing, climate change also provides some advantages. Increased biomass production in the northern waters – not at least in the highly productive Barents Sea – may become an important resource for the world's ever-increasing need for food and proteins. Furthermore, the Arctic's special role in global change makes it a potential laboratory for developing new green technology and new solutions that may be utilised in a global context, under the idea that: What works in the Arctic will work elsewhere.

The opportunities in an Arctic with much less summertime sea ice are numerous. New shipping lanes, increased commercial fishing, new

bioprospecting activities and harvesting marine ingredients for bio-production (including organisms at lower trophic levels in the food web and at greater depths,) are among the main gains from the situation. Oil, gas and minerals are other resources that may be possible to exploit increasingly further north in the near future.

A call for knowledge

However, today's rapidly changing climate and the major ecosystem changes that go with it, impose a fundamental challenge for management: the system is highly dynamic with large seasonal changes. We must avoid making decisions and investments for the future based on yesterday's situation. This calls for a



Photo: Jon Aars/Norwegian Polar Institute

Female polar bear between ice floes in the Barents Sea

continuously updated knowledge base and sophisticated earth system models to project future changes.

Also, we experience a northward expansion of marine species from the south. The fishing fleet has recently taken advantage of this development and fishing grounds are relocated northwards into the shelves of the Arctic Ocean, especially in the North Atlantic region.

This raises the question whether we may experience commercially viable fisheries in the Arctic Ocean in the future. The area of the Arctic Ocean beyond 200 nautical miles of Canada, Denmark/Greenland, Norway, Russia and the U.S is 2.8 million square kilometers. Up to now, scientists have documented an increase in zooplankton biomass over some areas of the continental shelf. However, scientists raise doubts about whether the same

will happen over deep water in the central Arctic Ocean. An important limiting factor for increased production is available nutrients, which are much lower in abundance in deep water than over the shelves.

When the Arctic marine systems become warmer, expanding pelagic fish stocks will likely migrate into the Arctic Ocean to utilise the short peaks in production there, but will likely retreat to the more productive shelves when the peaks decline. Thus, most of the fisheries in the Arctic Ocean may be confined to the shelves. As a precautionary action to avoid illegal, unreported and unregulated fishing (IUU) in areas beyond national jurisdiction, the 5 Arctic coastal states signed an agreement in July 2015 where they agree to not fish in this area. Furthermore, a scientific research and monitoring programme was established in order to obtain more knowledge in support for future management. The longer-term goal is that other countries also commit to withstand from IUU-fishing in this area.



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Climate-resilient green growth requires a joint approach

In a speech, German Federal Minister for the Environment Barbara Hendricks explains why support for climate-resilient green growth is imperative

About 18 months ago, in opposition to the national egotism that is on the rise in parts of the world, the United Nations made a clear commitment to solidarity and cooperation.

With the 2030 Agenda and the Paris Agreement, we stand together to demonstrate our support for climate-resilient green growth, and for sustainable development and solidarity.

While the headlines on world politics may give a different impression at times, I believe that something very positive has been set in motion. We, thought, for example, that it would take years for the Paris Agreement to enter into force.

In fact, it was only a matter of months. At the High-Level Political Forum on Sustainable Development this summer, 44 countries are willing to report voluntarily on their first steps towards implementing the 2030 Agenda.

This is testimony to the shift in attitudes we are witnessing and proves that we are moving forward. The global community as a whole is increasingly recognising that climate action and sustainability represent a very fruitful modernisation programme for national economies, with positive impacts on growth, employment, education, social equity and political stability. There is increasing awareness that human prosperity and well-being, peace and security, can only be achieved if we make fundamental changes to our economic practices.

We have to learn to respect the Earth's planetary boundaries and not live beyond our means. We have to ensure that economic growth benefits everyone. Environment organisations, development organisations and trade unions have contributed worldwide ensuring

these issues get the attention they deserve. I believe that if we want to achieve this transformation, we need a broad alliance across all regions of the world and from all sections of society. This conference is a good example of this.

G20 Action Plan

The very fact that you are meeting here in Berlin lends momentum to Germany's G20 presidency – I am grateful to you all. We have set ourselves an ambitious agenda. We want the upcoming G20 summit in Hamburg to send a strong message.

The G20 Action Plan on the 2030 Agenda, adopted during China's presidency, is to be supplemented with a Hamburg update. This update will list joint commitments by G20 countries on implementing the UN Sustainable Development Goals. Additionally, the summit aims to adopt a G20 climate and energy action plan. To this end, we have to present long-term strategies well before 2020, and we have to ensure that global finance flows are geared towards the goals of the Paris Agreement. Steering major finance flows towards sustainable investments, particularly in infrastructure projects, plays a key role.

I am very grateful to the Chinese government for making green finance a focal issue for the finance ministers during its G20 presidency. Initial recommendations have now been made for improving the private sector's capacity to invest in sustainable green projects. Examples of this include common standards for green bonds and greater openness in the finance world towards climate and environmental projects. We want to make further progress in this area during our G20 presidency.

Parts of the private sector are already leading the way. An increasing number of companies are moving away



from carbon-intensive investments. Many companies are already taking responsibility voluntarily. Policymakers have to support them in this. Investors, companies and informed consumers are rightly demanding more information - for example about protecting human rights throughout the supply chain, preventing corruption and respecting workers' interests. Companies that are more transparent than the legally prescribed minimum thus create competitive advantages for themselves and enhance their reputation. It is very encouraging to see that more countries are committing to the transformation to sustainable economies and societies.

The positive momentum from New York and Paris is continuing. We want to foster this momentum:

It is with that in mind that Germany and Morocco launched the NDC Partnership at the last Climate Change Conference in Marrakech. The Partnership is a forum for the important North-South-South exchange that helps emerging economies and developing countries in their climate action efforts.

It is the reason that my ministry and the Federal Ministry for Economic Cooperation and Development jointly launched the transnational network "Partners for Review". This network supports the follow-up and implementation of the Sustainable Development Goals.

And finally, it is also why my ministry will make a further €2 million available for the work of PAGE. We firmly believe that PAGE has become a key player for structural change towards socially sound and green growth.

This is an edited version of the [speech that was given by the Minister](#) at the conference in Berlin in March. ■

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German Federal Minister for Environment

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Cosmogenic nuclides: A unique position for earth science

What can cosmogenic nuclides tell us about the earth's surface? Prof. Dr. Dunai of The Institute of Geology and Mineralogy, University of Cologne explains

How many years can a mountain exist before it's washed to the sea? More than 50 years after Bob Dylan asked this simple question it can finally be answered with some confidence. Modern techniques in Earth surface sciences allow us to determine rates of change and decay of the Earth's surface with an unprecedented accuracy. Amongst these techniques, the application of cosmogenic nuclides has acquired a unique position.

“Motivation to conduct this research is the realisation that all terrestrial life ultimately depends on soil. We need to know about the rates and processes soils are naturally removed and replenished, and how human activity alters this critical zone for life, and we have now the tools to perform this research.”

Cosmogenic nuclides are continuously produced in the Earth's surface by high-energy cosmic particles. Since the production of these nuclides decreases rapidly with depth below the surface, their cumulative concentration in any surface material is sensitive to its erosion history. In those cases where significant erosion is absent, the cumulative concentration is a function of the duration of exposure to cosmic rays. It is this unique sensitivity that is used for many Earth science applications: either for determination of mass-loss in the case of eroding surfaces (e.g. Bob Dylan's mountain), or exposure dating in the case of stable surfaces.



Critical information on the state and evolution of the Earth's surface can be obtained utilising cosmogenic nuclides:

- Rates of soil production and erosion;
- Natural base level of soil-erosion; as benchmark for anthropogenic erosion;
- Sediment storage between sources and sinks;
- Timing and magnitude of mode-shifts;
- Delineation between climatic and other causes as drivers of change;
- Geo-hazard assessment (e.g. paleo-seismology);
- Reconstruction of climate change (e.g. extent and change of ice-sheets).

The exceedingly low abundance of cosmogenic nuclides in the Earth surface (typically several thousand to

a few million atoms per gram of material; for illustration: one gram of rock contains in the order of 10^{22} atoms of any kind) requires specialised, large-scale research infrastructure to determine their concentration accurately. The majority of measurements are conducted by accelerator mass spectrometry (AMS), a subset by noble-gas mass spectrometry (NG-MS). Depending on the query, specific cosmogenic nuclides are particularly suited; rendering a range of nuclides useful (^3He , ^{10}Be , ^{14}C , ^{21}Ne , ^{26}Al , ^{36}Cl , ^{53}Mn).

Being able to choose the most suitable nuclide for a specific scientific task is therefore important. In practice, however, this choice is commonly limited by availability or access. Only analyses of ^{10}Be , ^{26}Al , ^{36}Cl are routinely accessible to non-specialists, limiting the scope of the methodology.

The German research agency DFG recognised this shortcoming, funding

an AMS dedicated to Earth Science applications at the University of Cologne (CologneAMS; operational since 2012), later joined by a state of the art multi-collector NG-MS (2017). Alongside the University of Cologne invested in dedicated state-of-the-art clean room facilities. The Helmholtz centre GFZ-Potsdam collaborates closely with CologneAMS, having contributed significantly towards its research infrastructure. Since 2014, the methodology and research development associated with CologneAMS are boosted by institutional strategy funds of the federal Exzellenzinitiative at the University of Cologne.

As a result of this substantial joint investment and the unique collaboration between geoscientists and nuclear physicists at Cologne, and at international partner institutions (ANU-Canberra, ETH-Zürich, PSI-Villingen, SUERC and East Kilbride), the full range of cosmogenic nuclides will soon be available for Earth surface sciences at one point of access. Pertinent science no longer will be limited to what is accessible but can rely on what is best suited. Many collaborative international research projects already rely on our facilities.

My working group at the University of Cologne engages in both methodological research and applications of cosmogenic nuclides and fallout nuclides (the latter are a legacy of nuclear weapon testing era of the 1950s and 1960s; the methodology is related to that of cosmogenic nuclides and also relies on AMS).

Ongoing applied projects mostly centre on the question of how does the presence or absence of vegetation – as a result of climatic conditions or human interference – affect soil erosion. We approach this complex subject over decadal (utilising fall-out plutonium in agricultural areas), millennial to million year time-scales (cosmogenic nuclides in natural environments).

“Modern techniques in Earth surface sciences allow us to determine rates of change and decay of the Earth’s surface with an unprecedented accuracy. Amongst these techniques, the application of cosmogenic nuclides has acquired a unique position.”

On the short time-scales we study the effects of turning semi-arid savanna (in South Africa) or pampa (in Argentina) into cropland. On one side our results show that these fresh agricultural areas are prone to significant erosion by wind (up to 50% loss of the fertile soil size-fraction in less than 20 years). On the other side they indicate that adaptive agricultural methods (such as no-till farming) can largely reduce the impact of wind erosion, providing valuable informing on improved land management practices.

On the long to very long time scales our research currently focuses on semi-arid to hyper-arid environments of the Atacama Desert and adjacent areas in Chile. In the framework of the DFG-funded coordinated research center ‘Earth – Evolution at the dry limit’ (SFB/CRC 1211, first funding phase 7/2016 – 6/2020), we quantify

erosion in the absence of macroscopic plant cover, and the long-term response of the landscape on the emergence of ephemeral/permanent vegetation. Early results indicate that permanent vegetation cover, or the episodic removal of it, has quantifiable and profound long-term effects on landscape evolution.

Motivation to conduct this research is the realisation that all terrestrial life ultimately depends on soil. We need to know about the rates and processes soils are naturally removed and replenished, and how human activity alters this critical zone for life, and we have now the tools to perform this research.



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A German Adaptation Strategy for climate change

German Environment Agency's Petra Mahrenholz provides insight into Germany's Adaptation Strategy and how it is assisting in the fight against climate change

In 2008, the Federal Cabinet adopted the German Strategy for Adaptation to Climate Change, creating an important framework for this comparatively recent policy-making area. Today, the strategy has become an established component of the Federal Government's combined activities to meet Germany's requirements for climate change adaptation.

By the time the Paris Agreement was signed in 2015, it was already clear that climate change and climate adaptation are ongoing societal tasks which must concern all, both now and in the future. Ambitious climate protection aims to avoid and minimise adverse climate impacts worldwide and in Germany. However, there is no denying that climate change is already in full swing. Any responsible government must consider how societies and regions can adapt to climate change right now and Germany is no exception.

In recent years, there has been a proliferation of scientific findings on climate change and its impacts such as extreme weather events, both with regard to the status quo, and looking ahead to the future. The data situation and methodology in Germany provide a good basis for transitioning from knowledge to action. After the publication of initial reports in 2015 the German government will regularly provide [monitoring reports](#) of climate impacts and Germany's adaptation to them, as well as regular reports assessing the [future vulnerability](#) by 2100. The impacts of climate change are so wide-ranging that almost no segment of social, political and economic life will remain untouched over the next few years.

Progress report

Which measures has the Federal Government implemented in recent years, and which are currently ongoing? Which priorities has it set itself? The 2015



Image: © Andreas Depping / pixelio.de

[Strategy's Progress Report](#) investigates these questions, subdivided into 4 pillars:

- Pillar 1: Providing knowledge, informing, enabling and involving.
- Pillar 2: Framework-setting by the German Federal Government.
- Pillar 3: Activities for which the Federal Government is directly responsible.
- Pillar 4: International responsibilities.

Image: © Daniel Strauch / Fotolia



Internationally, Germany is a key provider of funding for climate change adaptation. In recent years, Germany's expenditure on climate change adaptation in developing countries has increased continuously, from €335m in 2010 to €1,124m in 2014. German Chancellor Dr. Merkel has announced Germany's intention of doubling its international climate funding by 2020 against the 2014 baseline.

In its 2015 Progress Report the German government states that consequences of climate change are continuing to escalate, and will impact all fields of life. A permanent, reliable supply of data and tools is needed in order to implement activities in all fields of action, and strengthen politicians and decision-makers with their own programmes and action concepts.

A quick look at the current raft of measures in the Adaptation Action Plan indicates that the German government is further differentiating its activities to provide optimum support for this task. Its creative and regulatory competencies will be defined in greater detail. However, the greatest challenge will lie in

reshaping the infrastructures to transform them into resilient, robust systems. All this requires further technical regulations, e.g. correct dimensioning of infrastructure, heat health action plans or risk maps for heavy rain, adaptation of legal instruments, e.g. adapting the building code in line with climate risks, qualification across a wide range of professions, and the development of suitable funding and incentive mechanisms, e.g. adaptation funding programmes supporting regional and local stakeholders in their capacity to adapt.

The aim is to get all actors involved in climate change adaptation. The earlier we start to incorporate climate change into our plans and activities, the less harm it will cause to society and our regions in future. ■

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Climate services – shaping a growing market

Climate services is a growing sector where market opportunities and ways towards operationalisation are being explored. Prof Dr Daniela Jacob of the Climate Service Center Germany outlines recent developments

Though still in its teenage years, the field of climate services has substantially developed towards a transition to adulthood over the recent years. Meanwhile there is a growing number of players active in this field, ranging from publicly funded service providers to fully privately financed consulting agencies; from actors with a strong scientific background to users with a profound knowledge of the business needs; from national and international donors to small communities that are seeking sound information for their local adaptation activities.

Given this large variety of actors, it is important to facilitate communication, to transfer knowledge and to share experiences on success and failure related to the development and support of climate service products. An open and intensive dialog based on partnership is key for the generation of new product ideas. A close exchange ensures that the community can learn from mistakes and avoid common pitfalls in the future. This culture of cooperation will boost the spirit of innovation which is critical for the development and operationalisation of new products and services.

In that light, it is essential to provide platforms that enable and maintain an open-minded conversation between the different climate service actors but which are also open for ideas

beyond the climate services world. The Climate Service Center Germany (GERICS), an innovation hub for prototype climate service products, acts also as initiator and facilitator of multilateral networks. GERICS recently designed and organised – in cooperation with different partners – 2 outstanding events that provided a venue for knowledge sharing and experience exchange between the various climate service actors.

The 5th International Conference on Climate Services (ICCS5), took place in Cape Town, South Africa, from 28 February to 2 March 2017. The meeting is part of a series of conferences organised by the international Climate Service Partnership (CSP), a platform for knowledge sharing and collaboration to promote resilience and advancing climate services worldwide. This year's conference was organised by GERICS jointly with the University of Cape Town (UCT).

The ICCS5 was held within the broad frame of the notion "Innovation in Climate Services and Capacity Building". Both issues, innovation and capacity building, are pivotal when it comes to addressing the evolving climate information needs and the development of responsible and effective climate services.

More than 200 participants from all over the world came together on this

occasion to share their latest findings and experiences. They represented all players active in the climate services arena. The ICCS5 provided a potpourri of different formats including regular talks, market place booths, poster discussions and interactive sessions to connect participants and stimulate discussions. Central topics were "Learning from Success and Failure", "Climate Services Business Models" and "Mutual Learning". As a result, the community gained new inspiration to foster ideas towards future climate service development.

Although climate services have matured substantially by now, a central finding of the ICCS5 was that they still have a long way to go. Important steps are still missing until climate services can be considered operational. In this respect, the identification and implementation of stringent and transparent evaluation procedures are important, as well as quality assurance mechanisms within the community. If a business case for climate services is to be developed, it is also necessary to define and assign specific monetary values to the various kinds of services.

The second event was the "Climateurope Festival 2017" in Valencia, Spain, from 5 to 7 April 2017. The festival was conceptualised by GERICS as part of the ongoing EU project "Climateurope". As primary objectives the project coordinates on-going and future European

climate modelling and observations initiatives, develops a Europe-wide framework for climate service activities, identifies gaps, challenges and emerging needs and enhances communication activities with stakeholders.

The festival was an innovative activity in order to facilitate a dialogue among European climate science communities, funding bodies, climate service providers and users. Inspired by the motto "Climate information at your service", the participants discussed the advantages and challenges that climate services face in the sectors water, ecosystem, and agriculture and food production. Shining the light on the way to operationalisation, innovative small and medium enterprises (SME), as well as start-ups in the field of climate services presented their business-cases. Throughout the meeting, discussions centred around improving ways to deliver better and more efficient climate services in order to enhance market development.

There was a clear spirit during the festival that sharing knowledge and expertise is key for the creation of a successful climate service market. Moreover, it became apparent that private providers of climate services are already pushing the climate services market and that businesses are ready to use climate services, because they profit from cost savings, business continuity, competitive advantage and a stronger reputation.

Common for both events was the clear statement that innovation needs failure. This is a crucial message to providers and users of climate services and for the donors as well. Only if we are open-minded enough to test new ideas – which implies that they might not work – we create chances and

The Climate Services Partnership

The Climate Services Partnership (CSP) is a platform for knowledge sharing and collaboration aimed at promoting resilience and advancing climate service capabilities worldwide. It is an informal, interdisciplinary network of climate information users, providers, donors and researchers who share an interest in climate services and are actively involved in the climate services community. Members of the CSP recognize that their collaborative efforts have the potential to exceed those of any single institution acting alone. GERICS was founding member of CSP in 2010. The CSP is managed by its secretariat, which is led by GERICS since 2015. www.climate-services.org

ClimateEurope

The five-year project is funded by the European Union under Horizon 2020 (project ref. 689029) and started in 2015. It contributes to the implementation of the "European research and innovation Roadmap for Climate Services", developed by the European Commission. The project links different European research projects and initiatives. Among them are, for example, the Copernicus Climate Change Service, the European Research Area Network for climate services, the European Network of Earth System Modelling, and the Climate-KIC. www.climateurope.eu

opportunities to generate exceptional climate service products. Furthermore, the need to keep up the dialogue between the various climate service actors was expressed during both events. This is of particular importance so as to ensure transparency in the process of climate service development and to build coordination amongst the different players.

As the needs for climate services are diverse and complex, there is no single institution that can deliver such services on its own. Only coordinated activities within the community can ensure the more orderly and productive development of climate services to facilitate the implementation of operational services. Equally important is an approachable climate service community that continues to grow and brings aboard new players from different backgrounds and cultures in order to broaden the collective expertise and to stimulate new

developments. In this context, the International Conferences on Climate Services and the Climateurope Festival are central pillars in widening the community and defining the road ahead. Now is the chance to get involved in guiding the field of climate services through adolescence and towards adulthood.



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Climate protection: Investing in a low-carbon Europe

Investment in climate protection is vital to overcome environmental challenges.
Hans Bruyninckx, Executive Director, European Environment Agency explains

Our climate is changing. We must reduce greenhouse gas emissions to limit the rate of climate change, and at the same time, take measures that help us prepare for current and future impacts. Both of these strands of action require unprecedented redirection of investments. This was acknowledged by the climate conferences in Paris and recently in Marrakesh. The finance sector can and will play an instrumental role in supporting Europe's transition towards a low-carbon, climate-resilient society.

Europe needs to invest substantially in climate change mitigation and adaptation. Estimates of the actual amounts needed vary significantly and, depending on the scope, scale or methodology, can amount up to hundreds of billions of Euros per year. Compared to the overall financing capacity of the finance system, these investments needs are relatively small. Yet, despite its extensive capacity, the finance system currently meets only a fraction of the investment need.

The main challenges for boosting climate-friendly investments include, among others, overcoming existing barriers and lock-ins in the finance system which prolong and promote unsustainable activities; and redirecting funds towards initiatives that boost climate resilience and reduce carbon emissions. For coherent and effective measures on the ground, investment needs should be addressed in a systematic way at all levels – European, national and local. Coherent and complete disclosure of climate risks by companies is a pre-requisite for making informed investment decisions. In addition to improving transparency on climate risks, long-term planning and commitment also send clear signals to investors.

Clear policy signals facilitate long-term investments

The 2015 Paris agreement has set the global objective

to 'make all financial flows consistent with a pathway towards low-emissions, climate-resilient development'. This objective was also confirmed by the 2016 climate change conference in Marrakesh.

The clean energy package, recently proposed by the European Commission, confirms the EU's commitment to a low-carbon and climate-resilient transition. The package expounds the target of at least a 40% cut in greenhouse gas emissions and proposes the targets of at least 30% for energy efficiency and at least 27% for renewable energy by 2030. It also highlights the important role that investments in clean energy transition and their economic co-benefits. According to the European Commission, by mobilising up to €177 billion of public and private investment per year from 2021, the proposed package can generate up to a 1% increase in GDP over the next decade and create 900,000 new jobs.

The EU policy framework and targets are in general implemented through strategies and concrete actions in the countries, including the national Low Carbon Development Strategies. A preliminary assessment of these strategies by the EEA shows that they vary considerably in scope and depth as well as ambition level. They include very limited information on financing needs and plans to redirect investments. Moreover, a long-term vision at national level in line with EU's decarbonisation targets is often lacking. Similarly, many countries have also adopted national adaptation strategies and action plans, but details on financing these are often not available. To strengthen investors' confidence, the Low Carbon Development Strategies and national adaptation plans should be complemented with national climate financing strategies.

Public sector investments will not be enough for financing the transition but can help mobilise and leverage private capital, which is indispensable for redirecting



Image: © Giulia Soriente, My City | EEA

investment at the scale needed. At least 20% of the EU's 2014-2020 budget is earmarked to climate-related action. The [EU's recent decision](#) to extend and increase the European Funds for Strategic Investments and the recently [established high level group](#) on sustainable finance are also important steps towards building a finance system fostering sustainability in Europe.

Finance system to offer innovative solutions

Climate financing strategies require the involvement of different stakeholders – public and private – at all levels, including the local level. The finance system also needs to evolve to cater to different types of needs and different sources.

Some European municipalities have already come up with innovative ways to fund their actions by combining different funding sources or developing new ones such as crowdfunding of climate bonds. According to our upcoming assessment, however, many municipalities still face difficulties to find finance for their climate adaptation actions. The lack of capacity and expertise in finding sources and applying for the most suitable type of finance poses an important barrier among others. Moreover, in many cases, climate adaptation measures are not yet considered as 'profitable investments' by financial decision-makers.

Increasing awareness of climate risks and of the additional benefits of adaptation measures (e.g. boosting quality of life and the attractiveness of the place benefiting from such measures) might result in a different assessment of what constitutes a good investment.

EEA and climate finance

Given the vital role of climate finance in making the necessary transition happen in Europe, the EEA is working towards assessing the connections between current and future actions for mitigation and adaptation on the one hand, and the finance and fiscal systems on the other. A greater understanding of these connections is a prerequisite for removing barriers to climate finance and redirecting funds to support low-carbon climate-resilient transition. We will be sharing our findings throughout 2017.

This article originally appeared on the [EEA website](#) and is available in 26 European languages. ■

Hans Bruyninckx

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From bright white glaciers to dark and dusty ice

Martin Hoelzle and Kathrin Naegeli, Department of Geosciences, University of Fribourg share how glaciers are altering in fast-changing landscapes

Glaciers are always thought of as clean and white surfaces representing an intact and untouched nature, not influenced by humankind. This somehow romantic and idealistic view of earlier decades of glaciers is starting to be more and more replaced by a view showing us fast-changing landscapes represented by dark-grey rock and debris dominated mountain ranges. Sometimes this change is so dramatic that many mountaineers, who are familiar with a certain glacier landscape, are stunned if they return in intervals of a few years to the same location and notice the strong changes. Several studies document that the coverage with debris, as well as a general darkening of the glacier ice surfaces take place today. From a scientific point of view, glacier surfaces do not only contain snow and ice but are heterogeneous mixtures of different kinds of surface materials.

These materials vary greatly in their distribution and particularly in their thickness. Thick debris coverage consisting of small stones and large boulders released by steep rock walls surrounding the glaciers can occur both in the accumulation and ablation zones. Rocks falling in the accumulation zones of glaciers are generally covered by snow and transported downwards by the glacier flow. In the ablation area, the debris is emerging to the surface due to the upwards directed flow of a glacier. In the abla-

tion zone, falling rocks accumulated directly on the bare-ice. Thus, debris originating from rock walls surrounding either the accumulation or ablation zone can reach several meters of thickness. Melt beneath such thick debris layers is decreasing exponentially with increasing debris thickness, as a result of the insulation of the underlying glacier ice from the atmosphere above. Hence, the existence of debris on the glacier surface also alters the energy balance, by allowing surface temperatures to rise above the melting point compared to a bare-ice surface, and by changing heat and moisture exchanges with the atmosphere.

Debris thickness and its impact

However, ice melt is strongly enhanced when the debris thickness is less than a few centimetres because of an increased absorption of shortwave radiation and therefore, a rapid transfer of energy from the atmosphere to the underlying ice. The ratio between outgoing and incoming shortwave radiation is called albedo, which in turn is a direct measure of the ability of a surface to absorb or reflect radiation. In recent years, many studies concentrated on the influence of thick debris on melt rates of the underlying ice. Only a few studies looked into the complex processes of fine, dispersed materials present on glacier surfaces and its influence on ice melt. However, these processes occur to be very important as they represent one of the

strongest feedback mechanisms associated to the current warming of the atmosphere and its consequences of glacier mass loss, the ice-albedo feedback. If one would like to estimate future melt rates based on climate model outputs, it is therefore essential to have a better process understanding of the influence of these fine materials covering large parts of glacier ice in the ablation areas.

Glacier surface albedo

The absorption of solar energy at the glacier surface is governed by the presence of different snow and ice characteristics. These are dependent on the crystal size and shape, the presence of light-absorbing impurities like mineral dust, soot, organic materials, and site-specific properties such as ice surface roughness or the availability of a water film. Remote sensing techniques, based on both airborne and satellite sensors, allow us to obtain information about the ability of the ice surfaces of mountain glaciers to absorb solar radiation. Typical albedo values in the ablation areas of some investigated glaciers in the western and southern Swiss Alps are around 20%, meaning that the glacier surfaces at these places are absorbing 80% of the incoming solar radiation. In the frame of the project called Swiss Earth Observatory Network (SEON), we used 3 different sensors to derive and compare the applicability of varying albedo retrieval approaches. A hyperspectral sensor, called Airborne Prism EXperi-

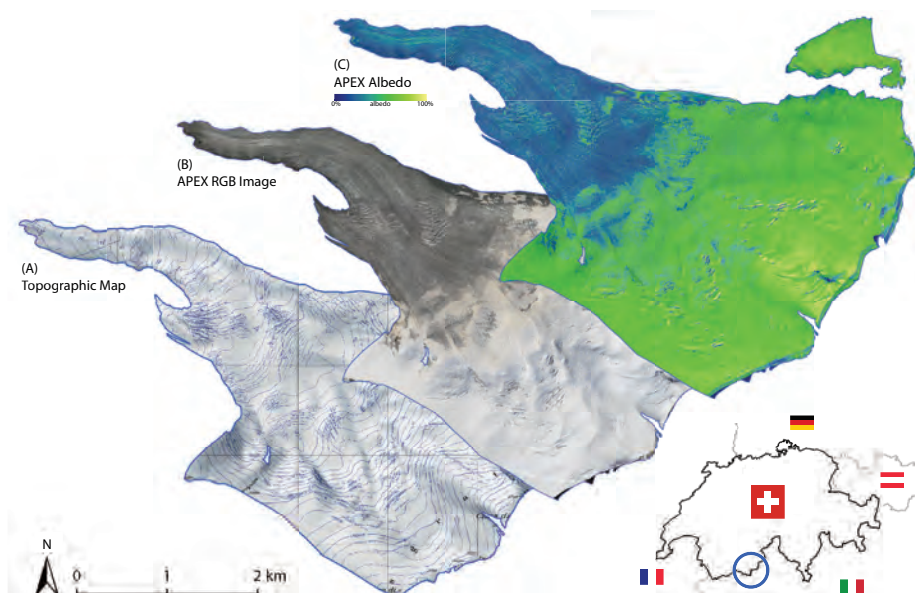


Figure: (A) Topographic map of Findelen glacier in the Matter valley, Switzerland (© swisstopo), (B) APEX imaging spectroscopy RGB image from August 2013 showing the dark bare-ice of the ablation area and the bright snow-covered accumulation area of the glacier, and (C) shortwave broadband albedo derived from the APEX dataset exhibiting low albedo, i.e. about 20% of the solar radiation is reflected, in blue and high albedo, i.e. about 80% of the solar radiation is reflected, in green. The inset in the lower right corner shows the location of Findelen glacier (blue circle) in the southern Swiss Alps at the border to Italy.

ment (APEX), having more than 280 spectral bands in the wavelength range of 400-2500 nm and a ground resolution of around 2 m was compared to 2 satellite sensors, Sentinel-2 with 11 spectral bands and a ground resolution of 20 m and Landsat 8 with 7 spectral bands and a ground resolution of 30 m. We could identify that all sensors deliver robust results, showing the great potential of satellite data to monitor glacier surface albedo. However, the comparison was limited in the sense that only a snap-shot of one particular point in time of the glacier surface was monitored. To include the temporal component, we therefore investigated how ice albedo varies over different time-scales such as seasonal changes, which are mainly determined by the variable presence of the snow cover. For longer time periods such as decades, we looked into the considerable inter-annual variability that is however strongly influenced by the uncertainty of the overflight time of the airplane or satellite. For the 2 decades 1999 to 2016, a

continuous darkening of glacier ice could be detected in restricted areas such as the glacier tongues or along lateral margins. However, no significant negative trend was found if the entire ablation area was averaged for individual glaciers. This finding emphasises the importance of a clear distinction of the spatial scale (regional, glacier-wide, bare-ice, point) when analysing and comparing albedo trends.

Albedo impact on melt

Moreover, we investigated how the albedo of ice influences glacier melt rates. Based on spatially distributed ice albedo derived from Landsat 8 and a wealth of measured point mass balance data from 12 Swiss glaciers, a mass balance sensitivity of -0.14 m water equivalent (w.e.) per year and 10% albedo decrease was revealed. Moreover, larger glaciers exhibited a stronger sensitivity compared to small glaciers, due to their low elevation areas that are affected by the ice-albedo feedback for a longer time

period. However, independent of the size and elevation range of an individual glacier, local climatic conditions, in particular the amount and timing of snowfall events, strongly impacts on the mass balance sensitivity to changes in ice albedo. Using a mass balance model, we were able to quantify that spatially explicit ice albedo enhances local ablation rates by up to 50%, depending mainly on the abundance of light-absorbing impurities in some areas of a glacier.

These studies clearly revealed that to improve mass balance modelling approaches, besides direct in-situ mass balance measurements collected in international monitoring activities coordinated by the World Glacier Monitoring Service, glacier-specific albedo values for different surface zones are crucial to obtain better results. Particularly for modelling future melt behaviour of glaciers, a better understanding and representation of the spatio-temporal variability of ice albedo is therefore needed, as the complex interplay of varying feedback mechanisms may amplify the influencing effect of ice albedo on glacier melt rates.



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Assessing soils, waters and structures

The interaction between soils, waters and structures are of great interest in the engineering sector, here Alexander Rohe from Deltares outlines why

In many environmental and civil engineering areas, such as geophysics, engineering applications and industrial processes, the interaction between soils, water and structures is of great interest. In particular, sudden catastrophic landslides, flow slides, avalanches and debris flows can cause a lot of damage in many parts of the world, due to their rapid movement and large travel distances. Similarly, failures of man-made structures (i.e., levees, dykes, and embankments) that can occur during intense rainfall, storm surges or tsunamis can result in severe damage.

Modelling framework

Modelling soil and water, however, causes conflicts in many existing numerical frameworks. Soil is a natural material with heterogeneous and varied properties – from organic peats in the fens to sands and gravels at beaches and rivers. Soil remembers its past. So it is history-dependent, and its material behaviour is non-linear. Water can flow. It can be very dynamic, turbulent and can move across large distances. Concepts of both fields – solid and fluid mechanics – are adopted and combined in the material point method (MPM). Based on this unified numerical framework, a computational software tool is being developed, aiming to model the interaction of soil, water and structures.

International collaboration

Six universities (Barcelona, Berkeley, Cambridge, Delft, Hamburg and

Padova), as well as the Dutch research institute Deltares, are joined together in a research initiative (Anura3D MPM Research Community)¹ to further develop advanced scientific methods which are implemented for engineering use in freely accessible and open source software. In the scope of the European research project MPM-DREDGE² (grant agreement PIAP-GA-2012-324522), the first international conference on the material point method for “Modelling Large Deformation and Soil-Water-Structure Interaction” (MPM2017)³ has been held to share the developments.

What have we learned about soils, waters and structures?

Six international keynote speakers emphasised the relevance of the research efforts from theoretical background to practical applications:

- Pieter A. Vermeer (Deltares Delft, The Netherlands): From stress characteristics to finite element method and material point method.
- Pedro Arduino (University of Washington Seattle, USA): Avalanche and landslide simulation using the material point method – flow dynamics and force interaction with structures.
- Xiong Zhang (Tsinghua University Beijing, China): Coupled incompressible material point finite element method for free-surface fluid flow and fluid-structure interaction problems.

- Deborah Sulsky (University of New Mexico Albuquerque, USA): Accuracy and stability of the material point method.
- Kenichi Soga (University of California Berkeley, USA): Material point method for modelling coupled soil deformation-pore water flow interaction.
- Zdzisław Więckowski (Technical University of Łódź, Poland): Application of material point method to soil-water interaction and granular flow problems.

“During the conference many application examples demonstrated the practical relevance and impact of the material point method (MPM) for engineering challenges of soil-water-structure interaction problems.”

Ploughing of the seabed is needed for the installation of cables and pipelines, and is an increasing area of construction, given plans in the UK and elsewhere for offshore marine energy. MPM is being demonstrated as a numerical tool to model seabed ploughing to enable predictions for tow force and speed needed for realising an expected trenching profile within given ground conditions.

Monopiles are used as foundations for offshore wind turbines, and are usually constructed using impact driven installation techniques. Vibratory installation is expected to be less harmful for the environment and



more cost efficient. MPM is shown to be capable of exploring if vibratory installation techniques can provide sufficient pile capacity which extends the possibilities of using conventional design tools.

Bridges represent a key part of infrastructure, playing a critical role in emergency response and post-event reconstruction after tsunami impact. MPM is used to numerically model bridge loading due to tsunamis, including the influence of debris carried by the tsunami, to evaluate demands on bridge superstructures. These problems involve complex contact interactions between solids and fluids that are not easily accommodated using typical fluid-oriented or solids-oriented numerical frameworks.

Liquefaction flowslides are the main geohazard for subaqueous slopes composed of loose sand, and form a major threat to the safety of coastlines

in the Netherlands and elsewhere. During a liquefaction flowslide the sand instantly transforms from solid-like material to a liquid-like behaving material. Often large volumes of sand are displaced over vast distances in a short time. MPM is used as a numerical modelling framework and encompasses both pre- and post-failure behaviour. This enables the quantification of consequences of flowslides and thereby a better estimation of risks.

What is next?

The scientific results of the MPM2017 conference are published in the *Procedia Engineering* series (volume 175)⁴. A selection of the most relevant papers is included as featured articles in a special column of the *Journal of Hydrodynamics*⁵. The second conference, MPM2019, will be held in Cambridge, UK in January 2019. In regular training courses practitioners are being trained in the application of Anura3D MPM software, to develop advanced solutions for daily engineering challenges.

1 <http://www.anura3d.com>

2 http://cordis.europa.eu/project/rcn/105988_en.html

3 <http://www.mpm2017.eu>

4 <http://www.sciencedirect.com/science/journal/18777058/175>

5 <http://www.sciencedirect.com/science/journal/10016058/29/3>



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How have renewables changed the global energy landscape?

Dr Hans-Wilhelm Schiffer, Executive Chair World Energy Resources, World Energy Council highlights how renewables have transformed the global energy supply

Since 1970, global energy consumption has more than doubled. Conventional resources, in particular oil, natural gas and coal, had a dominant share in supply and also covered most of the growth in demand in the past. Even in 2015, these fossil fuels still accounted for more than 80% of global energy consumption. The contribution of renewables, including non-commercial biomass, was 14%, with nuclear energy supplying 5% in 2015.

Developments in decades to come will differ substantially. However, total energy consumption will rise at a much more moderate pace than in the past, i.e. by up to one third by 2060. Electricity consumption will double during this period. But even this is a considerable slowdown in growth compared with the five-fold increase in electricity consumption seen between 1970 and 2015. Unlike in the past, the emerging rise in consumption will essentially be covered by renewable energy sources. This is true especially of the electricity sector.

Above all it is this sector that is experiencing an unprecedented change in supply structure. The global capacity of renewable power generating installations for example, more than doubled from 1,037 gigawatts at the end of 2006, with average annual rates of more than 7%, to 2,100 gigawatts by late 2016. This means that renewable resources now account for about one third of global power generation capacity.

Their share in global electricity output increased from 18 to 24% during the same period. This growth by six percentage-points is mainly attributable to developments in wind and solar power. The combined share of these two renewable energy sources that still amounted to less than 1% in 2006 grew to more than 5% in 2016. The contribution made by hydro remained at a constant 16%. Other power sources like biomass

or geothermal energy have been able to increase their share in global electricity generation from a total of 1.5% in 2006 to 2% in 2016.

These rapid developments recorded during recent years for wind and solar, in particular, are mainly due to strong financial support granted to renewables, especially in the form of state-guaranteed feed-in tariffs that are valid for many years. This has led to low-risk and, at the same time, financially attractive investment in renewable energy. A transition to larger plants for wind power, continued technological progress and the achieved massive cost cuts above all for solar modules have also improved the attractiveness of investment in wind and solar capacities.

“An important key to reducing carbon emissions in the heat market and the mobility sector as well is an increased input of electricity. This requires these sectors to be linked as far as possible. Further strategies involve a boost in energy efficiency and the implementation of carbon capture and utilisation and/or storage (CC(U)S).”

Renewable energy to play an important role

The World Energy Council published “World Energy Scenarios to 2060” at the 24th World Energy Congress. The result of the three Hard Rock, Modern Jazz and Unfinished Symphony scenarios explored by the Council is that, depending on the scenario concerned, the share of renewables in global power generation will rise to 40 – 63% by 2060. While, still at 23%, the share of renewables in global power generation was not higher in 2015 than in 1970. Renewables are expected to play a much more important role in the decades ahead. This comparison with developments in the past shows the extent of the transformation that may be expected in future.



The expansion of renewables use for power supply in itself, however, will not be sufficient to achieve the target of limiting the temperature increase to less than 2 degrees Celsius compared to pre-industrial levels that was agreed by the international community of states in Paris at the end of 2015.

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An important key to reducing carbon emissions in the heat market and the mobility sector is an increased input of electricity. This requires these sectors to be linked as far as possible. Further strategies involve a boost in energy efficiency and the implementation of carbon capture and utilisation and/or storage (CC(U)S).

Regarding energy efficiency, there is still huge untapped potential that could be exploited with suitable measures in the future. The overall CC(U)S technology chain, i.e. capture, transport and utilisation and/or storage, is in place. For its broad implementation, however, appropriate national framework conditions are indispensable. This applies not only to the development of infrastructure but also to financial support for this technology, which has already been a successful approach in the case of renewables.

Policy parity in the implementation of sustainability goals, especially the ambitious climate plans, ensures that the transformation of energy supply will be cost-efficient – a prerequisite for its success. ■

Dr Hans-Wilhelm Schiffer
Executive Chair World Energy Resources

World Energy Council
www.worldenergy.org
www.twitter.com/WECouncil

Delivering flexible and secure energy solutions

Dom Barton, of Metropolitan Infrastructure Limited explores the national challenge to deliver sustainable, affordable and secure energy solutions

With heating accounting for 40% of the UK's carbon emissions and over 2 million UK households in fuel poverty, the challenge to provide sustainable, affordable and secure energy supplies has never been greater. It directly affects the lives of individuals and their communities now and underpins the continued provision of their vital support services – including healthcare, social care, education and housing.

District energy and multi-utility solutions

Metropolitan is the leading independent district energy and multi-utility infrastructure provider in the UK. We are the only company combining all the traditional utility networks and future-proof district energy schemes as part of the complete solution for new build and regeneration sites nationwide.

We design, build, fund, own, and operate networks for decentralised and traditional energy and have delivered some of the UK's highest-profile, lowest-carbon new communities.

Our district energy networks provide sustainable, affordable and secure energy solutions for:

- High-density residential and mixed use commercial new developments;
- Urban regeneration areas;
- Combined regeneration and new development schemes;

- Retrofit of existing residential and commercial buildings.

We bring genuine choice in the delivery of district energy and multi-utility solutions, and their long-term economic operation, without the need for intervention from incumbent utility providers.

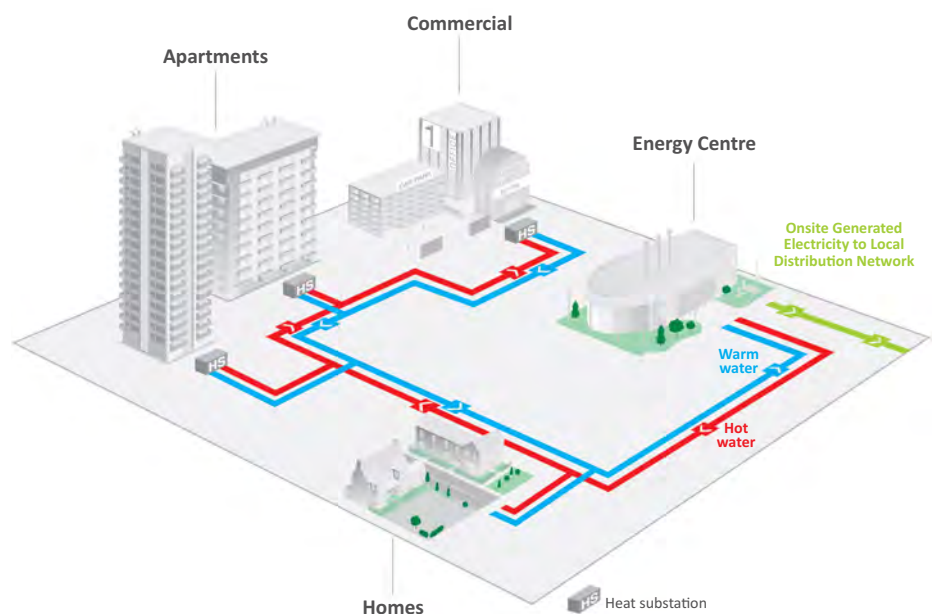
From network adoption to fully constructed and financed options, our investment models provide maximum flexibility with customers choosing the route that best suits their needs and objectives.

The only partner you need for all your energy and utility assets, Metropolitan provides solutions for:

- District energy;
- Electricity;
- Fibre-to-the-Home (FTTH);
- Water and wastewater;
- Gas.

What is district energy?

District energy reduces total carbon emissions and creates more affordable energy for all. Most importantly, it provides the opportunity to drive down fuel poverty. District energy networks allow different sources of low-carbon heating such as Combined Heat and Power (CHP), heat pumps, energy from Waste (EfW) or fuel cells



to supply heating through a network of insulated underground pipes to individual properties.

Scalable solutions

We provide solutions that are flexible, scalable and designed to evolve with the needs of the development serving the growing number of people living and working there. Once the initial part of a district energy network is operational, there are often opportunities to extend it into adjacent areas as a retrofit solution. This brings improved carbon performance to an entire area.

Transforming communities

Alongside energy networks, we deliver other enabling infrastructures, such as electric and fibre networks. These networks ensure that the provision and usage of energy are as efficient as possible while ultrafast Fibre-to-the-Home (FTTH) networks bring life-changing benefits to consumers' personal and professional lives.

Heat Trust guarantee

Metropolitan was one of the first to register a scheme with the Heat Trust, and as members, we commit to abide by the scheme which serves to protect and safeguard the interests of all heat customers.

We are committed to obtaining Heat Trust status for all our networks, to offer independent reassurance to residents that our heat tariffs are always fair. Customers connected to our electric or fibre networks have complete freedom to choose their supplier and service package.

Public sector funding

Both the UK and Scottish governments have active strategies to promote the decarbonisation of heating for buildings, and have dedicated funding available to enable district energy projects.

Funding is not limited to just local authorities and could be used to connect new loads to existing heat networks within other public sector organisations, such as NHS buildings and universities. We can incorporate such funding within our solution.

Models to reduce energy costs

Public sector organisations can choose to progress schemes themselves or look for partners in the private sector to realise their objectives. Metropolitan have proven and flexible Energy Services Company (ESCo) solutions and partnership models which allow for the separating of supply and distribution. We will also ensure scheme delivery is phased to match overall development investment timelines.

An ESCo is a commercial operation providing efficient and cost-effective energy to the development. We welcome the opportunity to share ownership of the ESCo to ensure community needs are being met both now and in the future.

With the option to sell any excess power generated back to the market, the ESCo model ultimately creates an efficient, secure and reliable community-based energy solution with reduced energy costs for residents.



Dom Barton

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CASE STUDY

Kings Cross, London

Metropolitan is already delivering one of the largest regeneration projects in the UK, at Kings Cross in London. Eventually, there will be 2,000 new homes of which 330 are affordable housing alongside commercial premises, underpinning the creation of over 5,000 jobs in high-value knowledge sectors.

Our district energy network at King's Cross uses a Combined Heat and Power (CHP) plant with natural gas driving the engines, as well as plans to install a 1.4MW fuel cell to meet the increased heat demand for future phases.

The efficiency statistics speak for themselves:

- **Carbon:** 50% saving in carbon emissions based on traditional utility solutions.
- **Electric:** 80% efficient compared to 30% in the conventional UK electricity supply.
- **Heat:** An energy centre meets almost 100% of heat demand and 80% of power demand.

A fully managed ESCo is part of the solution for the local delivery of de-centralised energy, and this includes providing professional metering and billing services to the householder. The ESCo is a joint venture with Metropolitan and Argent, who maintain a stake in its long-term success and the ongoing interests of the King's Cross residents.

Sustainability through technology: The power of N

Popularism and bumper sticker science should not stop us tackling sustainability through technology, argues Ingenuity Lab Director Carlo Montemagno

Ingenuity Lab is a unique organisation, designed and created to solve many of the grand challenges facing a modern world. Ingenuity Lab is a research organisation that focuses on the development and deployment of effective solutions to seemingly intractable challenges.

It works using a formal connect-and-develop process which involves building teams from members of government, industry, and academia. Central to this process is problem identification and the visualisation of the ideal solution. Often the identified problem is not the problem, but a symptom. Symptoms tend to be obvious, but quite often provide little insight into the most effective solution. With the recent intense discussion surrounding the newly imposed carbon tax in Canada, I think that it is time to extract ourselves from the emotion of the issue surrounding climate change, examine the impact of humanity on our environment, and identify the salient challenges needed to ensure global sustainability.

The unassailable fact is that the Earth's climate is changing. But the Earth's climate has been changing since its creation. The Earth's atmosphere, governed by complex, non-linear physical processes is easily perturbed. Changes in solar radiation, volcanic activity, deforestation, construction of cities and roads, large-scale irrigation and, yes, the release of CO₂ into the atmosphere, can all impact the Earth's climate. The

challenge is teasing out the climate variations caused by natural phenomena which we cannot manage from the impacts caused by anthropomorphic activities.

Firstly, we need to understand the impact of human activity versus natural processes on the climate. Then, isolate the impact of different human activities to further identify the effect that each activity has on the environment, especially when many of the activities occur simultaneously. For example, the change in albedo – the amount of solar energy absorbed/reflected – caused by the expansion of population centres is usually accompanied by an increase in CO₂ emissions. Which of the two impacts is more important? Are their collective impacts additive or multiplicative? There are many questions yet unanswered. If we cannot clearly define and quantify the “cause”, how can we craft an effective solution?

Disagreeing with Malthus

The bottom line is that human activity has impacted the Earth's environment since our society transitioned from hunter-gatherers. In 1798, Thomas Malthus postulated that humans were quickly going to exceed the carrying capacity of the Earth and that the positive population checks of starvation, disease, and war were necessary. He also dismissed the idea that technological advances in agriculture would provide the solution to the Earth's resource limits. I hear echoes of Malthus in much

of the dialogue surrounding climate change. While no one is proposing eugenic behaviour for addressing man's impact on the environment, there is a distinct tenor in the dialogue that humankind must accept a lower quality of life and reduced opportunity for future generations. There is also the implied truth that the human race cannot address the challenges associated with man's impact on the environment through advances in technology. I soundly reject both premises.

When I was growing up one of my favorite TV shows was *Get Smart*. I always waited for the moment in the show when Maxwell Smart would use his shoe phone. It was hilarious because most people perceived it as ridiculous. The concept of portable communication was outlandish. Nine years ago when Apple introduced the iPhone, it revolutionised global communication. In just 30 years, the technologies of science fiction fantasy transformed the way we engage in commerce, deliver healthcare, and interact as people. It effectively shrunk the world, making the Earth a single village where virtually every voice can be heard.

Popularism politics and bumper sticker science

Unfortunately, not every voice should be heard at the same volume. The cult of personality has enabled individuals without the requisite gravitas to seed popularism politics and bumper sticker

science. By feeding personal prejudices, rational discussion has been kicked to the curb and has been replaced by intensely polarised emotion. Culturally, Canadians have an intense connection to the environment. I believe that it is fair to say that the wonder of nature is strongly woven into the fabric of Canadian society. This is why Canadians feel compelled to lead the charge against global warming and why Canada has acted to impose a significant tax on the use of carbon. The question that many are asking, both inside and outside of Canada is, is this an effective path for addressing the global warming challenge?

Canada is currently responsible for releasing approximately 1.6% of all of the global CO₂ emissions. The European Union, China, India, Russia, Japan, and the United States are collectively responsible for releasing over 70% of the global CO₂ emissions. It is doubtful that even a 50% reduction of Canadian CO₂ emissions would have any material impact on global warming. To have any real effect on global warming, CO₂ emission reductions must occur in concert with all six of the major emitters. Even with over 10 years of significant effort, it has not been possible to achieve a meaningful coordinated global response to CO₂ emissions. Acting in isolation will only stress the Canadian economy and place an unnecessary burden on Canadians without achieving the desired goal of reducing man's impact on global warming. There is a better path forward.

We must recognise that humankind has impacted and will continue to impact the Earth. It is our responsibility to access the Earth's bounty in a sustainable way. Our ultimate goal should be to consume each of Earth's resources within cyclic processes to maximise the utility of all of the

resources that we harvest. The economic reusing of resources would ensure their continued availability for future generations. Achieving this vision can only be accomplished through technological innovation.

Examining the challenge of CO₂ emissions you find opportunity. Let's flip our perspective; instead of labeling CO₂ as a waste product we should recognise it as a valuable raw material. Carbon is the foundation, the building block of all living organisms. At the very core of the global ecosystem, nature uses the Sun's energy to assemble all living organisms from CO₂. Visioning the solution to CO₂ atmospheric emissions, suppose we can generically insert our industrial processes within the web of nature's carbon cycle. We take the CO₂ which would normally be emitted into the atmosphere, such as from an electrical power generating plant, and instead, using light, repurpose the CO₂ into valuable products. Effectively we insert the carbon that would have been wasted and transform it into the fabric of our society. Ingenuity Lab is currently commercialising this new technology.

Using the power of N – inspiration from nature to guide the manipulation of matter using nanotechnology to build networks – Ingenuity Lab succeeded in replicating the natural process of carbon assembly and translated it into an industrial process. The process required learning how to convert light into the various chemical fuels of life and the ability to cheaply fabricate nano-compartmented systems to assemble an artificial metabolism that fixes and transforms CO₂ into valuable products. While not the total solution to the global climate warming challenge, it does pull back the curtain to display the possible. It shows that the potential for technological achievement is boundless.

Advancing sustainability through technology

We must consider the past technological achievements of modern man as governments assess the optimum strategy for addressing global sustainability challenges. These achievements speak loudly about the human potential for creative innovation. Canada needs to occupy the position of a leading global steward of the environment, but must achieve it as a champion of sustainability through technology. It is the path forward.

Set the stage for a bright future for coming generations by embracing the potential of the possible, as well as understanding that technological achievement can drive market forces that lead to a more sustainable world. World leaders need to focus on providing an environment that supports the crafting of solutions to the global warming challenge and not at regulatory instruments as the primary weapon of choice. This strategy will accelerate economic and societal prosperity and has a much higher likelihood of long-term success. Canada, believe in the inventiveness and creativity of your citizenry. Provide the needed environment, and the people will deliver. The future belongs to the bold.

 ingenuity lab

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Fusion energy could be the future of power production

Neil Alexander for the Canadian Nuclear Association shares why society should be looking to fusion energy to power homes and businesses in the future

Modern society loves energy. Whether it is lighting our offices, heating our homes or delivering our goods, it all takes energy.

But delivering the energy we need is becoming a problem. Fossil fuels have been the backbone of our development but we now realise burning fossil fuels is unsustainable and we must wean ourselves off them as soon as possible. There are alternatives but each comes with its own advantages, disadvantages and limitations. Nuclear fission has been delivering cost-effective power for decades but has barriers to entry that can restrict its application. Renewables, such as wind and solar have a large physical footprint, but are often not close to where the energy is needed and are intermittent. Biomass locks up large quantities of land, is hard to transport and still leads to the release of greenhouse gases. Lots of new energy models have been tried but none have been an unqualified success and none can be freely and sustainably replicated. Fusion could change that.

“It may well have taken time to get where we are today but with few constraints on deployment and a massive demand for what it delivers, fusion could easily be the next great step in mankind’s development. And it may come sooner than you think.”

Fusion as a source of energy

Fusion would be a high-density energy source entirely under mankind’s control with an affordable, easily available fuel. It could be easily replicated in almost any jurisdiction and doesn’t have environment damaging carbon emissions.

That is why economic fusion is the holy grail of the energy industry.

When matter condensed out of energy after the big bang, an electron combined with a proton to form our simplest element, hydrogen. That is why it is by far the most common element in our universe.

But it is not the lowest energy atom. That title belongs to Iron 56. If the repulsive forces that keep light nuclei apart can be overcome they will fuse and give out energy, and lots of it.

This is where the energy of the Sun comes from. Every day when the Sun rises we are reminded that fusion works.

The issue of creating power from fusion is then, not one of its fundamental science, but rather one of engineering, materials science and control. The Sun uses its massive gravity to confine the fuel and the energy produced just dissipates into space. Controlled fusion, here on earth, requires us to find another way to contain fuel at a hundred million degrees Celsius and then to collect the energy and convert it into something useful. The Sun is self-sustaining. We begin with a cold fuel that we need to heat before the reaction can start by putting massive amounts of energy very quickly into a very small target.

Mankind has risen to the challenge, imagining many ways in which this might be done and then proving that it can. Historically the experiments have been large, as magnetic confinement has been used to hold a hot plasma (a state of matter where electrons have been stripped from the atoms) or powerful lasers have been used to create shock waves in solid fuel pellets. Notable experimental facilities include the Joint European Torus (JET) in the UK, National Ignition Facility (NIF) in the U.S. or more recently the Wendelstein 7-X



Modern society loves energy but delivering that energy is becoming a problem

stellarator in Germany. Thirty-five countries have come together to support the next phase of the Tokamak development known as the International Thermonuclear Experimental Reactor (ITER) in France. Construction of this large and complex facility will take some time and is expected to cost in excess of \$20billion.

It has been a hard slog for fusion as it has had to overcome many challenges at the very edges of our knowledge and capability. Without the benefit of the Sun's gravity the temperatures needed for ignition are 6 times higher than the Sun's core and at the moment, Tritium and Deuterium (isotopes of hydrogen) have to be used rather than much more available hydrogen itself. The fusion process kicks out a lot of radiation and the materials used must be able to tolerate that radiation.

At times people have joked that commercial fusion power was 30 years away when it was first considered and it is still 30 years away. But there is powerful evidence to suggest that technologies develop exponentially and that fusion is now lifting off that initial flat part of the curve so that from here on in progress could accelerate away. Certainly, this can be seen in the announcements of technological progress on the big

projects, but just as importantly it can be seen in the surge of spin-off commercial concepts such as Vancouver's General Fusion or First Light Fusion in the UK. Even ex Google executives are getting in on the game, with Mike Cassidy recently announcing the creation of Apollo Fusion.

It may well have taken time to get where we are today but with few constraints on deployment and a massive demand for what it delivers, fusion could easily be the next great step in mankind's development. And it may come sooner than you think.

Dr. Alexander is also a Principal Consultant at Bucephalus Consulting, and was one of the signatories to Fusion – 2030, a roadmap for reinstating Canada's Nuclear Fusion Research program. ■

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Fusion energy: Unlocking the zero-emission grid

The opportunities provided by fusion should not be overlooked. Here, Michael Delage, of General Fusion Inc. explains the potential of the energy source

A cornerstone of any realistic path to overcoming climate change is developing sources of energy that are emission-free, on-demand and economically viable. Such sources would sustain the world's growing population and broaden the opportunity for economic prosperity. The need for these sources is urgent: global electricity demand is forecast to increase by 69% in the next 20 years, and while renewables are growing rapidly, the majority of this demand nonetheless looks set to be fulfilled by fossil fuels.¹

The clean energy grid will need a mix of generating technologies to supply the diverse needs of consumers. When it comes to sectors with high energy intensity, such as industry or dense urban areas, fusion energy is a very attractive option. Fusion has the potential to provide clean, safe and on-demand power worldwide. It also has the potential to demonstrate the best energy payback ratio (EPR) and lowest carbon life cycle footprint of any source, making it a powerful tool to tackle climate change.

Fusion: a national priority

The potential of fusion has long been recognised by the scientific community. Over 30 years of investment by governments in research and development has brought tremendous scientific advancements, and a number of countries now consider further development of fusion to be a national priority.

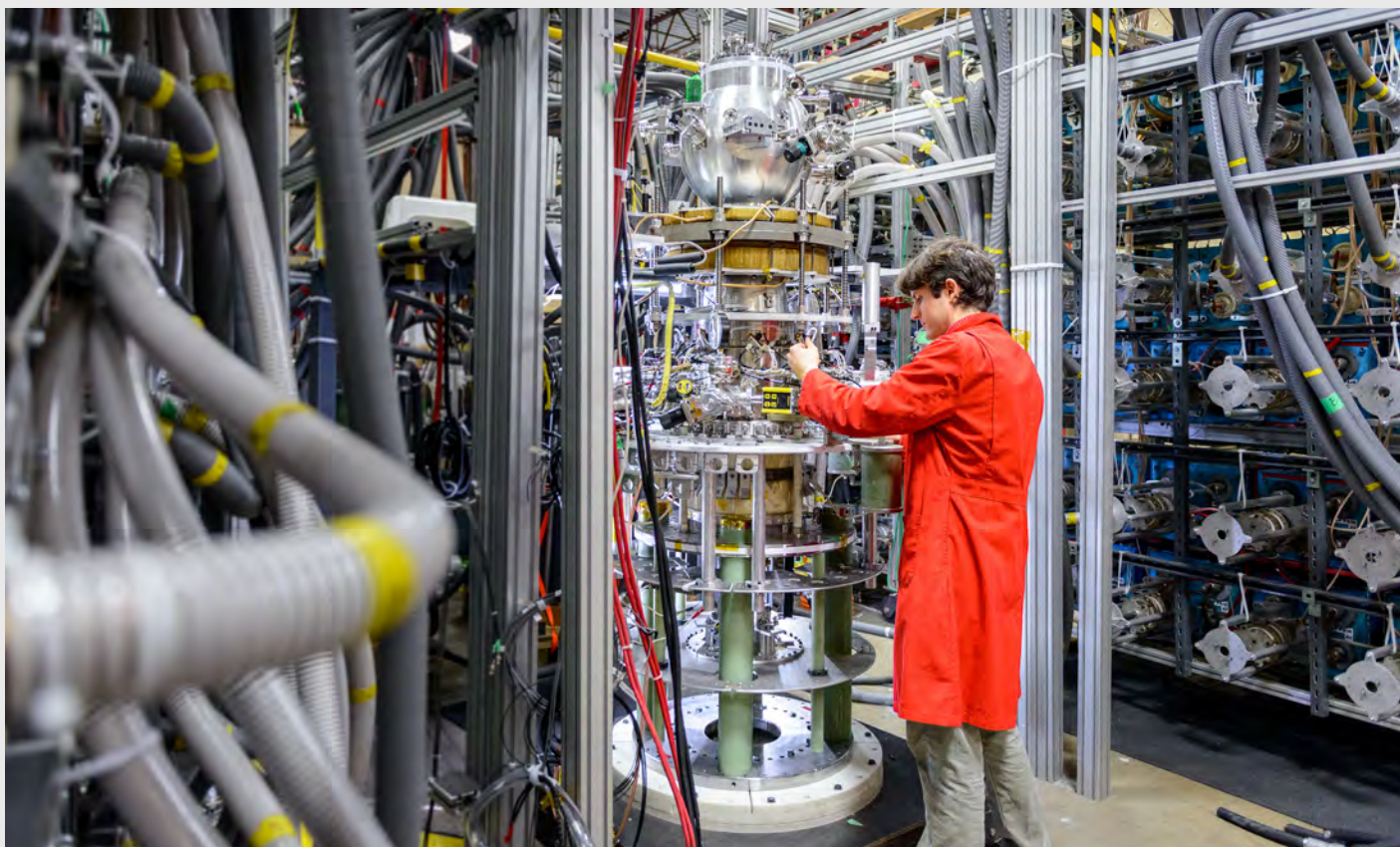
In addition to their involvement in the 35-nation ITER fusion project, China also plans to train 2,000 new fusion scientists by the end of this decade, and South Korea is investing heavily in the field.^{2,3} These projects are demonstrating the scientific understanding that is enabling fusion to move from lab experiments to applied engineering projects.

Now is an innovative time in fusion, both in government and the private sector. New ideas are springing up: proposals for fusion system designs that are more practical to implement, at lower capital cost, and which will lead us to commercially viable power plants sooner than the earlier concepts.

This renewed wave of enthusiasm is the result of a combination of factors. The scientific knowledge gained through decades of research has provided us with an excellent understanding of the principles underpinning fusion. Fields such as plasma physics, key to achieving the extreme temperatures needed to fuse the hydrogen nuclei fuel, have been intensively studied and the parameter space we must work within has been established.

In parallel, substantial technological advances have taken place in fields complementary to fusion. Computing power and electronics, simulation, and materials science have progressed dramatically since the early days of fusion research in the 1960's. Previously only feasible on the most powerful of national laboratory supercomputers, simulation of the behaviour of fusion plasmas is now possible on commercially available cloud computing platforms.

These advances provoked a vanguard of private fusion companies such as General Fusion, Tri Alpha Energy and Lockheed Martin to enter the space, capitalising on new technologies to push forward the development of innovative new approaches. With parallels to the emergence of companies such as Blue Origin and SpaceX in the aerospace industry, serious private sector investors are funding sophisticated efforts to pursue practical solutions with the goal of advancing the timeline for a commercial solution to fusion by decades.



Private companies such as General Fusion (pictured here) are drawing on 30 years of research in fusion to develop new approaches focused on commercial power plants

Backed by venture capital, these firms are developing new, power plant-focused approaches at a pace not previously seen. In the coming years we will see the first demonstration prototypes emerge, which will marshal the energy industry to drive fusion's commercialisation.

These advances come not a moment too soon. The latest figures show that while the deployment of clean energy infrastructure is growing rapidly, it is being outpaced by the staggering level of new demand. Some perspective: In 2015, China alone was responsible for 40% of global renewable power growth, but that represented only half of the country's electricity demand increase⁴.

Much as we see a mix of technologies supplying our energy needs today, de-carbonising the world's electrical networks will require a new mix of generating technologies incorporating distributed renewables, large scale storage, and high output, on-demand sources. Energy companies, corporate partners and governments around the world are recognising the ability of fusion to make a significant contribution to

this mix, and are investing to unlock the full potential of the zero-emission grid. ■

1 US Energy Information Agency, May 11, 2016. International Energy Outlook 2016. Figures 5-1 & 5-3

2 University of Science and Technology China Newsroom, March 24, 2011. National Design Panel for Magnetic Confinement Fusion Reactors Established at USTC

3 Nature, January 21, 2013. South Korea makes billion-dollar bet on fusion power.

4 International Energy Agency Newsroom, October 25, 2016. IEA raises its five-year renewable growth forecast as 2015 marks record year.

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Denmark sets ambitious targets for climate and energy policy

Lars Christian Lilleholt, Minister for Energy, Utilities and Climate, reveals how Denmark will fight climate change and emissions via a new energy policy

Three innovative and significant climate targets have been unveiled by Denmark's new liberal conservative government which will see the country emitting 80-95% less CO₂ as a society than in 1990, meeting at least 50% of its total energy needs through renewable energy by 2030, and becoming the first country in the world to build new off shore wind turbines subsidy-free.

The Danish government, which is composed of Venstre, the Liberal Alliance and the Conservative People's Party, is pursuing an ambitious green transition which will maintain Denmark's position as a green pioneer with a market-based, cost-efficient climate and energy policy. Denmark must achieve as much as it can in terms of renewable energy and climate gains for the money it invests, and the green transition must support growth, competition and employment.

Objectives of the government's manifesto:

By 2050 Denmark is going to be a low emission society which is independent of fossil fuels and living up to the EU target of an 80-95% reduction in greenhouse gasses compared with 1990 levels.

By 2030 at least 50% of Denmark's total energy needs should be covered by renewable energy.

Denmark is going to be a world leader in offshore wind and the first country in the world to build new offshore wind turbines subsidy-free.

Denmark will have the most integrated, market-based and flexible energy system in Europe which will be able to handle an increasing amount of renewable energy in a cost-efficient way. At the same time we must maintain one of Europe's highest levels of security of supply and

Image: © Steen Brogaard



lowest wholesale market prices for electricity. There must be an integration of energy systems across countries and sectors (electricity, heating, gas, transport and supply) and an efficient use of resources.

Denmark will work towards executing structural reforms of the European Emissions Trading System (ETS) which can reduce quota numbers so that in the future there are clear price signals both inside and outside the quota sector for the benefit of the green transition.

In the autumn of 2017 the government will present a proposal for a new energy agreement for the period after 2020.

The Paris Agreement was the first step the global green transition, and now the whole world will have to deliver on the promises that were made in Paris. As a member of the EU, Denmark will be at the forefront in fulfilling



its obligations, pushing towards new and ambitious goals while at the same time contributing experience and solutions for the benefit of other countries. With the government's new ambitious targets for climate and energy policy, we set-out a clear direction for Denmark's green transition which will continue our unique growth model, where since 1990 we have managed to increase our GDP by close to 80%, keep energy consumption at a constant level and at the same time significantly reduce CO₂ emissions.

An integrated, market-based and flexible energy system

Overall, the total consumption met by renewable energy (RE) in the EU today stands at 16%, with the target being to increase this figure to 27% by 2030. Today, 29% of Denmark's energy comes from renewables and the government aims to realise 50% of energy consumption from renewable energy sources by 2030.

Such a significant target will secure Denmark's leading position in the development and implementation of new green technologies. Denmark must be a world leader in the development of an integrated, market-based and flexible energy system which can integrate large amounts of renewable energy.

We need to be independent of fossil fuels by 2050

In autumn 2017, the government will publish a proposal for a comprehensive new Energy Agreement for the period after 2020 which will be partly based on the Energy Commission's work. This new Energy Agreement will have the primary aim of ensuring the continued transformation of the energy system.

At the same time, Denmark has ambitious 2030 targets for reducing emissions outside the quota system. The government will prepare a cost-effective strategy for meeting the Danish reduction targets in 2030 which will be ready before the end of 2017.

Together, these 2 measures will ensure that Denmark's greenhouse gas emissions will fall significantly and that Denmark keeps the green transition running at a high tempo. The 2 measures will be important milestones on the journey towards the long term goal in 2050 of Denmark as a low-emission society that is independent of fossil fuels. ■

Lars Chr. Lilleholt, Danish Minister for Energy, Utilities and Climate

Danish Ministry of Energy, Utilities and Climate
<http://old.efkm.dk/en>

Reducing energy consumption requires communication

Thomas N. Mikkelsen highlights how Natconsumers has developed a methodology to communicate more effectively with consumers to reduce energy consumption

Reducing residential energy consumption is an important part of the wider goal of improving energy efficiency, but it's not always easy to change long-established habits.

"We aim to take this research and the knowledge that we've gained in terms of understanding the kinds of messages that people respond to, and try to apply that to help reduce household energy consumption."

Many different methods have been tried over recent years to engage with energy consumers, with the wider goal of improving energy efficiency and sustainability. Previous efforts have been very much focused on price, as the key motivator to encourage people to change their energy consumption patterns, but now researchers in the Natconsumers project are taking a new approach. We thought we needed to start a conversation with the end customer. It's not about dictating to them and ordering people to do things, it's about creating a conversation. This will be a more effective way of engaging with consumers. It's about being relevant and understanding the situations where you can talk about energy, which are not always related just to money and potential cost savings.

The approach is further elaborated by fellow partner, Alberto Cuetos in mentioning, that "this could be something as simple as talking to end customers about how weather patterns affect



Image: © Visualisation by Strategic Design Scenarios

their energy consumption. For example, if a consumer lives in an area which has been experiencing a lot of rainfall, or a prolonged cold snap, then that will affect consumption patterns, and can provide a starting point for more effective, emotionally intelligent and relevant communication".

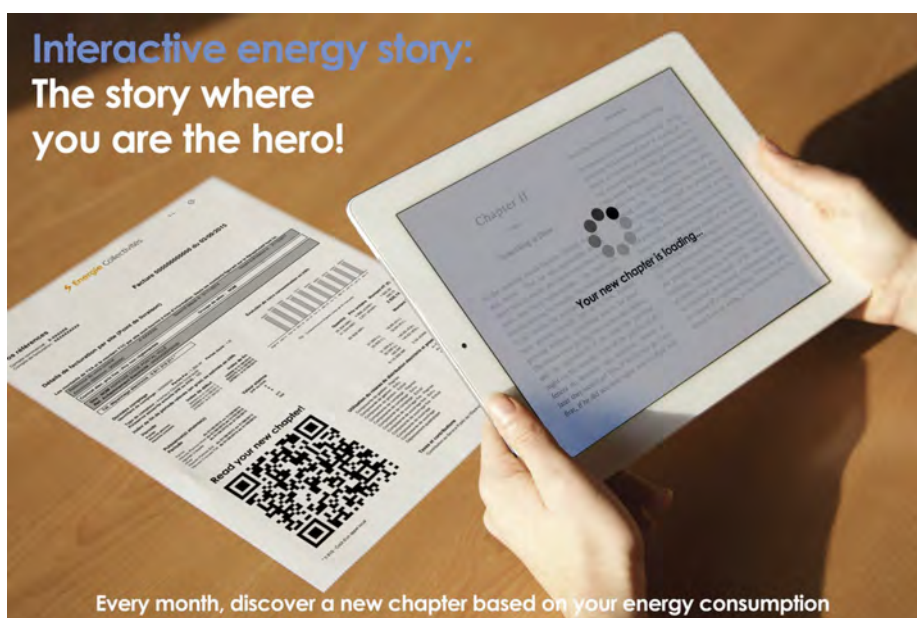
"Basically very simple measures – but all the more powerful, as they interact with our daily life by asking relevant questions like: Do you know what the cold weather means for your energy consumption? Did you know you can do x to change y? Or a consumer may be getting married or having a child. Many things could trigger a discussion about their energy consumption," outlines Alberto.

The starting point in terms of identifying these triggers is a user-centered framework, which the project is devel-

oping to segment consumers. We develop communication by asking questions and getting feedback.

User-centred framework

The goal is to build a kind of self-learning tool that will constantly develop and evolve to reflect consumer priorities. Researchers gathered data from across Europe, and while energy consumption patterns of course vary significantly across different regions. There are similarities in terms of behavior and communication preferences, which will inform the ongoing development of the framework. We've been trying to categorise communication in terms of both what is more static and what is more dynamic. But this is only a starting point – as the machine starts learning, we find that people respond more as we become better at understanding their specific priorities and circumstances.



From these foundations, researchers can then look to communicate with consumers in a way that's relevant to them, and develop personalised actions aimed at reducing energy consumption. This information on consumer priorities could also be highly relevant for utilities and energy companies, something which the project could explore in future.

"What came out of this project is basically a process, and by going through that process, you can identify the priorities of the customers that you are talking to," says Alberto. "We aim

to take this research and the knowledge that we've gained in terms of understanding the kinds of messages that people respond to, and try to apply that to help reduce household energy consumption."

ABOUT NATCONSUMERS

Natconsumers aims at raising consumer awareness on energy as part of everyday life and provoking direct actions by making consumption visible and by summarizing it into tailored daily tips.

LEARN more

NATCONSUMERS has developed a handbook on how to work with and implement a Natural Language in the energy sector. It will be published during the final conference in May 2017. <http://natconsumers.eu>

Thomas N. Mikkelsen is a partner and director at VaasaETT, a leading international specialist research and advisory company. He is responsible for working with customers across a range of tasks, including providing strategic advice, customer profiling and segmentation models.

Alberto González Cuetos is an Innovation Consultant in Izertis, a visionary technological consulting firm. He is responsible for innovation analysis, and international project planning and management.



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Tackling climate change in Sweden

Open Access Government's Editor Laura Evans examines how Sweden is tackling climate change and the targets in place to help the nation become carbon neutral

Air pollution and climate change is a huge challenge all over Europe. In Sweden it is estimated that air pollution contributes to around 5,500 premature deaths each year. In February the Swedish government adopted a historic climate reform. The climate act and new climate goals aim to help Sweden reach an ambitious, long-term and stable climate policy.

Speaking about the historic act, Sweden's Prime Minister, Stefan Löfven said: "The climate act is historic and represents an epochal shift for Sweden. Just as we keep our fiscal house in order, we must also put our house in order regarding climate policy."

"This is the most important reform that our generation of politicians will carry out for Sweden's young people, our children and grandchildren. Sweden will be one of the world's first fossil-free welfare nations."

Sweden aims to be carbon neutral by 2045, reducing emissions by 63%, by 2030. Sweden leads the way between all 28 EU Member States with regards to renewable energy use by share. By 2014, over half of the country's energy consumption was provided by renewables, including electricity, heating and cooling as well as transport. By 2020 Sweden hopes to achieve a 49% share of renewable energy in gross final consumption of energy.

The country aims to have no net emissions of greenhouse gases at all by 2045, as outlined in their current Energy Policy. In the [2017 Budget Bill](#), the government aims to strengthen efforts towards a toxin-free every day environment, a fossil-free welfare society and renewable energy. In order to reach the target of 100% renewable energy by 2040, the government aims to encourage the expansion of solar energy. Within the budget, the funds that are allocated to investment for solar power this year are 8 times higher than in 2015.

Image: © Kristian Pohl/Regeringskansliet



Swedish Minister
for the Environment,
Karolina Skog

In order to reach these targets and reduce the effects of climate change, not only in Sweden but worldwide, Minister for the Environment Karolina Skog believes that cities have a major role to play. She recently [attended the COP22 Climate Change Conference](#) in Marrakech, and highlighted how cities are crucial for tackling climate change and how urban development is a key focus for municipalities and regions in implementing the Paris climate agreement.

Speaking at the conference, Skog said: "Social inclusion, gender equality and access to good quality public transport are key in the work on urban development. As the minister responsible for urban development, I have a vision of sustainable cities for everyone, and to get there we need to tackle several challenges at the same time."

The Minister highlighted in her speech that cities have a big responsibility in climate transition, and that government and states must support their work through political visions and funding.



"I have high hopes that the strong willingness we see in cities and businesses the world over will carry climate efforts forward," Skog added.

Minister Skog also spoke with regards to climate change and its impact on the health of the people of Finland. During this particular seminar at the conference, organised by the World Health Organization (WHO), it was estimated that 6.5 million people are already dying each year due to air pollution. With such a high number already suffering the spread of illnesses is expected to increase in line with the increased number of global emissions expected.

"We must make sure that the climate action we take is also good for the air we breathe. For example, if we burn biomass in the wrong way it can significantly worsen air quality. This must be avoided at all costs – poor air quality is the greatest and most acute environmental problem we face," said Skog.

Goals for urban development necessary

The government's budget bill for 2017 is said to be the largest environment and climate budget ever presented in Sweden. Investments in climate action reach a total

of SEK 12.9 billion for the period 2017 to 2020. The urban environment agreements will be reinforced with an additional SEK 750 million for 2017 to 2018.

Speaking at the conference, Minister Skog commented on how the development of cities is integral to these goals. "Over the next 35 years, we will build cities for 3.5 million people. This places enormous demands on infrastructure. From the point of view of policy, we need to set goals for the development of these cities and make sure to steer investment flows in a sustainable direction. This is something I will do back home in Sweden over the coming year." ■

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Using surplus heat to create healthier environments

Surplus heat from cities and industry can help create healthier environments. The Swedish University of Agricultural Sciences's Håkan Sandin explains

The Swedish Surplus Energy Collaboration (SSEC) takes the form of a cohesive research and development programme based at the Swedish University of Agricultural Sciences (SLU). SSEC operates in close co-operation with a large number of partners and stakeholders all over Sweden, 8 subprograms and more than 50 collaborators.

Using untapped resources

It is well known that plants and fish growth is stimulated by moderate increases in temperature and that controlled and acclimatised environments also provide a healthier and safer life

for human beings as well. The SLU, together with its partners demonstrates in practice the possibilities of how to utilise the very large amounts of low-grade heat and other unused resources that depart from various industrial processes. These resources are used to create a new land based industry for fish, greenhouse and open land-based production of fruit and vegetables, all in an industrial scale. Putting these resources in use also makes the industry more efficient and more environmentally friendly. The district heating systems is a crucial part of the new production systems at many places.

On 17 December 2012, a unique partnership was signed between SLU, ESS the European Spallation Source AB, E.ON Sweden AB, Malmö City and the Municipality of Oskarshamn. Today 15 partners are included in the cooperation: Härnösand, Bjuv, Mönsterås, Ljusdals and Hofors Municipalities, Kraftringen Energi AB, Gävle Energi AB, Ramboll Sweden AB, Veolia Sverige AB and Sydgront, Svenska Odlarlaget (the two biggest Growers Organisations), as well as those listed above.

ESS AB and Findus Sweden AB (who joined the co-operation within 12 months of the other partners) left the

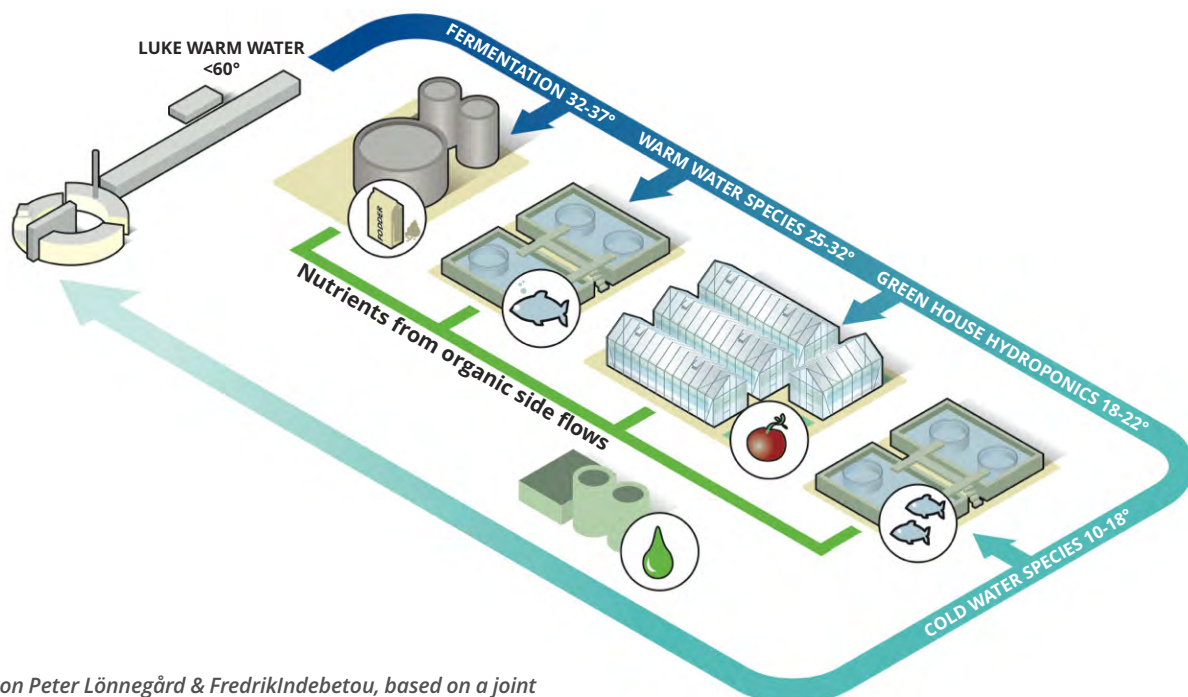


Illustration Peter Lönnegård & Fredrik Indebetou, based on a joint concept of A. Kiessling, H. Sandin and F. Indebetou

cooperation after a very successful collaboration over only 3 years.

Biological cooling

A new cooling concept has been developed, biological cooling with ESS and a new production of giant shrimps has been established together with Findus.

Even if only 15 partners are working together many more businesses, official authorities and academia are involved all over Sweden.

SSEC operates with 2 concepts or subprograms, namely Urban Food and Urban Health.

The question is: how can we economically exploit the very large residual heat that is cooled off today? The heat in different processes lost in Sweden amounts to at least 150 TWh. This is as much energy as the total Swedish electricity use, but the benefits have so far been non-existent due to the off-cooled heat consists largely of

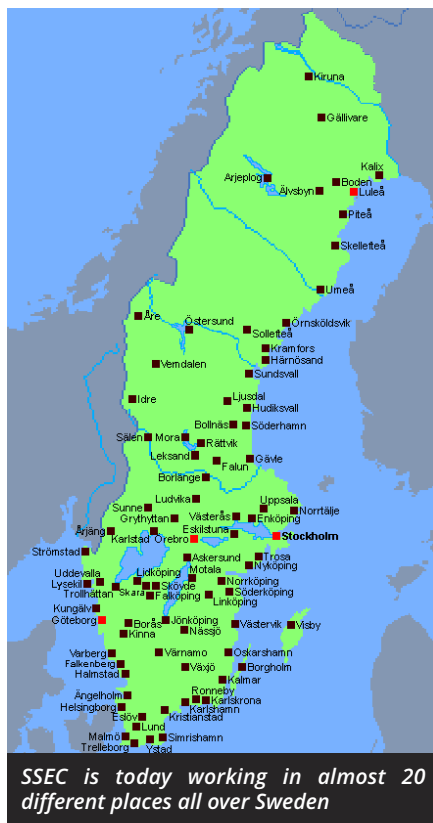


A Symbiosis Center in Bjuv is emerging called Food Valley of Bjuv

low temperatures. New technology is developed in order to benefit these low grade heat.

Today the visions also include how we can use other unused resources, such as food waste, waste of other organic material, industrial infrastructure, carbon dioxide etc. Currently over 40% of all food produced and consumed in Sweden becomes food waste.

Europe's leading centers for integrated food production using surplus heat and other residual flows from our cities and industry, also called Symbiosis Centers.



SSEC is today working in almost 20 different places all over Sweden

The cooperation agreement covers areas as diverse as the production of vegetables and fish, to creating healthy and attractive living environments for people, to contribute to local and regional development, and well as strengthening cooperation between academia and business.

The impact on regional development is very positive since the project results in innovation, new businesses and many new jobs all over Sweden.

SSEC is today introducing and contributing to new industrial development in a number of places in Sweden. Contributing to building

SSEC

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Swedish district heating: Reducing the nation's CO₂ emissions

Annika Johannesson, Communications Manager, Swedenergy explores how the Swedish district heating network is helping to lower emissions

Sweden has reached the climate goals from the Kyoto protocol. In the last decades, Sweden has made substantial reductions in its CO₂ emissions, while maintaining high and sustainable economic growth. Sweden is also known for recycling waste. Less than 1% of the waste is landfill, the rest is reused and recycled, to new products or to energy. So what is the secret behind the Swedish success, so far?

The main reason for this success in climate politics is the nation-wide expansion of efficient district heating, supplied by non-fossil energy sources. The Swedish Environmental Protection Agency has pointed out district heating as one of the reasons behind the success. Accounting for half of Swedish heating, district heating has gone from being almost exclusively powered by

fossil fuels in the 1980s, to now, 2017, being about 90% renewable and recycled heat.

District heating network

District heating is an intelligent, environmentally friendly way to heat homes, schools and other premises, etc. As the name implies, district heating comes from somewhere within the district. Instead of every building having its own boiler, district heating is supplied by a central plant which can use advanced methods to run on many different fuels or recover heat from other sectors, for the benefit of households, industry and the environment.

They say that the district heating plant is the heart of a district, spreading warmth right the way around it. In

many processes large parts of energy are set free in the form of surplus heat. The fundamental idea behind modern district heating is to recycle this surplus heat which otherwise would be wasted – from electricity production, from fuel- and biofuel-refining, and from different industrial processes. Furthermore district heating can make use of many kinds of renewables (biomass, geothermal, solar thermal).

The main reason to invest in district heating in Sweden was to create a healthy environment in Sweden's cities. While changing the fuels from oil to renewables, the climate benefits came as an extra bonus. In Sweden biofuels, largely residues from forestry, account for more than 40% of the energy supplied. District heating also uses waste (around 20%), as well as waste energy from industries (8%) – partly by taking advantage of this excess heat and power.

A big part of the district heating comes from combined heat and power plants (CHP) where electricity and heat are produced at the same place. It's really an energy efficient way to use the fuels. In a CHP plant more than 90% of the energy in the fuels is utilised, compared to condensing power plants or only district heating plants with lower efficiency.

The 1991 carbon dioxide tax, consistent political support for renewable energy and a strong forestry sector have all led to the growth of the bioenergy sector. But most important for the increase of district heating in Sweden is probably the strong local governments as key actors in the national climate strategy and the endorsement of energy system efficiency.

District energy is an efficient, environmentally responsible method of heating and cooling buildings. A third of the energy consumption in Sweden is related to heating. But, compared to other EU member states it's not much. In Europe in general, the energy use for heating stands for around 45%.

Heat Roadmap Europe

The European research project Heat Roadmap Europe has studied the heat sector in Europe and pointed out district heating and cooling as a solution for EU to reach the goals for climate, energy efficiency, and security. Decarbonising the heating and cooling sector requires



energy efficiency on both the demand and supply side. The heat savings can cost-effectively reduce the total heat demand in Europe by approximately 30–50%. District heating can capture excess heat, which is currently being wasted, and can replace fossil energy sources to heat EU cities. Based on cost and energy considerations, district heating should increase from today's level of 10% in the EU up to 50% by 2050.

District heating is an opportunity also for the Great Britain. The interest is rising and Swedish actors are happy to share their experiences to help on the way to an energy efficient heat sector. ■

Swedenergy (Energiföretagen Sverige) is a non-profit industry and special interest association for companies involved in generation, distribution and retail of electricity, heating and cooling in Sweden. Swedenergy has about 400 individual member companies including state-owned, municipal and private sector companies as well as associate members of different types.

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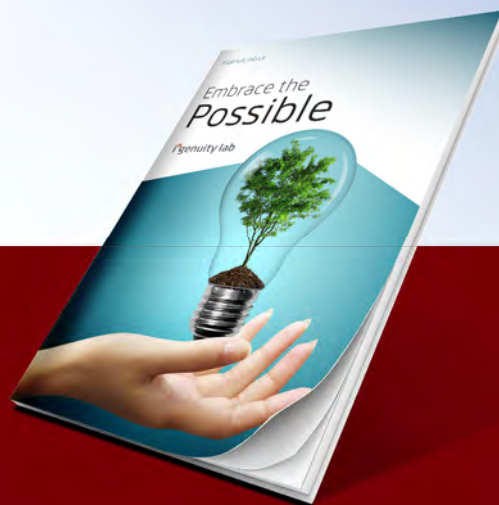
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A sustainable transport strategy for Europe

M F Warrender, Open Access Government, highlights EU Commissioner Violeta Bulc's innovative plan to finance sustainable transport and infrastructure projects

February 2017 marked the launch of the European Commission's new and innovative proposal to finance transport and infrastructure projects in Europe. This proposal will seek to combine €1 billion of grants to help achieve the "twin objectives boosting investment to fund innovative, sustainable transport infrastructure upgrades, while supporting jobs needed to put that infrastructure in place."

European Commissioner for Mobility and Transport, Violeta Bulc, [commented on the proposal](#), stating that: "Achieving our vision for seamless, intelligent and sustainable mobility in Europe requires investments that public funds alone cannot provide. That is why we are launching an innovative solution to make the best of our resources, and unlock untapped private investments, with particular focus on Cohesion countries. Today's action is a sign of solidarity on the move."

This investment highlights the importance of transport innovations through Europe, while also supporting the upcoming road mobility initiatives to be launched later this year.

Roads

Road transport provides jobs for 10.6 million people across Europe, and carries more passengers than all other methods of transport combined. The 2017 Road Transport Strategy outlines 4 main initiatives:

- **A well-functioning internal market** (A more cost-efficient road transport network will make EU firms more competitive globally, thus encouraging job creation).
- **Fair competition and workers' rights** (Simplifying rules and improving cooperation between member

states will ensure better working conditions for transport workers and operators through ensuring enforcement of social rules).

- **Decarbonisation** (CO₂ emissions from heavy goods vehicles represent around 30% of all road transport emissions. With renewed political momentum following the Paris COP21 agreement, road transport will begin to play its part in fighting climate change. Encouraging new charging solutions, with the possibility of providing additional value-added services will cut costs for businesses and people, while better controlling emissions and optimising the use of energy and infrastructure).
- **Digital technologies** (Facilitating the use of digital technologies by proposing common standards and platforms will contribute to improving road safety, the enforcement of road transport rules, and ensure digital technologies will be used to their full potential).

Bulc, who has been a European Commissioner since November 2014, commented that “We need the sector to be more competitive and, at the same time, socially and environmentally responsible.”

Aviation

Another transport sector that is undergoing immense improvement and renovation is Air; in December 2015 the European Commission launched an Aviation Strategy for Europe, allowing all elements of the aviation ecosystem to come together.

In her speech in January last year, *Time for Delivery*, Bulc stated firmly that, “A competitive and sustainable air transport sector will allow Europe to maintain its global leadership position benefiting citizens, industry, and driving jobs and growth. In 2015, we outlined an ambitious vision for the aviation sector. In 2016, it is time for delivery.”

This aviation strategy aims to contribute directly to the Commission priorities of jobs and growth, digital single market, energy union and the EU as a global actor through a series of proposals:

- An ambitious external aviation policy.

- Tackling limits to growth both in the air and on the ground.
- Maintaining high EU standards.
- Innovation, investments and digital technologies.

These proposals will boost Europe’s overall economy, as global air transport over the long term is expected to grow by around 5% annually, until 2030 when there will be 16.9 million flights per year – despite the current economic crisis. The aviation sector also contributes €110 billion to EU GDP, it ensures that remote areas of the Union can stay connected, and benefit from industries such as tourism, which in some regions would be non-existent without aviation. Connectivity is also a core driver for jobs and growth. Innovation is a vital ingredient to maintaining high standards within Europe.

The technology required is provided through the air traffic management research programme SESAR, (the joint initiative between the European Commission, Europe Control and the entire Aviation sector) which aims to modernise infrastructure and raise efficiency by optimising capacity – and so enable these innovations to become a reality.

Overall, the European transport systems are becoming more and more vital every day, and Bulc has recognised this. She said, “I am confident, that – together – with understanding, cooperation and collaboration, we will get to our destination – a Single European Transport Area that serves the needs of people, businesses (big and small) and our planet.” ■

M F Warrender

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Enhancing road safety applications for truck drivers

Christos Oikonomopoulos-Zachos, IMST GmbH details how advanced communication techniques can be used for road safety applications

The ROADART (Research on Alternative Diversity Aspects for Trucks) project aims to evaluate diversity techniques and antenna concepts, in order to develop an in-vehicle platform for cooperative intelligent transportation systems (ITS) for trucks and heavy duty vehicles in the Horizon 2020 call MG-3.5a-2014, "Cooperative ITS for safe, congestion-free and sustainable mobility".

Highlighting large vehicles for road safety

Most of the previous and ongoing ITS projects addressed mainly issues regarding passenger cars. Trucks have not been thoroughly considered and investigated yet. ROADART aims to fill this gap with the development of an in-vehicle platform for cooperative ITS. More particularly, requirements for large vehicles are considered initiating the need for new system architectures, e.g. in terms of system partitioning, diversity and antenna concepts. This will lead to new system architectures and antenna configurations in order to ensure satisfactory quality of service (QoS). An example of a dedicated use case under critical conditions for road safety applications is the platooning of several trucks driving close behind each other through tunnels with walls close to the antennas that support the communication systems. Due to the importance of tunnel safety, significant research effort is needed in order to check the behavior of the antenna

pattern, diversity algorithms and ray tracing models especially for trucks passing through tunnels. Cooperative adaptive cruise control (CACC), a safety-critical application, will be implemented on a truck, to evaluate the theoretical results and to support the planned measurements. Herewith, a safety approach for increasing robustness w.r.t. wireless communication impairments on the application layer will be developed and implemented.

"It is clear that the number of crashes can be reduced if the driver of a truck or heavy duty vehicle is warned in time or informed about upcoming situations or dangers."

The ROADART Project

The ROADART project focuses on multi-antenna wireless transmission systems and all possible diversity configurations for Truck-to-Truck (T2T) and Truck-to-Infrastructure (T2I) communications. The performance of these techniques will be also evaluated with respect to reliability, availability, throughput etc. taking into account all the peculiar parameters for T2T/T2I wireless networking. After this evaluation step, the optimal antenna diversity technique will be proposed and implemented.

ROADART also introduces novel beam formers in vehicular communications with the use of compact electronically controlled parasitic arrays. ROADART

will develop geometric stochastic channel models based on T2T multi-antenna radio channel measurements. These models will apply to environments of highways and tunnels.

ROADART also looks into proposing an efficient and operational cooperative framework to increase robustness and reliability of T2T and T2I links. The development of the framework will be based on mathematical and simulation analysis that will lead to the design of novel relaying protocols and optimised power allocation and relay placement schemes. Special attention will be given to specific applications like tunnel crossing and platooning. Within the ROADART project the partners will design, implement and evaluate a safety framework for time-critical cooperative-driving applications, focusing on the application layer, in order to obtain robustness against wireless communication impairments, in particular packet loss and (time-varying) latency. To this end, CACC is chosen as the cooperative driving application of interest, being both time and safety critical.

The main use cases of Day 1 V2V applications are road safety applications. ROADART aims to provide reliable communications for trucks with cars or infrastructure as a basis for all road safety applications. More specifically, the use cases which can benefit from this project are:

- In-Vehicle signage (simplex);
- Road work warning (T2I application);
- Probe traffic data;
- Hazardous location warning.

It is clear that the number of crashes can be reduced if the driver of a truck or heavy duty vehicle is warned in time or informed about upcoming situations or dangers. Moreover, the number of accidents during truck platooning with the transmission of immediate warning signals through the reliable T2T wireless links could also be minimised.

Additionally, several applications in the vehicle or truck may benefit from the information gained via T2T communications. For example, the Probe traffic data collected by the road operators may be used for traffic optimisation and then used as feedback for the truck navigation systems. Therefore, the route calculations can take into account highly accurate and up to date traffic information. Furthermore, efficient and effective truck platooning leads to a reduction of gas emissions for the following vehicles. Through reliable wireless communication links, an application that can ensure safe platooning with small inter-vehicle distance and relatively high speeds can be proposed. This would take into account not only the cost-effectiveness of transportation services but also the adaption of the platoon in traffic conditions and minimisation of gas emissions.

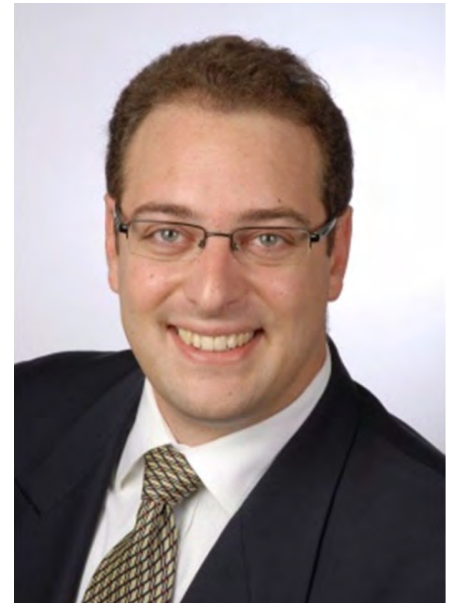
The envisaged platform of the ROADART project targets high quality, low latency, and high throughput T2T and T2I efficient communication links. The ability to transfer reliable and duly-delivered traffic information content

among trucks will allow the adaptation of the platooning conditions on real-time traffic disruptions. Moreover, it will ensure the uninterrupted and safe transportation provided by heavy-duty vehicles. Not only the advanced communication techniques and antenna concepts, but also the localisation capabilities provided by this platform in hostile environments, e.g. in tunnels, will allow for safe platooning.

The aforementioned highly accurate and up to date traffic information generated from the data collected by the In-Vehicle ITS Platform also allows for the detection of traffic disruptions and take them into account for route calculations of navigation systems. Moreover, the trucks will operate as a "traffic condition sensor" and through T2I communication, it will be possible to continuously update information and inform drivers and vehicles in the area.

Finally, due to traffic optimisation and reduction of traffic jams the greenhouse gas emissions (GHG) may be significantly reduced. This can be achieved through reliable and uninterrupted communication T2I links. As mentioned before, platooning can also lead to significant reduction of GHG emissions, as long as the requirements for safe platooning are met.

Although trucks are in the focus of the project, other V2V communication systems may benefit from the results. Some passenger cars will omit the shark fin antenna on the roof top in the future. Therefore, the best position for V2V antennas will not be available anymore, and alternative system architectures should be considered. A diversity-based approach, e.g. by exploiting antennas in the side mirrors, could be a viable and effective solution and



Dr. Christos Oikonomopoulos-Zachos was born in Volos Greece in 1976. He studied electrical engineering at the RWTH Aachen University (Dipl.-Ing. 02, Dr.-Ing. 2010). In 2009 he started working at IMST in the department of Antennas & EM-Modelling. Since 2011 he is project leader in the field of automotive antennas

benefit from the investigations of this project. With the application of robust diversity and beamforming techniques the resulting ROADART platform will assure a sustainable and holistic approach for corporate ITS systems in a way that state-of-the-art systems cannot provide.



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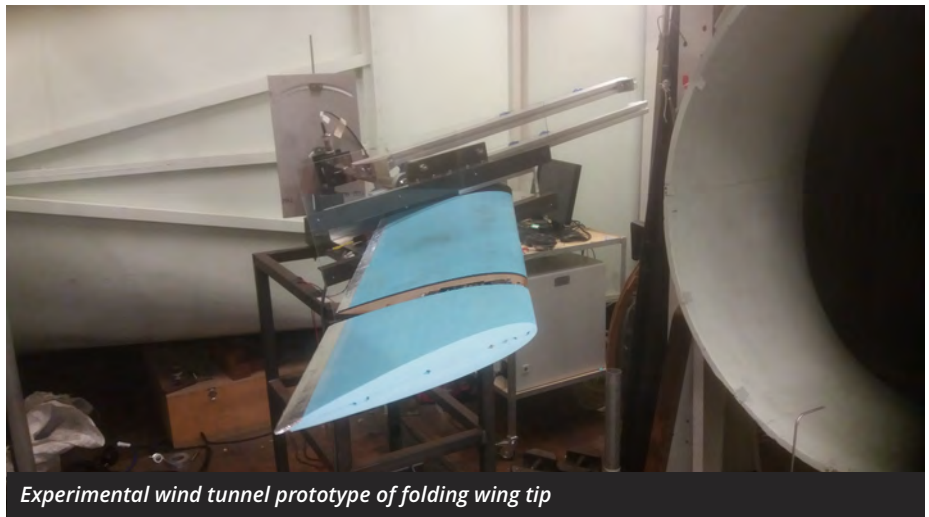
Folding wing tips could improve aircraft performance

Improving aerodynamic performance could be achieved using folding wing tips. The University of Bristol's Professor Jonathan Cooper explains

There is much current effort in the aerospace industry, supported by university research, which is funded by the likes of the European Community Clean Sky and Flightpath 2050 initiatives, to develop aircraft that are more fuel efficient and environmentally friendly. The main design strategies that can be used to achieve these goals are: better aerodynamics, less structural weight and improved engines. It is likely that in the not too distant future the traditional civil jet aircraft configuration, of passengers sitting in a cylindrical fuselage with engines attached to swept-back wings via pylons, that we have known for the past 50 years will change.

Improving aerodynamic performance

Considerable research has been devoted worldwide towards improving aerodynamic performance through the reduction in the aerodynamic drag that occurs in-flight; one of the simplest ways to do this is to decrease the so-called "induced drag" by making the wings longer. However, this is not straightforward as a greater wing span leads to an increase in the aerodynamic loads, which in turn leads to heavier aircraft. Perhaps the major limitation to such a design concept is the maximum wing size that is allowed at airports; airlines have to pay increased fees to use larger airport gates, and consequently this has led to a restriction on the size of today's typical aircraft designs.



Experimental wind tunnel prototype of folding wing tip

A possible solution to the airport gate size issue is to make use of folding wings, which can be employed on the ground in a similar way as the retractable wings used by planes on aircraft carriers. Such an approach would enable larger wing spans to be achieved, giving improved aerodynamics, without the financial gate size penalties. This technology is currently very relevant to civil aircraft designs; an option on the latest version of the Boeing 777X has a folding wing capability that can be activated during taxiing to and from the airport gates.

The possibility of including a folding wing design has opened up the possibility of using such a device in-flight to reduce the loads resulting from straight and level flight, and also from gusts and turbulence; potentially removing the weight penalty incurred by extending the wings. Research at the University of Bristol, funded by the

EU Marie Curie ALPES (Aircraft Loads Prediction using Enhanced Simulation) Initial Training Network and also the UK's Aerospace Technology Institute, has demonstrated that it is possible to achieving a significant wing-tip extension with a limited or even minimal impact on wing weight.

"Considerable research has been devoted worldwide towards improving aerodynamic performance through the reduction in the aerodynamic drag that occurs in-flight; one of the simplest ways to do this is to decrease the so-called "induced drag" by making the wings longer."

The main idea consists of positioning the hinge on the wing so that it is not parallel to the free-stream (the direction that the aircraft is flying in); it can be shown that the orientation of the hinge line relative to the airflow is a key parameter to enable successful loads

Possible position for gust loads reduction.

Possible upward positions for entry into gate.

Undeformed position for normal flight including cruise.



alleviation. When an upwards gust of air hits the wing, the wing-tip will fold upwards, thus reducing the angle of the wing-tip relative to the airflow and hence, decreasing the aerodynamic loads acting on the wing. Similar decreases in loads can be achieved in straight and level flight. Simulated studies¹ using representative flexible civil jet aircraft computational models have explored the effect of wing-tip hinge position and orientation, attachment stiffness and damping, and also wing-tip weight on the static and dynamic response of an aircraft. It has been shown that significant reductions in the loads were possible without causing any problems to the aircraft's stability.

Further investigations² have involved the development of an initial prototype experimental demonstrator created in order to validate the folding wing concept. The rig consists of a model wing

with a hinged wing-tip placed in an open jet wind tunnel to replicate the airflow experienced by an aircraft. Furthermore, it was possible to mimic a turbulent airflow using a gust generator placed upstream of the test structure. Initial studies have considered the effect of hinge angle, hinge stiffness and airspeed on the loads reduction capability of the wing-tip device, and results have confirmed the loads reduction potential of the concept predicted by the simulations.

Work is continuing to evaluate the benefits of the folding wing concepts and also to determine how they might be implemented and operated on full-size aircraft. However, despite the considerable promise, there are many hurdles such as complexity of the mechanism, extra weight, safety issues and the cost that will have to be overcome before we see folding wingtips on aircraft in the future.

1 A. Castrichini et al, "Preliminary Investigation of Use of Flexible Folding Wing-Tips for Static and Dynamic Loads Alleviation". *Aeronautical Journal* v121 n1235 Jan2017 pp73 – 94.

2 R.C. Cheung et al "Testing of Wing-Tip Spring Device for Gust Loads Alleviation" 58th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference. AIAA 2017-0630. 2017



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The Internet of Trains: For safety, efficiency and comfort

Particularly for bogies with flattened wheels, the Internet of Trains can bring all-round benefits, writes ZNAPZ CEO Marcel Van Velthoven

The Internet of Things is entering our world more than we realise. Many pieces of equipment today have sensors, supplying us with all kinds of information. Obviously we have internet access on mobile devices such as smart phones, and our mobile devices can make use of this data to tell us, for example, what movements we made today and how that may affect our health. With the growing popularity of health apps, we are rapidly getting used to this.

That a similar “health device” also exists in trains – in bogies, to be very precise – is probably not known to

most people. However, with the huge number of passengers using rail transport today (1.65 billion on franchised rail services in the UK in 2015, according to the UK Office of Rail Regulation, and well over 547 million in the Netherlands), we all experience the result of the improved technology.

As I wrote in [an earlier article](#), trains are equipped with many devices, giving us a lot of information about the train’s health and performance. Sensors inside doors indicate their level of wear and tear, and whether they are still able to close safely within the expected amount of time. Sensors

in the water basins of toilets indicate if they can still be flushed and hence are clean to be used. This goes on and on.

An important part of the train is the bogie, containing amongst other components the wheels that are in contact with the tracks. It is because of the wheels on the track that trains have a lower resistance and run more efficiently than any other form of transport. However, the wheels of rail vehicles are exposed to high wear and tear. This leads to “flattened wheels”. One can imagine that even the smallest flat surface on a wheel can lead to problems. First it causes the wheel to



hit the track instead of rolling across the track, causing track and wheel to endure a higher force and resulting in damage to both elements. But where is this happening, at what speed, with what force, and what are the consequences, short and longer term?

Rail infrastructure companies have extended the track with sensors. These sensors indicate the temperature and pressure of the wheels passing by. This is combined with the load of the train and the temperature of the air. With this set of data, it is possible to identify which wheel on which bogie of which train is flattened and relatively how much. The combination of this data supports the maintenance of the trains and the tracks.

Automatically, via the 'Internet of Trains', a signal can be sent to the train operator, informing them that a specific train has wheels that have a deviation (roundness) that is beyond an acceptable tolerance. This information can be fed back to the maintenance department who can

now quickly plan and execute a wheel correction. This prevents further deterioration of the wheels, and because the deviation is detected early, the wheel repair effort is significantly less than if the flattened area had increased. If for any reason a wheel or wheels flatten quickly the train operator can be informed to reduce the speed of this train, lessening further damage to the wheels and the track.

Wheel flattening is identified earlier than it would be with regular inspections, and this leads to longer life for the track. Also, in severe cases with limited inspection routines, flat wheels can lead to the track breaking, which could ultimately lead to a train derailment with very severe consequences.

An additional benefit is increased comfort for passengers. A flat wheel leads to an uncomfortable ride. There are also lower noise levels for the environment as flat wheels cause significantly more noise than round wheels. This is all because with the

Internet of Trains we are able to assess the asset health of the train in real time and take corrective actions early.

Identifying asset behaviour and what is required to make assets behave the optimal way is one of the core competences of ZNAPZ. Identifying which data is required to perform optimal Asset Management and making this data and the required analysis and models available to the asset owner and/or operator is our core business, in which we support rail organisations across the world.



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Cycle-friendly employers: A framework for business

Marco Ciarrocchi, Bike2work Project Manager at the European Cyclists' Federation highlights how cycle-friendly employers can benefit European businesses

Bike2Work is a project aiming to encourage a significant modal shift from motorised commuting to cycling. Bike2Work uses a two-fold approach to target both employees' behaviour through campaigns, and employers to meet the needs of cyclists. Funded by the European Commission in the framework of the Intelligent Energy Europe, the project focused both on implementing bike-to-work schemes in partners' countries and on involving employers to implement bike-friendly measures in the workplaces. After 3 years across all of Europe, half a million commuters selected cycling over any other transport mode to reach their workplace and with over 148 million km cycled – approximately 3620 times the equator – the Bike2Work project contributed, only in 1 year, to save a total of 20,916 tons of CO₂ emissions.

The two-fold approach

Given certain conditions, cycling to work is one of the most natural and spontaneous behaviours, especially in cities where private transport causes a lot of congestion and time is wasted sitting in the car. In order to break the barriers that hinder cycle commuting, people need to be persuaded but companies also need to be convinced that employees that cycle to work are a benefit for them.

The project connects Bike2Work campaigns and employer bicycle-friendliness and achieves a mutual reinforcement of effects. A Bike2Work campaign usually lasts between 4 weeks to 4 months and encourages participants to use the bicycle to get to work. Gamification, competition and rewards are key elements in every successful Bike2Work campaign.

To achieve high visibility and participant' engagement it is important to keep track of basic statistics like the number of participants, kilometres/days cycled, CO₂



saved etc., especially online real-time display of statistics encourages competition, boosts motivation (specially by keeping personal track records), as well as helping to identify winners and give away prizes.

Convincing employers to increase their cycle-friendliness was not and is not an easy process. Besides offering consultations on how to become more cycle-friendly, many other tools have been developed and shared with companies, like the 'Guidebook for Bicycle-Friendly Employers', a manual addressed to company coordinators, CSR, environmental and mobility agents that helped SMEs to promote cycling in operation and to build an in-house cycling culture.

Why should companies become cycle-friendly?

Improving the situation for employees that cycle to work will lead to a reduction of illness costs, employees that cycle to work throughout the whole year have one third less sick days than those who travel by car. Furthermore, bicycles require less space and less complex infrastructure: production costs and maintenance for bike storage facilities are far lower for companies than



car parking. Studies estimate that up to 7 bikes can be parked on one single car parking space (12 m²). Employees traveling by bike have better accessibility to their company, they have less problems finding a parking space and therefore also tend to arrive at work earlier. Cyclists decompress the entire transport system and thereby reduce costs of traffic jams and delays, a cycle-friendly workplace contributes in climate protection, energy and CO₂ saving.

In order to give European companies a special incentive to increasingly focus on bicycle friendliness, Bike2Work developed an EU-wide certification framework for bicycle-friendly companies, based on 6 main criteria. Each bicycle-friendly measure would contribute to define the CFE level of a company. A minimum number of measures must be achieved per action field in order for employers to receive the certification.

The Bike2Work project may be over, but due to the popularity of the campaigns, the national Bike2Work campaigns are still growing and convincing people all over Europe to shift to a more sustainable commute.

The campaigns that took place during the Bike2Work project were hugely successful and garnered support from over half a million commuters around Europe. National contexts differ and each campaign had unique characteristics but all of them effective and ambitious. Around 150 million km were cycled in one year only and 20,916 tons of CO₂ emissions were saved. ■

Further info can be found below.

Bike2Work project: www.bike2work-project.eu

CFE Certification Framework: <https://cfe-certification.eu>

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How can we fight cybercrime in a digital age?

In an increasingly connected world tackling cybercrime must be a consideration for everyone, says EU Commissioner for the Security Union, Julian King

The first thing that I did this morning was to check if I had any pending updates to install on my smartphone. I recommend to everybody, without apology, this mildly annoying start to the day.

The publication by WikiLeaks, of documents which purport to show that the Central Intelligence Agency (CIA) has been developing its abilities to exploit vulnerabilities in everyday 'smart' devices in order to gather information, will inevitably increase our anxiety about the Internet of Things – the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.

We appear to be entering a new and darker phase in our relationship with technology – in particular the 'smart' variety which is rapidly altering our interactions with everything from our laptops to fridges, cars and, yes, televisions. When machines that we watch for our entertainment become smart enough to watch us back it is time to pause for thought about where this journey from the analogue to the digital world is leading us.

It wasn't supposed to be like this. Technology's promise was to make our lives easier but, reading the latest headlines on the capability of intelligence agencies to reach inside our smart devices, you could be forgiven for believing that the utopian future is being transformed into a dystopian present that was predicted with chilling accuracy by George Orwell in his novel '1984'.

Exploitation of data by criminals

There is a legitimate debate going on about access to data by national intelligence agencies for specific law enforcement purposes. But, as Europol's Serious and Organised Crime Threat Assessment 2017 reveals, the activities of national intelligence and law enforcement agencies are being met and matched by highly sophisticated crime syndicates.



Julian King, Commissioner for the Security Union

For almost all types of organised crime, criminals are deploying and adapting technology with ever greater skill and to ever greater effect. This is now, perhaps, the greatest challenge facing law enforcement authorities around the world.

Cryptoware – ransomware using encryption – has become the leading malware in terms of threat and impact. It encrypts victims' user-generated files, denying them access unless the victim pays a fee to have their files decrypted.

Europol points out that the online trade in illicit goods and services is an engine of organised crime. Online fraud is now the most common crime in the UK, with almost one in 10 people falling victim. Half of all companies in Europe have experienced at least one cyber security incident. Globally, the cost to society of cyber-attacks and cyber hacking in 2015 was estimated to be around \$315 billion.

The dark web, a collection of websites operating on an encrypted network hidden from traditional search engines and browsers, is the criminals' bazaar where, subject to the right introductions, I am reliably informed that I can rent a botnet for a modest sum which I could use to launch a Distributed Denial of Service attack against anyone I felt like.

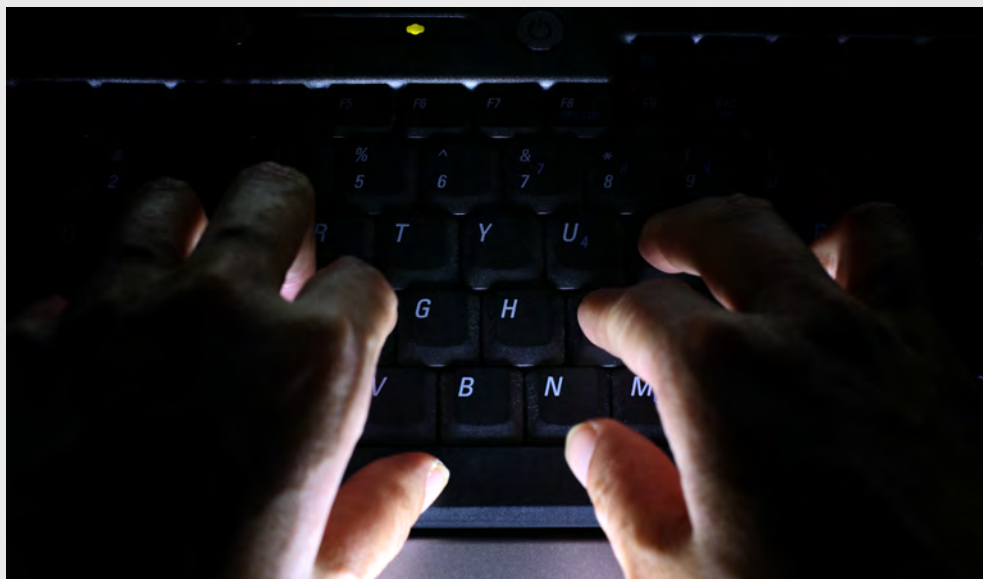
As the Internet of Things grows we are inadvertently lowering the threshold both in terms of cost and availability for these attacks. My smart fridge and TV have factory-set security codes, which is insecurity by design. This needs to change.

Increasing security

Working with colleagues across the European Commission, I am determined to implement a plan for reducing our vulnerability to cyber threats by increasing our resilience to attacks, stepping up the fight against cybercrime, investing in cyber security (a public-private partnership launched last year is expected to trigger €1.8 billion of investment by 2020) and strengthening international cooperation.

The NIS Directive (NIS) on the security of networks and critical information aims to ensure that all EU Member States have a national Cyber Security Strategy, a national authority responsible for network and information security, and Computer Security Incident Response Teams (CSIRTs) in place by the time the Directive enters fully into effect next year.

Implementation of this directive by all Member States is the most important step we can take to ensure greater protection of our key infrastructure, and a greater shared understanding and cooperation between all the main actors.



But it's of course not enough. We also need law enforcement and judicial authorities to have the necessary means to find and punish cyber-criminals. The European Cybercrime Centre at Europol has a key role to play in that respect. Setting up an appropriate legal framework at an EU level is also necessary. We need to continue to work together with the private sector, as a key partner in the fight against cybercrime and cyber security threats.

The interconnected world offers many opportunities for citizens, governments and public and private enterprises to make a positive contribution to society. But it also offers unprecedented opportunities to criminals, terrorists, and hostile states. We must be better prepared for whatever the future holds. ■

Julian King
Commissioner for the Security Union

European Commission

https://ec.europa.eu/commission/commissioners/2014-2019/king_en

www.twitter.com/JKingEU

Tackling cybercrime is a major challenge for Europe

Head of the Europol Cybercrime Centre, Steve Wilson shares how his organisation is tackling cybercrime and explains why a collaborative approach is needed

In an ever changing digital world, cybercrime has become one of the major challenges for organisations throughout Europe. Set up in 2013 by Europol, the European Cybercrime Centre aims to strengthen the law enforcement responses to cybercrime. Costing EU Member States an estimated €265 billion a year, protecting European citizens, businesses and governments from online crime is essential for the economy.

Head of the Europol Cybercrime Centre, Steve Wilson answers Open Access Government's questions about tackling the worldwide problem and the challenges that come along with it.

What are the main challenges with tackling cybercrime?

One of the greatest challenges for investigating cybercrime has always been attribution. You may find an online nickname associated with some form of criminality, or perhaps obtain an IP address, but determining who is behind that alias or IP address has always been the greatest obstacle.

What we call the loss of location is a big issue for law enforcement agencies. This is linked to the increasing criminal use of encryption, as well as anonymisation tools, virtual currencies and Darknets such as TOR¹, which have led to a situation where establishing the physical location of a perpetrator, the criminal infrastructure that is being used to facilitate cybercriminality or the relevant electronic evidence has become increasingly difficult. In these situations, it is often unclear which country has jurisdiction and what legal framework regulates the collection of evidence or the use of special investigative powers.

However, undoubtedly one of the biggest challenges we face now is related to the loss of data or the inability to

access relevant intelligence and evidence, often because of encryption. A growing number of manufacturers and electronic service providers implement default encryption of their services and devices. At the same time, tools that enable personal encryption of communications and other data are widely available. While this counts as a positive development to increase cybersecurity in general, traditional investigative techniques like wiretapping are becoming less effective, and the possibilities of digital forensic analysis are severely hampered as criminals are also protecting their data with encryption. It is important to note that the criminal use of encryption is a threat that cuts across all crime areas, not just cybercrime.

The widening criminal use of cryptocurrencies such as bitcoin² and the increased use of tumbler/mixer services³, effectively prevent law enforcement from 'following the money' and significantly complicate the possibilities for asset recovery and the prevention of fraudulent transactions.

The constantly evolving nature of cybercrime requires law enforcement to continuously update their skills and expertise. This requires up-to-date, relevant and standardised training. While we currently do not have EU-wide standards for training and certification, we are actively involved with other stakeholders such as the EU Commission, CEPOL, the European Cybercrime Training and Education Group (ECTEG) and Eurojust to establish a Training Governance Model at EU level, which aims to address these points. This is based on a Training Competency Framework that we helped develop, which identifies the main roles in law enforcement and the judiciary involved in combatting cybercrime and the corresponding required skill sets. The Training of Trainers (TOT) Project and the training activities under the EMPACT policy framework are already paving the way towards addressing the expertise gap at EU.



How important are partnerships such as, with Europol and the Global Cyber Alliance to help tackle the problem worldwide?

Tackling cybercrime is not a responsibility that law enforcement can, or should, shoulder alone. Cybercrime and cybersecurity are cross-cutting issues so it is very important to align and cooperate with the relevant players in this area such as GCA and others if we want to be on the forefront of the fight against cybercrime.

Cybercrime in particular requires close cooperation and working trust-based partnerships with industry, the financial sector, the CERT/CSIRT community, academia and other stakeholders as they all hold parts of the puzzle that are required to effectively and efficiently tackle cybercrime. We have different advisory groups representing different stakeholder communities that offer a great platform to establish and develop our partnerships.

For us this of course also includes close cooperation with the EU institutions and other EU agencies such as ENISA, CERT-EU, Eurojust or CEPOL.

By sharing best practices, lessons learned and tools we are building and further expanding a resilient network better prepared to face cybercrime and cybersecurity risks, thereby contributing to a safer and more secure cyberspace.

Why is the EU a particular threat for cybercrime?

The internet penetration rate for Europe is now close to 77%. This has a direct impact on the life of EU citizens and businesses alike since most aspects of our daily life now have a digital component. Many EU countries maintain fast, resilient internet infrastructure which attracts not only industry but also cybercriminals who use it to carry out their attacks.

Moreover, the EU has a well-established, internet facing financial sector and e-commerce industry, which are key targets for cybercriminals.

These factors, together with the relative economic affluence of the region, make Europe an attractive target for cybercrime.

How much does cybercrime cost victims throughout Europe each year? And, how much of a problem has cybercrime become?

One of the measurable costs of cybercrime is the continued increase in the global investments made on cybersecurity. It is however very difficult to obtain accurate figures on the costs of cybercrime due to underreporting, lack of common definitions and difficulties in assessing the damages caused by cybercrime. While it is possible to estimate some costs, direct financial costs for example, other damages are harder to evaluate, such as the financial damage to a company's reputation or the loss of intellectual property. There are some studies which forecast that global cybercrime costs will be in excess of \$6 trillion annually by 2021⁴.

Cybercrime has become increasingly financial motivated, banks and the financial sector are a key target for cybercriminals, with some of the main threats being banking Trojans, ATM malware, DDoS attacks, card-present and card-not-present fraud, CEO or Business E-Mail Compromise (BEC) fraud and ransomware. The crime-as-a-service business model which underpins cybercrime provides access to cybercrime tools and services that allow even entry-level cybercriminals to conduct attacks hugely disproportionate their skill level, often for negligible costs. Couple this with the increased digitisation of citizens' lives, businesses, and public services and we have a substantial problem indeed.

What are the key challenges and threats with regards to cybercrime?

The term cybercrime covers a wide range of criminality. Some of the main threats we highlighted in the 2016 IOCTA were the aforementioned crime-as-a-service business model that promotes the connection between specialist providers of cybercrime services and tools and real-world organised crime groups. Ransomware, particularly that which uses encryption, is the leading malware threat and is likely to remain so in the near future. In the area of payment fraud, we have seen the development of logical and malware attacks against ATMs and the compromise of contactless (NFC) cards. When it comes to Child Sexual Exploitation, the live streaming of abuse is becoming a bigger issue with the use of end-to-end encrypted platforms for sharing media, coupled with the use of largely anonymous

payment systems. One of the cross-cutting challenges we are facing in the fight against cybercrime is the abuse of Darknets and encryption.

Some of the other challenges we face are related to legislation, despite the existence of international legislative instruments, differences in domestic legal frameworks in the EU Member States and international instruments often prove to be a serious impediment to international criminal investigation and prosecution of cybercrime. This is partly due to an incomplete transposition of international instruments to domestic legislation. The main differences regard the criminalisation of conduct and provisions to investigate cybercrime and gather e-evidence.

“By sharing best practices, lessons learned and tools we are building and further expanding a resilient network better prepared to face cybercrime and cybersecurity risks, thereby contributing to a safer and more secure cyberspace.”

The complex transnational nature of cyber investigations require a strong cooperation effort, not only from Law Enforcement Agencies across Member States, but also in third countries and with private organisations, but Europol has been proven to have a leading role in facilitating this articulation, being an exceptional information hub, providing expertise and operational support.

As technology continues to evolve, how do you think cybercrime will evolve with it? Are we ready to tackle this?

Cybercriminals are very flexible and quick to adopt, abuse or exploit any new technology which can enhance their criminal lifestyles. We need to invest in training and capacity building and keep the pace with technological developments to beat cybercriminals in their own game. Relevant alliances and Public-Private Partnership initiatives are fundamental to achieve this, law enforcement cannot fight this fight alone: it takes a network to defeat a network.

It is also essential to raise awareness of cybercrime threats, not just within industry, but with the public, who are regularly the victims of cybercrime. Every person adequately equipped to defend themselves is another person prevented from becoming a victim. To

some degree cybercrime may even be a generational problem. Just as sanitation and personal hygiene has led to a reduction in diseases and infection, similarly, the new generation of internet users should have digital hygiene engrained into them from an early age which will be a critical defense against cybercriminals.

Since it was established in 2013, how has the Cybercrime Centre helped to reduce the amount of cybercrime in the EU?

One of the most recent examples I can provide is the dismantling of the Avalanche network which was used as a delivery platform to launch and manage mass global malware and money mule recruiting campaigns. Europol hosted the command post during the action day and supported Germany in close cooperation with the United States Attorney's Office for the Western District of Pennsylvania, the Department of Justice and the FBI, Eurojust and global other global partners during the course of the investigation. The operation marks the largest ever use of sinkholing to combat botnet infrastructures and is unprecedented in its scale, with over 800,000 domains seized, sinkholed or blocked.

Another good example of how EC3 has not only helped to reduce the amount of cybercrime, but also helped to identify and save child victims from abuse was through the third Victim Identification Task Force (VIDTF). VIDTF saw 25 experts in victim identification from 16 countries and 22 agencies coming together to work on shared materials at Europol's headquarters over 12 days. They were supported by Europol staff, all specialists and analysts in this crime area, and together we were able to successfully identify several victims of child sexual exploitation and save them from further abuse.

Through our innovative and collaborative approach we have also have a big impact in the area of fraud. For example, in the last Global Airline Action Day 193 individuals suspected of traveling with airline tickets bought using stolen, compromised or fake credit card details were detained.

Furthermore, EC3 plays a key role not only on the operational side but also on the strategic and prevention aspect. Since 2013, we have produced a yearly Internet Organised Crime Threat Assessment⁵ which provides a number of key recommendations to address the issues

and challenges of cybercrime, and identifies several priority topics to inform the definition of operational actions for EU law enforcement in the framework of the EU Policy Cycle. On the prevention side, we have launched several campaigns, including the No More Ransomware initiative⁶, which is not only an awareness campaign for victims of ransomware but also a place to go to when you fall victim of this crime. As such, it is also an excellent example of what we can achieve collectively together with industry and other law enforcement partners in countering one of the main cybercrime threats.

Overall, I would say we have been having quite a relevant role in helping to reduce cybercrime. We aim to continue doing it, always improving, in cooperation with other relevant stakeholders. ■

1 According to the IOCTA 2015 and 2016, cybercriminals make increasing use of Darknets and other similar areas offering a high degree of anonymity. These environments are also increasingly hosting hidden services and marketplaces devoted to traditional types of crime, such as the drug trade, selling stolen goods, firearms, compromised credit card details, forged documents, fake IDs, and the trafficking of human beings.

2 Unlike centralised virtual currencies such as WebMoney or Perfect-Money, decentralised virtual currencies such as Bitcoin do not have a single administrating authority that controls the currency.

3 A tumbler or a mixer is a service that attempts to break the links between the original and the final address by using several intermediary wallets. The service may also randomise transaction fees and add time delays to transactions.

4 <https://www.herjavecgroup.com/wp-content/uploads/2016/08/Hackerpocalypse.pdf>

5 <https://www.europol.europa.eu/activities-services/main-reports/internet-organised-crime-threat-assessment-iocta-2016>

6 <https://www.nomoreransom.org/>

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The Customs X-Ray Simulator

A new platform for cargo X-ray image interpretation training

The development of transportation and information technology has advanced the interconnectedness of global markets. With this global economic integration, new trade partners, shipping and transport routes emerge. The weight of goods carried by heavy goods vehicles (HGVs) to or from the UK alone amounted to 1.63 billion tonnes between October 2014 and September 2015 (UK Department for Transport, 2016). The number of main freight units handled by major ports rose to 12.8 million units (UK Department for Transport, 2015). Similar growths in freight units are being reported by other European transport hubs.

The growing cargo traffic requires efficient inspection procedures. Hence, shipments passing checkpoints are risk profiled by the Customs Administrations to identify inconsistencies between declared and transported goods, illegal material, and threats to society.

For this reason, the Center for Adaptive Security Research and Applications (CASRA) has developed a new platform for cargo X-ray image interpretation training, called the Customs X-Ray Simulator. This test and training system was specifically designed for cargo X-ray screening officers by computer scientists, psychologists and security experts of CASRA in close collaboration with customs organisa-

tions funded by the EU 7th Framework project ACXIS.

This article explores aspects of the daily work routines of cargo X-ray screeners, identifies the challenges in the process and explains how training with the Customs X-Ray Simulator may improve the screening competency of customs officers. Besides the practical implications, the subchapters ahead also provide an inside look into the scientific research behind computer-based training, the ACXIS project and the Customs X-Ray Simulator.

The customs X-ray screening process

Most borders and ports now use X-ray screening for unit load devices (ULDs) and containers to identify smuggled items and security threats. This technology is particularly useful as it provides an image of the shipped content without the need for physical interference. The truck is being sent through an X-ray scanner, after which the scanned image is analysed by the operator. Only if a further investigation is needed, the shipment is put aside for manual inspection. Taking the decision whether the freight carrier is clear or not is a difficult task since the inspected ULD can be rather large in scale while the prohibited items can be comparably small (e.g. pills, bricks of cocaine and (chemical) precursors to drugs). Adding to the matter of differences in scale, there are additional

elements that need to be taken into consideration: The variety in texture and composition of the goods themselves, the packaging of the products, the types of vehicles used to transport the freight. Each of the following freight categories poses these unique challenges to the screening process:

- Liquid bulk: Such as oil and liquefied gas.
- Dry bulk: Such as agricultural products, minerals and coal.
- General cargo: Includes common trade goods as well as forestry, iron and steel products.
- Ro-Ro traffic: A term for roll-on, roll-off cargo which is driven on and off the vessel by a motorised vehicle.
- Lo-Lo traffic: A term for lift-on, lift-off shipping containers, craned on and off the vessel.

Another key aspect in the screening process is identifying whether the load matches the information on the waybill. Differences in the types of goods, as well as the amount of goods listed must be compared to the actual shipment, as inconsistencies may have an impact on the taxation.

For all these reasons, investigating cargo goods may take anywhere from minutes to a few hours. On that

account, how do customs officers cope when faced with such challenging tasks? What influences their screening performance?

Two important detection performance factors

Knowledge-based and image-based factors have a large impact on human detection performance (Schwaninger, Hardmeier and Hofer, 2005). Knowledge based factors relate to knowing which items are prohibited or not and/or match the waybill, what they look like in X-ray images and how they can be distinguished visually. They are especially relevant for objects that are rarely seen in everyday life and that look quite different in an X-ray image (e.g. contraband goods and Improvised Explosive Devices, so called IEDs). Image-based factors refer to characteristics of X-ray images. Objects are more difficult to recognise if depicted from an unusual viewpoint, when superimposed by other objects or if the load is heterogeneous and complex.

Mastering cargo X-ray screening by adopting airport security training

Adaptive, computer-based training (CBT), which contains training levels based on the user's individual detection performance and learning progress, has shown to be very effective in strengthening X-ray image interpretation performance in cabin and hold baggage screening at airports. The abilities to cope with effects of viewpoint, superposition and image complexity are also important in cargo X-ray screening and may be

taken into account when recruiting officers.

A study on the competency of cargo X-ray screeners

As an example of training evaluation in the domain of cargo X-ray screening, a study investigated whether a customised CBT can improve the X-ray image interpretation competency of cargo screeners (Michel, Mendes, de Ruiter, Koomer and Schwanninger, 2014). The X-Ray Tutor (XRT) training system, developed by CASRA, was adapted to fit the needs of cargo X-ray screening for the study. The results of the study revealed significant increases in detection performance for screeners having trained weekly using the C-XRT (a test version of the Customs X-Ray Simulator). In addition, a decrease in the average inspection time per image was revealed for the second measurement of the C-XRT group as a result of training.

The EU funded ACXIS project

As important as frequent training, is the creation of a platform where information can be shared nationwide with other customs sites. Because of that, standardising X-ray images recorded from different models of X-ray machines is crucial.

ACXIS (Automated Comparison of X-ray images for cargo scanning) is a research project funded by the European Union, under the 7th framework Program. The aim of the project is to promote scientific research and development by combining different partners with complementary expertise

for improving cargo X-ray screening. ACXIS researchers, including CASRA, work on establishing a unified X-ray image standard. X-ray data that has been converted into a standardised format can be stored in a database which may be shared with other sites. This manufacturer independent reference database is filled with over 30,000 X-ray scans from a large variety of containers and trucks provided by custom organisations and processed by CASRA.

ACXIS also develops Assisted Target Recognition (ATR) methods to automatically detect regular and illicit goods through dedicated algorithms. The impact of the ATR method, as well as the impact of a systematic computer-based training for cargo officers on their performance, is assessed through a validation study. Final results and publications are expected by early 2017.

The Customs X-Ray Simulator

Combining scientific results from the CBT studies and the algorithms used to unify X-ray images for ACXIS, CASRA has developed a training system called the Customs X-Ray Simulator. This new platform can be used for training purposes and/or evaluating the X-ray image interpretation competency of cargo customs officers by simulating operational reality.

The navigation on the software suite requires no prior knowledge. Due to the high degree of individualisation, new procedures may be integrated into test units quickly and comfortably.

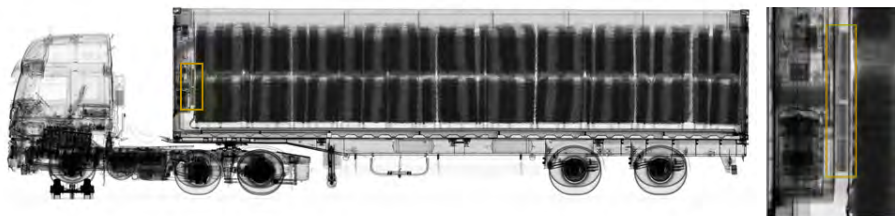


Figure 1: A user interface of the Customs X-Ray Simulator showing an X-ray image of a container with smuggled drugs hidden behind the cooler, marked by the object-specific assist frame

Creation of own content

The Customs X-Ray Simulator is divided into libraries, modules and series. The content manager is able to create customised image libraries by uploading their own material, e.g. X-ray images, scans of waybills and/or manually added information from the waybill. These libraries may be used to create test and training modules that can be bundled into series and assigned to certain persons or groups of personnel, with the option to allow access for a designated period of time.

For example, series A contains objects hidden between pallets in the container, whereas series B contains objects attached to the walls and the cooler of the ULD (Fig. 1). If an increase in frequency of one of the two smuggling methods is being registered at a specific border, series A or B can be assigned to the staff of the affected checkpoint for training purposes. New cases can also be uploaded to the library and allocated to the corresponding module. The images and case specific information may be exchanged with other national customs agencies on a centralised database.

Furthermore, it is possible to create individual information slides or slide

blocks to launch or conclude a simulation and provide theoretical background knowledge (Fig. 2).

Simulator for computer-based training

During training, it is important to expose users to a broad variety of X-ray images depicting prohibited objects from different angles in order to improve their image interpretation competency and object recognition. The interface of the Customs X-Ray Simulator features a variety of supportive functions. In addition to the zoom function, the object-specific assist frame (Fig. 2) is designed to

draw attention to possible smuggling goods inside the cargo. Also available to the test user is the button “Waybill”, which displays a list of additional information and/or a scanned copy of the waybill documents. Along with this, integrated are following image enhancements to mimic real-work-conditions:

- NEG: Creates a “negative” of the image;
- SEN: “Super Enhancement”, increases the contours;
- LOW LUM: “Low Luminosity”, reduces the brightness;
- HIGH LUM: “High Luminosity”, increases the brightness;
- B/W: “Black/White”, displays the image in grey scales;
- PSEUDO COLOURS: Colours the image, 4 available colour schemes.

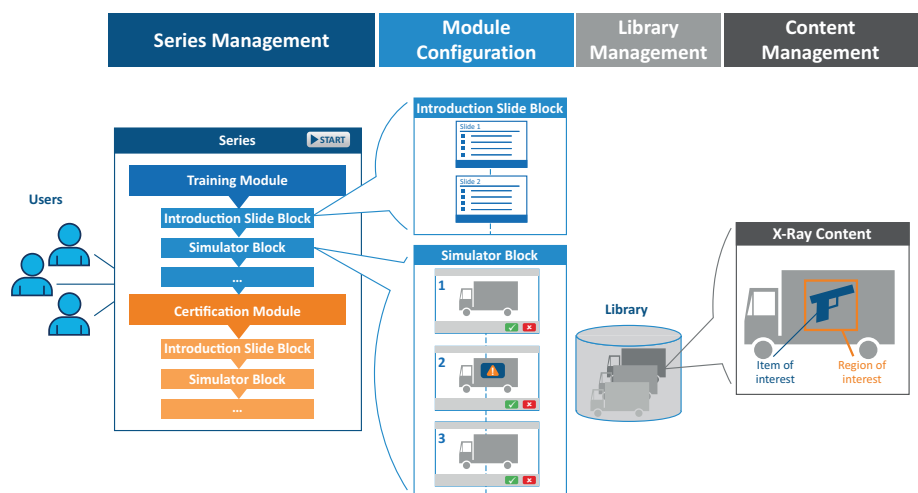


Figure 2: A content management overview of the Customs X-Ray Simulator software

Immediate feedback

When a screener correctly reports that an X-ray image contains an item that does not match the waybill and/or is prohibited, the response is counted as a hit. If an incorrect answer has been given, the response is categorised as a false alarm. The customs screening officer is presented with trial feedback after each image and a block feedback after he or she completes a training session. In the trial feedback window the photograph, X-ray image, the training time and further details of the simulated scenario can be examined (Fig. 3).

Administration and reporting functions

Thanks to the administration functions, users can be monitored and managed easily. New user accounts can be swiftly imported via templates and organised in user groups. The reporting functions provide the administrator with overviews of each user's training, test behaviour, and results. Reports may be exported for further data analysis.

Centralised database

X-ray images, information from the waybill, registration documents, and customised tags can be uploaded on to the shared database. The application architecture supports fully web-based clients by using HTML5 and AngularJS. The software can be used on-premises, by installing it on a server, located on the customs administration's premises. In this case, the configuration data and the user's results are stored on a local centralised database. This option enables



Figure 3: Display of the feedback feature on the interface of the Customs X-Ray Simulator training program

the nationwide review and exchange of images and information between different customs sites.

In the future, Customs Administrations from different nations will be able to extend their knowledge worldwide by operating on a shared database of valid, standardised, high quality images.

As shown throughout this article, scientific results have demonstrated that there is large potential for improvement in cargo X-ray screening. The use of a computer-based training, such as the Customs X-Ray Simulator, can significantly improve the detection performance of customs screening officers. Not only allows this new platform the exchange of knowledge, experiences and information relevant for successful image interpretation, but it also positively impacts the real, day-to-day work of customs

officers by enhancing their visual knowledge of X-ray images.

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How can the cyber skills gap be closed?

Dr Bernard Parsons, Co-Founder and CEO at Becrypt, says the cyber skills gap can be addressed through education and training

Rumblings of the skills gap and its consequences for the future of our economy have become a familiar sound over the last few years, particularly since the recession of 2008. But while the economy has picked up and the UK's employment figures are strong, many key technical industries are still struggling to find recruits with the skills they need.

A survey last year of 90,000 UK businesses by the UK Commission for Employment and Skills, indicated that the skills gap is widening. The research found that firms were struggling to fill one in 4 vacancies because of a lack of suitable candidates – the highest proportion in 10 years. Technical jobs drawing on STEM (science, technology, engineering and maths) skills are the most impacted, including crucial fields such as energy, transport and manufacturing.

Among the worst affected is the cyber security industry – a situation that could lead to a number of potential

negative consequences. Aside from its role as a key element of our high-growth tech sector, a strong cyber-security sector is contributor to national security.

Research from the job listings site Indeed found that the UK has the second worst cyber skills gap in the world, behind only Israel, reflecting both the level of activity within the sectors as well as available resource. The report noted that the number of people searching for cyber roles was just 31.6% of the number of job postings, meaning there were 3 times as many jobs available as workers to fill them.

Can the skills gap be closed?

Central to narrowing the skills gap is ensuring there is a steady flow of newcomers entering the industry. Some of these new entrants will be crossing over from other fields, but increasingly they will be entering into cybersecurity as their career of choice after finishing education. As with many other tech-based sectors,



cybersecurity has suffered from a lack visibility, leading to students forgoing it for other fields which appear to be more exciting or rewarding.

The government has taken several steps to try and rectify this issue, most recently with its CyberFirst scheme, launched under the National Centre for Cyber Security. The scheme aims to create a more positive image of the industry for the crucial 14-18-year-old age range, who will be making decisions that will define the next several years of their education and career. More than 2,500 residential courses are being run around the UK, with the goal of not only encouraging more young people to consider the field, but to support them through their degree and into their first job.

The scheme is also working closely with the cyber industry itself, which is vitally important for giving young people insight into how the sector actually works. Becrypt is one of several companies that have signed up

to offer their support, which ranges from financial input to providing training and work experience for students and graduates.

“Research from the job listings site Indeed found that the UK has the second worst cyber skills gap in the world, behind only Israel, reflecting both the level of activity within the sectors as well as available resource. The report noted that the number of people searching for cyber roles was just 31.6% of the number of job postings, meaning there were 3 times as many jobs available as workers to fill them.”

Beyond supporting education, firms can offer more advanced opportunities for newcomers to the industry by creating internships and apprenticeships. These deliver invaluable hands-on experience within the day-to-day work of cybersecurity, something that can be difficult to impart in school or even university. Providing these opportunities also gives the host company a chance to work with the best and brightest new talent, and if things go well, enabling them to take them on directly once the apprenticeship is complete.

If the level of response to Becrypt’s own apprenticeship positions is any indication, the good news is that there is no shortage of young people eager to join the industry. However, closing the skills gap requires a sustained effort with both governmental support and funding, and grassroots involvement from security specialists. ■

Dr Bernard Parsons
Co-Founder and CEO

Becrypt

www.becrypt.com/uk

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Citizen and the state: The government at your service

The relationship between the citizen and the state is sacrosanct. Cabinet Minister Ben Gummer explains how the government will work for the people

To govern is to serve – that principle is in question. As the Prime Minister has reflected, what occurred last June represented a direct challenge to the way that government operates and interacts with its citizens. Our collective faith in democracy and the relationship between the citizen and the state has faltered.

The referendum vote was a message not only to leave the European Union, but to address that gap that has come to separate those who govern and those whom we seek to serve.

If governing is to serve the people, it is the consistent delivery of effective and efficient public services for the citizen that underpins everything we do as a government. But while the vital work to improve and reform our everyday public services will continue throughout this Parliament – building upon fantastic achievements by my predecessors – there remains the question not

simply of how public services work better for the user, but what public service actually means to the individual citizen.

Indeed, this is a question that transcends the professionalism and dedication of the thousands of committed civil servants I have the privilege of working with every day. They go to work wanting to do things for the better and for the public good. Yet that genuine spirit of public service is lost in the opaque interface that currently exists between the citizen and the state.

In too many of their interactions with government, the public is made to feel as though they are the servants of the government, rather than the other way around.

And it is not simply the user who is disadvantaged by this relationship. Public servants are not able to fulfil their vocation. We have asked them to work in poor



Cabinet Minister Ben Gummer

buildings, to antiquated working patterns, in excessively hierarchical organisation structures, and with sub-optimal technology. By reducing the ability of our public servants to work productively, we are compromising their ability to serve the public.

Relationship between citizen and the state

It is my simple ambition to reverse that relationship. I want to see a revolution in the way we deliver public services – so that people up and down our country feel that government is at their service, at every single stage in the journey and at every single moment of every interaction.

The public has a right to expect the same quality of service from the government as they do from private providers.

Whether it is filling in a tax return online, paying council tax, claiming Universal Credit, applying for a grant of probate, visiting a government building or applying for a driving licence, the citizen's journey must be as efficient and smooth as possible – all while maximising value for money for the taxpayer and delivering our commitment to be the most transparent government in the world.

Key areas of change

That is why I am today announcing four areas in which we will deliver the profound transformational shift that is necessary to restore faith in our democracy.

First, we will drive forward a renewed focus on digital government as the means to deliver services for the taxpayer. Today we are publishing our Government Transformation Strategy, outlining our commitment to utilise the virtues of technology to reshape government

by ensuring millions of people are able to access online the services they need, whenever they need.

As well as moving as many services online as possible, we must harness the value of open data as a means to innovate and improve the range of services available to the public and enhance the transparency of government. We will appoint a new Chief Data Officer – alongside the assembly of a Data Advisory Board – in order to best align our efforts to make the best use of data across government and drive our open data and data transformation policies.

Third, we will work to ensure that our Civil Service has an equality of representation around the United Kingdom, so that public servants have a depth of experience of the public they serve. The Cabinet Office is currently reviewing the location of government agencies and arms-length bodies, and will consider relocating them where they could generate local areas of expertise, support private sector growth and enable a fairer distribution of Civil Service expertise, especially at a senior level.

And fourth, we will deliver all of these changes – and more – while maintaining this Government's constant drive to identify and drive efficiencies in government, root out fraud and error wherever possible, and make considerable savings for the hard-working taxpayer.

Every single member of the public deserves a government that is responsive, accountable and effective – twenty-four hours a day, every day of the week.

As I hope I am able to convey to you this morning, we will deliver our commitment to transform the relationship between the citizen and the state so that the latter serves the former – not the other way round. Only by doing so will we deliver the Prime Minister's commitment to build a country that truly works for everyone. ■

This article was originally written for and appeared in The Times - <https://www.gov.uk/government/speeches/government-at-your-service-ben-gummer-op-ed>

Ben Gummer MP
Minister of the Cabinet Office

The Cabinet Office

www.gov.uk/government/organisations/cabinet-office

Managing digital transformation: The bridge to enterprise

The evolving relationship between citizens and local authorities creates challenges when managing digital transformation. Web Labs' Garry Lander explains

Managing digital transformation at a directorate level has achieved good results, with specialist legacy software providing directorate specific solutions. Some enterprise software i.e. CMS for the corporate web site, CRM for customer services, electronic forms for online data capture and GIS for mapping have all made contributions to an enterprise wide solution.

The short-term plug and play solution of putting a web front end on every directorate legacy system and providing separate web portals for say planning, payments, benefits and housing, can often result in several web portals with different branding, disjointed customer journeys, and a multitude of different log ins, where no consideration is given towards personalisation.

Digital transformation at the directorate level fails to address many age-old problems. Directorates can be left vulnerable to small pockets of expertise leading to challenging continuity issues. Reduction of duplicated administration tasks is essentially impossible. Cross channel communications can be complex and labour intensive. The majority of directorates require dedicated resourcing and attempts to share those resources can be challenging.

Around the clock communication

The relationship between the citizen and the local authority has changed in

the light of technology and social changes. The customer now expects to communicate with their local authority via multiple channels 24/7 as they would with any other organisation. In addition, they expect a high level of service and personalisation whether they are communicating via telephone, web site, social media, or in person.

All Portals require a degree of administration, much of the administration function is replicated from one directorate to another but when dealing with legacy and disparate platforms, reducing replicated functionality can be daunting. Attempting cross channel fertilisation can lead to an almost bewildering and quite often costly reliance on API/connector development.

A philosophy for change

Digital transformation at directorate level can only take an organisation so far where more and more resource has to be allocated for increasingly incremental returns, (the law of diminishing returns).

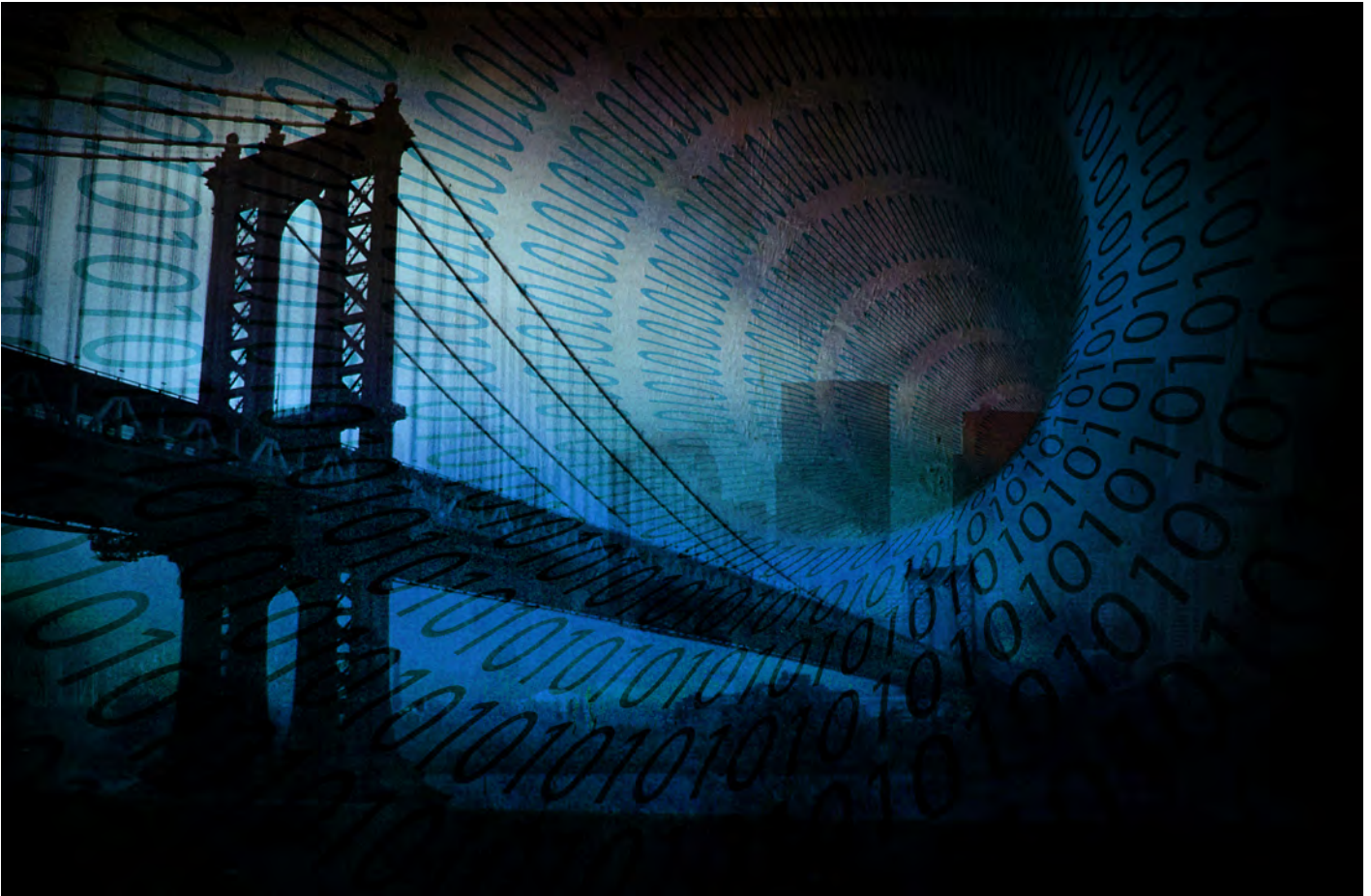
In today's customer service society this is just not good enough and can only make peripheral contributions towards a cohesive, enterprise wide, digital by default strategy that can be planned and implemented over the next half a decade, leading to single sign on, one citizen portal/website, as well as a reduction in cost of administration and improved and personalised customer centric service.

At director level a portal or directorate management philosophy has to be replaced with an enterprise management philosophy, a utopian view of enterprise management would be 2020 vision across all directorates, shared administration and resources, straight through to the processing of citizen, authority, and contractor communications.

Controlled access to all portals from a single point and shared administration across all directorates. When enterprise vision has become enterprise reality then development can start to focus on break out developments and multi enterprise or cross enterprise solutions such as health and social care, local government and local SME relationships. Budgets that were previously employed for incremental improvements in directorate performance can now be re-allocated to multi-enterprise programmes and potentially initiatives that add value.

The London Borough of Southwark

The London Borough of Southwark has come a long way over the recent years, replacing brochure web sites with fully transactional and responsive web portals. Unnecessary administration effort between the client and the back office legacy systems and all of re-keying of data between systems is being replaced by utilising an integration engine within the Web Labs Digital Transformation Platform (The Bridge).



The London Borough of Southwark now has 175,000 registered users, who signed up out of a potential population of 288,000, as well as new registrations that are accruing at a rate of 3,000 per month. There are 80,000 online Revs and Bens transactions per year and landlords licensing revenue has seen revenue increases of £110,000 in the first 6 months.

The success of the LB Southwark citizens portal has led to an approach by the NHS (Southwark Clinical Commissioning Group) to incorporate their online services into the MySouthwark portal so that citizens, besides locating NHS services and accessing health advice will be able to register with a GP, book and manage their appointments via the local government portal.

At Southwark much of the directorate thinking and planning has been replaced with an enterprise solution

approach which utilises re-usable code, shared administration and a dramatic reduction of task replication.

“The Bridge is a unique development tool that has allowed LB Southwark to accelerate Digital by Design Initiatives in a structured and economically viable progression. The Bridge enables non IT personnel to perform and manage cross directorate tasks and functions without compromising either the integrity or security of the directorates” *Dave Dixon, Service Improvement Manager LB Southwark.*

Web-Labs “The Bridge” is an enterprise hub and is a complete “development environment” where one intuitive GUI user interface integrates CMS, EDRMS, e-Forms, e-Democracy and customer self-service systems under one umbrella. The Bridge’s powerful integration engine simplifies connectivity to back office and legacy systems

enabling a single portal into council’s online services and information which is tailored around residents, businesses, and service user’s specific needs and requirements.



Garry Lander

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How can your organisation meet the transformation agenda?

Sungard Availability Services provides technical knowhow and support to meet the transformation agenda and help organisations achieve their cloud ambitions

In publishing its [transformation agenda](#), the government has boldly and publicly committed to change the way it does business to “deliver public services effectively and at speed”, in response to people’s expectations.

While noting “the UK government is one of the most digitally advanced in the world”, Ben Gummer MP, Minister for the Cabinet Office and Paymaster General, who is spearheading the transformation programme admits that, “government has been slow to use the transformative potential of digital technology to change the way it does business.”

The strategy document outlines how government intends to change that through a sweeping programme of digital transformation, which it explains is, “in essence a change of working, of culture and of disposition – changes that are made possible by digital technology. That technology is not change itself; it enables the change that is so transformative.”

Finding they lack the resources or specialist expertise in-house, some central government departments and local authorities are turning to [Sungard Availability Services](#), (Sungard AS) a leading provider of custom production and recovery IT services, to help them meet the technology aspect of this transformation challenge. Sungard AS partners with government departments,



local authorities, housing associations and other public sector organisations to successfully transform the IT infrastructure on which their public services depend.

IT transformation in practice

Local authorities are starting to reap the benefits of switching to a more flexible, agile and resilient IT infrastructure, and embarking on digital transformation programmes towards the end of their outsourcing or managed IT services contracts. One forward-thinking local authority saw it as an opportunity to grasp the flexibility

and cost-savings achievable through exploiting cloud technologies across the entire IT operation. Providing vital services to the borough’s 400,000 citizens, this council relies heavily on its IT infrastructure and therefore needed a seamless transition, with no degradation of services.

The council turned to Sungard AS to guide it through a phased transformation programme with aggressive timescales. With many streams of activity, the complex programme to transition the council’s solutions into the Microsoft Azure cloud was com-

pleted, with some legacy systems hosted in a secure, resilient environment. The migration was successfully executed on time, within budget and so seamlessly that many council employees and supporting agencies were unaware it had even taken place.

The council is now benefiting from highly available and secure infrastructure – many environments with SLA-backed levels of uptime – considerably lower IT running costs and greatly enhanced IT flexibility and scalability. This is in addition to more predictable IT infrastructure spend as costs have moved from the CapEx to OpEx budget, and greater cost-effectiveness as the council pays only for services used.

Control without the headaches

Sungard AS works many central government departments, supporting them to achieve 'cloud first' ambitions with tailored, government-approved secure cloud services.

One such department needed a cloud partner it could depend on to host 4 important applications and provide a disaster recovery service to minimise downtime. It contracts Secure Government Cloud Services from Sungard AS via the digital marketplace. Under G-Cloud contracts, Sungard AS provide enterprise class, multi-tenancy, scalable IT infrastructure from a secure hosted environment, resiliently connected.

Departments retain control over their all-important applications without the burden of owning and managing underlying infrastructure. Although this comes with the assurance of 99.99% uptime, many departments also contract additional cloud-based

recovery to cover their hardware and operating system.

In this age of high profile cyberattacks and platform outages, keeping data secure and IT infrastructure up-and-running has never been more important. OFFICIAL data is hosted within 2 UK-based data centres, supported around-the-clock by a dedicated, security-cleared operations team. In addition, solutions need to scale up quickly and easily according to demand.

Whatever the IT environment, Sungard AS works with it

In a very short period of time, cloud adoption has moved from experimentation to mainstream production workloads. But, as many organisations have found, migrating applications to a cloud environment is not easy, contrary to the hype. To start with, one size does not fit all. The needs of the applications are what determine the right infrastructure and cloud choices and, consequently, some 85%¹ of organisations are adopting a 'multi-cloud strategy' – choosing different clouds for different applications.

However, some legacy systems are not suitable for cloud so Sungard AS works with whatever infrastructure the organisation has, including the most complex Hybrid IT environments. Hybrid IT is a reality for most with almost 3 out of 4 organisations forced to rely on legacy systems that are not suitable for cloud, adding to the complexity of their IT environment.

Rapid technological advances married with the history of procurement strategies across the public sector has resulted in a mix of legacy hardware,

complex data inter-dependencies and contract restrictions. Consequently, many public sector clients value Sungard AS' comprehensive consultancy support to avoid making costly mistakes.

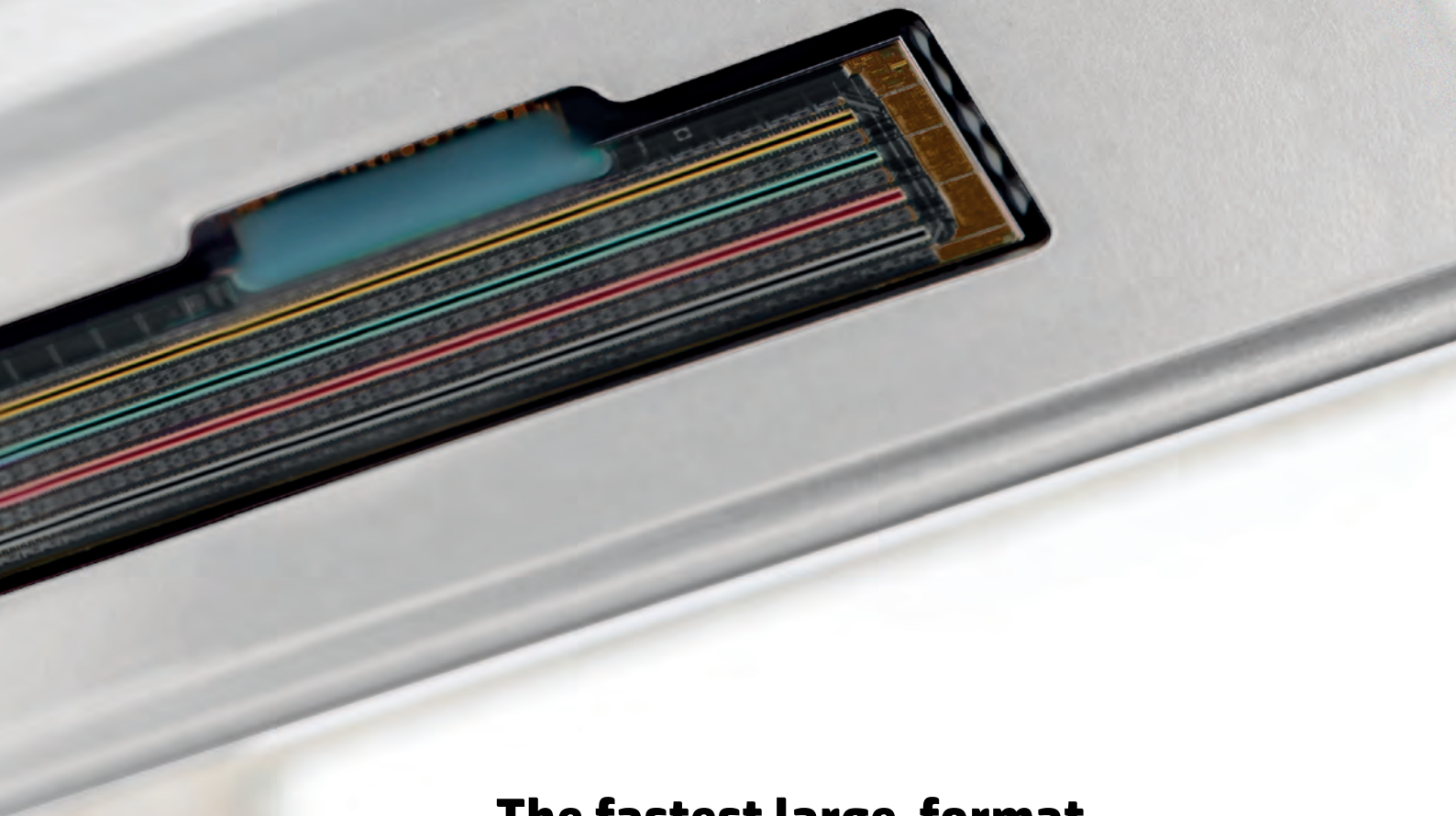
This starts with listening to their business requirements. We then work with the department or council concerned to identify which applications are cloud-ready, which are best served in a physical environment and build a plan to migrate. We then help architect and manage the right environment for the all-important applications and even provide the resources – skilled subject matter experts – to deliver the technology transformation as part of the delivery team, thus avoiding the potential pitfalls that many of these programmes experience.

Let us know if you would like more information about how Sungard AS can help you meet the transformation agenda.

1 IDC FutureScape: Worldwide IT Industry Predictions 2017



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1. Fastest based on internal HP testing and methodology compared to alternatives for large-format printing of technical documents, GIS maps, and point-of-sale (POS) posters under \$200,000 USD as of March, 2015. Production costs savings based on comparison to a setup consisting of one monochrome LED printer and one colour production printer, both under \$150,000 USD, as of April, 2015. Production costs consist of supplies and service costs, printer energy costs, and operator costs. For testing criteria, see www.hp.com/go/pagewidexlclaims.
2. With a maximum linear speed of 23 meters/minute (75 feet/minute), the HP PageWide XL 8000 Printer is 60% faster than the KIP 9900 printer which, at 14 meters/minute (47 feet/minute), is the fastest rated LED printer as of March, 2015.
3. Using HP SmartStream software compared with using equivalent software programs. For testing criteria, see www.hp.com/go/pagewidexlclaims.

Meeting the Printing needs of the AEC Industry

How new technology enables the production of high-quality prints more efficiently and cost-effectively



Thomas Valjak, EMEA Head of Large Format Printing HP Inc in the Graphics Experience Center in Barcelona, Spain

Repro houses play a critical role in reproducing high-quality technical drawings and other documents for AEC customers. This includes architectural and engineering blueprints and renderings, and folded and finished bid sets containing all the drawings and construction sets needed to complete a project.

Although traditionally a high number of AEC technical documents are produced in black and white, coloured prints are increasingly becoming a pre-requisite. The move into colour can be attributed to the belief that it improves communication, readiness and indirectly saves time and costs throughout the bid, design and construction process.

Eliminating complex workflows

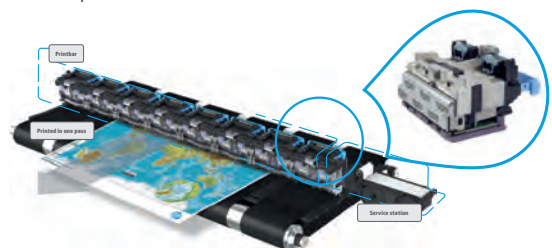
Many repro houses use an LED printer for monochrome print runs and an inkjet printer for colour. Managing both monochrome and colour printing, along with bid sets that consist of a mixture of small format and large format pages, means having to rely on a wide range of printing hardware and software. This has often led to inefficient processes, where costs are greater and workflows can contain an increase in the number of stages needed. As AEC clients face tighter project completion times, repro houses are also under increasing pressure to deliver high-quality short-run print runs with quick turn-around capabilities.

Automation is one of the key factors of a smoother and faster print process. Technology including end-to-end workflow software, combined with peripherals such as on-line folders, makes print management more efficient. Additionally, automatic detection and correction of corrupted PDFs, automatic selection of small and large format pages and on-screen soft-proofing can all help reduce job preparation time by up to 50 per cent. This frees up time to take on more jobs. Easy-to-use workflow software like HP SmartStream can also make a repro house better able to weather workforce turn-over, as it minimises the need to train new workers in complex operations.

When speed matters

Streamlining workflows is one way to speed up turn-around times but increasing the speed of printers is also critical. In 2015 HP was bringing the record-breaking speed of HP's PageWide Technology to large-format printing. HP PageWide Technology uses tens of thousands of tiny nozzles on a stationary print bar rather than a scanning print-head. This results in print speeds of up to 30 A1 pages/minute. Instead of using two separate devices, one printer can be installed for both monochrome and colour, and colour prints can be produced at the same cost as black-and-white. In addition, new graphic applications such as retail temporary posters and maps can be added to the offering.

Based on proven HP Thermal Inkjet technology, HP PageWide print heads are designed to have a long life. The reliable drop ejection process reduces print quality defects from 'nozzle outs'. Automated print head servicing and calibration, including nozzle compensation, ensure consistent operation and minimal service intervention.



HP 841 PageWide XL Printhead module

Costs under control

For print service providers looking to meet the demands of AEC clients, gone are the days of the LED and inkjet printer sitting side-by-side. Both colour and black & white printing will be able to be produced at much lower costs than ever before. This will make it easier to meet clients' increasingly high expectations whilst having a much needed positive effect on the bottom line.

Additional information under hp.com/go/pagewidexl

Governments must adopt an agile mind-set towards security

Fen Labalme and Robert L. Read of Agile Government Leadership, explain the role of an agile security process in highlighting and preventing security risks

Just as agile software development rapidly iterates on evolving user stories, agile security must rapidly iterate on an evolving threat environment as technology plays an increasingly important role in society. In order to protect against ever-changing vulnerabilities, we must rethink how we approach securing complex government systems.

Existing regulations, such as the Federal Information Security Management Act (FISMA), represent a static approach to security, requiring voluminous documentation of systems to achieve an official Authority to Operate (ATO) but having no real-time monitoring or verification that the system matches the documentation. This is the antithesis of an agile process, providing no incentive for continuous improvement.

Fortunately, government is working to improve this ineffective approach with the recent mandate for Continuous Diagnostics and Monitoring (CDM) by the Department of Homeland Security. CDM is an attempt to identify risks on an ongoing basis, but it doesn't solve all security challenges for government (and in some ways, it adds new ones).

Ultimately, agencies themselves must adopt a more agile cultural mind-set when it comes to security. As agencies work to implement CDM requirements, they can also work to pivot away from slow-moving, risk-averse attitudes and embrace more agile, effective security. Here are some ways to start:

Have the courage to iterate

While CDM will enable better real-time review of systems and faster response to threats, agencies must start thinking beyond temporary fixes and demonstrate agility by iterating to new systems more frequently. Government tends to cling to old systems that have

been deemed “secure”, applying security patches and nauseum instead of updating to new systems. This makes it difficult for innovative vendors (who are using the latest versions of everything) to safely provide beautiful solutions that work.

Agencies must understand that rapid iteration and fast response to problems is LESS risky than using an old system that was once deemed “secure” after a battery of tests, but is now 7 years out of date. Instead of fearing new systems, governments should embrace updates with an agile mind-set, realising that newer technology provides a more stable foundation that is far more secure (even with bugs) than an old system that is full of holes and patches.

Keep metrics flexible and responsive

One of the goals of CDM is to track metrics and standards of agency IT security (strong passwords, up-to-date patches, etc). But agility is lost when documentation of metrics takes priority over new learnings. For example, two-factor authentication might be shown to be more effective than a strong password, but agencies and vendors are still forced to comply with requirements based on outdated information.

Government should be open to changes in the way security is measured, just as an agile process demands changes in project direction when a better path is discovered. Adhering to outdated metrics because they are in the documentation is like traveling an old, rutty road even when a clear path is within sight, simply because the old road is the only one shown on your map.

Learn from failure

In an agile development process, there is intense focus on what can be learned from the customer or users. An agile security process applies that same intensity of



focus to what can be learned from adversaries. Agencies should continually retrospect on any failings in security – not just applying patches, but embracing innovative ways to avoid the problem in the future. Being agile means having the courage to diverge from the status quo in an effort to achieve the highest performance possible.

Embrace open source

Agile technologists and vendors in the open source community are eager to provide solutions to government, but are hindered by the fact that the CDM requirements are behind closed source code. If the Department of Homeland Security would publish the APIs and data formats required for collecting and transmitting the required metrics, agencies could more easily benefit from the collective knowledge of open source innovators, gaining access to solutions that reflect the most recent learnings.

Security is never “done”

Agencies shouldn’t ask “Are our systems secure?” Security is not a destination to be reached or a project to be checked off a list. Rather, agencies should ask “How

have we recently improved our security?” That is an agile question that will prompt a re-examination of static approaches and lead agencies on a journey of continuous improvement towards better, faster security. ■

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Robert L. Read, PhD Presidential Innovation Fellow Founder, Public Invention

Agile Government Leadership
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Reaping the full rewards of Agile in government

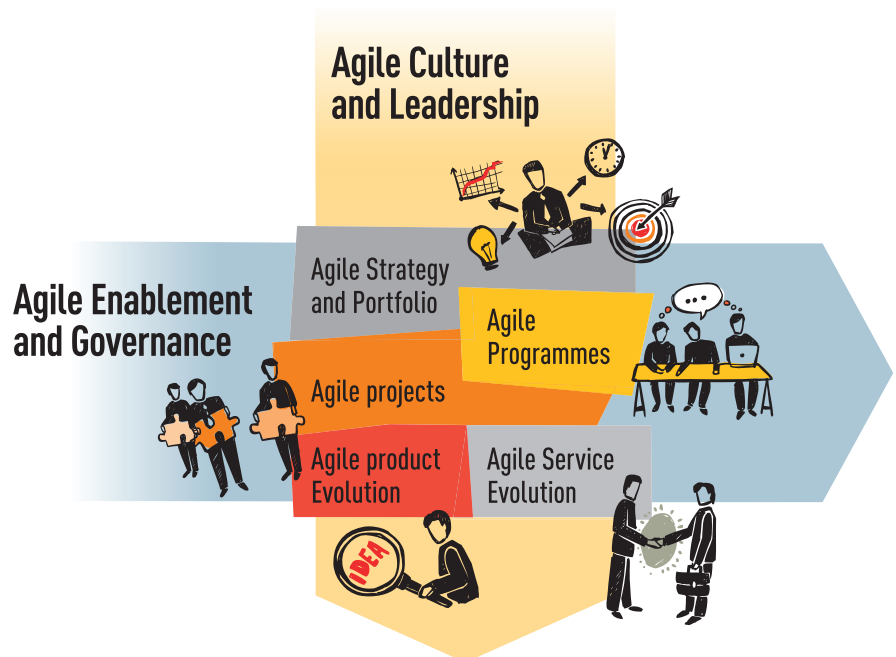
Agile Business Consortium's Geof Ellingham outlines the benefits of Agile methods in digital service development and how it can help public services

The UK is recognised as a world leader in digital government, topping the UN E-Government Survey index for both development and e-participation¹. This has been led by the UK's Government Digital Service (GDS) with its tenacious focus on user needs, common design principles, and openness, balancing the needs of citizens and government, as well as Agility.

In the UK, unlike almost anywhere else in the world, government appears to be ahead of the private sector in the adoption of Agile methods in service development. Agile is mandated by GDS for central government digital services, and both the National Health Service and local government are developing their own related digital standards with Agile at their heart.

Despite this, government is struggling to adapt the way it leads and manages change to get the most out of the speed and flexibility that Agile promises. As Daniel Thornton from the Institute of Government observed earlier this year, "Agile development involves decision-making which is swift, and as close to the user as possible. This is not how decisions are made in government, with its overlapping layers of control from the centre and within departments and agencies. Public servants need to learn the specialist skills to do this..."

Agile Business Consortium, a global not-for-profit organisation which provides advice, guidance and training to



Agile practitioners working in all sectors, believes it's time for the wider Agile community to step up the cross-sector Agile learning, to the benefit of both government and the private sector.

What is Agile service development?

Agile is built on simple principles which were radical when they first emerged 20 years ago, and still remain relevant today. Yet they are challenging to put into practice in large, complex and hierarchical organisations like government departments. These ideas are articulated in many different lists – here's a short one:

Agile is collaborative – we have users, technologists, front-line staff and managers working together, often in the same room, throughout the design and delivery of a new service.

Agile is flexible – we know that requirements will change throughout a project, and welcome the improved understanding of user needs that this change represents... we don't hate "scope creep" but embrace change and aim to make decisions quickly and as close to the problem as possible.

Agile is about people, not technology or other "stuff" – we focus on what users and businesses need, and how the people who deliver services can meet those needs – sometimes, but not always, with the help of technology.

Agile is transparent – we prefer showing models, prototypes and the actual product, rather than producing reports, spreadsheets and presentations. We also prefer sharing our challenges to hiding them.

What special challenges does Agile face within government?

Agile's first big success in government was the creation of the very first version of GOV.UK (the single website for all central government services), which was built in an Agile way by a small team in a mere 10 weeks.

Although this was a huge achievement, this was a very different challenge to the one facing e-government. In some ways, it was more like a modern tech start-up company – flat, lean, co-located and flexible.

The challenge with scaling Agile to work across government is that the environment is the opposite of a start-up. The need for ministerial accountability to the public tends to create a risk-averse atmosphere in which decisions are made far away from (and sometime after) the problems to which they are responding. This creates a disconnection between the rapid design and evolution of a service, and the decision-making hierarchy, exacerbated by the fact that many of the technical staff are IT contractors, not full-time civil servants.

In response to the special complexity of government, GDS has created the GOV.UK Service Standard and Supporting Service Manual, which defines a development lifecycle for digital services (Discovery-Alpha-Beta-Live) and provides a set of design standards and a host of supporting guidance. This has produced some excellent results in the design of citizen facing services (e.g. Tax your Vehicle). However, there is often the need to deliver more complex and far-reaching changes through projects and programmes, and this is where challenges emerge. There is currently no Agile method which effectively addresses the Agile develop-

ment of Digital Services within a project or programme structure.

For this reason, the Agile Business Consortium have been developing a new version of their widely recognised Agile Project Management (AgilePM®) framework and qualification, which is specifically targeted at digital service development. This has been developed taking into account the needs of many other organisations such as the NHS, local government and private sector organisations who are also looking to develop new and improved digital services.

This will enable any organisation to develop a consistent approach, a common language and a skilled workforce (with appropriate accreditation opportunities) for the successful design and delivery of digital services whether through evolving improvements or step-change transformation.

Agile Business Consortium has adapted the AgilePM qualification to explain how the concepts can be easily aligned to the GDS lifecycle and roles, to provide a flexible governance structure to use alongside Scrum, Kanban or any other IT development methodology. The new course, AgilePM and Digital Services, will also cover some of the distinctive elements that GDS has injected into Agile discourse, such as citizen over government and assisted digital and it will also include the tried and tested concepts of alpha, private beta and public beta within the project lifecycle.

How are we doing this and when will it be available?

The course is in alpha at the moment (meaning we're trialling a prototype with real people to see how it works), and we'll be sharing those experiences and launching our public beta programme in

May 2017. If you'd like to participate in the public beta programme and get early access to the new course, please email the Agile Business Consortium info@agilebusiness.org.

Founded in 1995 as the DSDM Consortium, the Agile Business Consortium is a not-for-profit membership organisation that aims to provide global leadership in promoting, supporting and enabling the adoption of Agile at all levels.

It focuses on enabling effective business change and transformation, and in particular on improving culture, structure and leadership to deliver strategic goals.

The Agile Business Consortium offers advice, guidance and accredited products and services across a wide range of industries, government organisations and charities through an international network of Agile practitioners and partners.

¹ <https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2016>

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What are the prospects for public sector ICT suppliers in 2017?

Rob Anderson, analyst in the public sector team at GlobalData, predicts a buoyant market for public sector ICT this year and in the longer term...

In a post-referendum, pre-Brexit world of economic uncertainty, what are the prospects for public sector suppliers in 2017? Theresa May and Phillip Hammond may have signalled the end of the era labelled 'austerity', but the country's budget deficit is still a millstone. Although control of public finances will be kept under tight rein, there is definite scope for optimism.

The Cabinet Office, through its [Crown Commercial Service \(CCS\)](#) and [Government Digital Service \(GDS\)](#) arms, has recently reiterated its intent to expand its business with SMEs, but has also indicated it is open to new propositions from suppliers of all shapes and sizes. In local government and other areas of public service delivery, transformation remains a vital, if thorny, issue.

In addition to transformation, cloud platforms and data exploitation will be priorities. These may seem familiar to established observers of public sector ICT, but there are definite indications that the next year will see a confluence of these three strands that accelerates real adoption, resulting in a buoyant market.

A new way of thinking for public bodies

True transformation involves consideration of technology, processes and people – the latter necessitating culture change. What has passed for digital transformation to date has mostly been a neater user interface and digitisation of forms. To effect the required step change in efficient service delivery, public bodies must genuinely invert their thinking in redesigning end-to-end processes to reflect a citizen's needs using techniques such as customer journey mapping and robotic process automation. It's taken some time to pervade, but the message on Liam Maxwell's iPhone case exclaiming "What is the user need?" is finally coming of age, evidenced by a proliferation of job openings such as Business Management

Analyst, Head of User Research, Business Change Strategy Lead, and UX Designer.

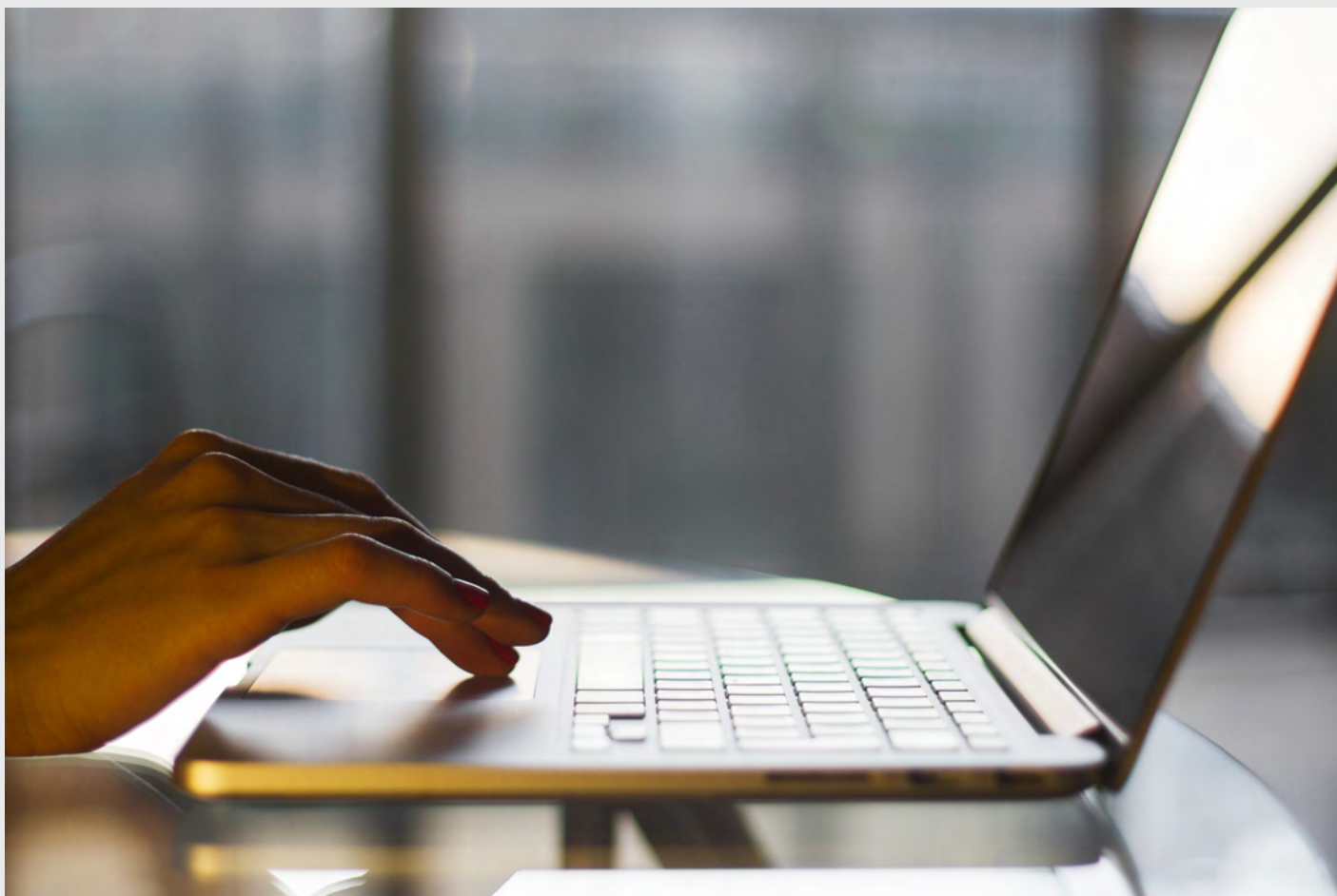
Cloud computing is now an inevitable by-product of transformation as the availability of lower cost standards-based (open or de facto) platforms and superfast broadband tips the balance against the continuation of multiple iterations of on premise infrastructure. [G-Cloud](#) has been much vaunted as the key driver in the move to the cloud, and will continue to evolve, with contract lengths likely to be extended to the delight of customers and suppliers alike.

2017 will bring greater acceleration of cloud usage due to the arrival of UK data centres from three giants of technology: Microsoft, Google and Amazon Web Services. Data sovereignty has been an oft-quoted though much-abused barrier to cloud service uptake which will disappear at a stroke. With partner ecosystems for all three delivering a plethora of as-a-service solutions to meet all manner of application requirements, the last vestiges of all-encompassing IT outsourcing arrangements will tumble as they reach their contract end dates.

The third area offering hope to IT providers is data exploitation. The government remains committed to delivering open data sets that facilitate re-use and innovation in public service delivery.

Aggregated data opportunities

Undoubtedly it faces challenges in getting necessary data sharing legislation passed by Parliament, though this is in no small part due to a lack of clarity in categorising different types of data. Of course there will be a public backlash against citizens' personal data being openly shared and consequently put at risk of misuse. But the unfettered availability of operational data, performance data and aggregated anonymised



data on individuals offers tremendous opportunities for more timely service delivery, more and better connected services, reduced losses due to fraud and error, and ultimately a much improved user experience.

“Cloud computing is now an inevitable by-product of transformation as the availability of lower cost standards-based (open or de facto) platforms and superfast broadband tips the balance against the continuation of multiple iterations of on premise infrastructure.”

In terms of routes to market, CCS continues to strive to corral departments, agencies and authorities from all parts of the public sector to use its services and frameworks, and a healthy pipeline of market-centric frameworks is being built. Brexit will almost certainly have no immediate impact on procurement regulations, and is unlikely to over the longer term either, given the UK's position in driving such legislation. So, the rules of the game remain the same. Yet there is no substitute for good old-fashioned selling: Getting to know your customer – either directly or through part-

ners – and building a relationship that delivers value and addresses their individual needs.

Opportunities abound for those organisations that clearly understand the public service market, its challenges and drivers, and can deliver agile dynamic and innovative solutions which satisfy the key needs. Furthermore, the skills gap in the public sector is well documented. Supporting clients with knowledgeable, well-trained staff pays dividends. Investments in relationships will always trump investments in products. ■

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Critical communications and the Internet of Things

Nigel Hawkins, Managing Director EMEA, Everbridge highlights how critical communications can utilise technology developed in the Internet of Things sector

The Internet of Things (IoT) is one of the fastest growing and highest profile trends in technology. According to Juniper Research, by 2020 there will be 38 billion IoT devices in the world. IoT is often considered from a consumer standpoint – think smart thermostats and fridges. However, governments can significantly benefit from IoT compatible critical communications.

The power of multi-modal, two-way communication

Critical communications platforms are already deployed by businesses, local authorities and national governments around the world to warn and advise people in the event of a crisis. These incidents can range from sourcing a relevantly-skilled IT technician to repairing a broken server, and engaging with the public during a terror threat.

Central to the success of critical communications platforms are 2 key functions. The first is the capability to deliver messages using a variety of different methods – this is known as multi-modal communications. No communications channel can never be 100% reliable, 100% of the time, so multi-modality transforms the speed at which people receive the message. Multi-modality facilitates communication via multiple communication devices and contact paths including email, SMS, VoIP calls, social media alerts and mobile app notifications, amongst many others.

Multi-modality ensures that it is easier to receive a message. Two-way communication makes it simpler to confirm a response. In a critical emergency every second counts, so organisations can use communications platforms to create and deliver bespoke templates that require a simple push of a button to respond. In doing so, the level of response to critical notifications can increase significantly.

What does this have to do with IoT?

Combining data from IoT devices with a critical communications platform offers a new emergency alerting platform for automated decision making and sophisticated communications. This provides businesses with the ability to add context to critical alerts, connecting the right people to physical devices, at the right time, to take the appropriate action. IoT also enables physical devices to respond to situations and act accordingly.

“A leading coffee shop brand uses a critical communications platform to manage brand reputation and crises. The platform allows the business to send quality assurance and emergency product recall alerts directly to store POS systems so that store managers receive the alerts before opening.”

IoT – ‘things’ thinking for themselves

The most effective way to take action during a critical event is often not people communicating with other people. An increasing number of devices connected to the internet rely on embedded intelligence to communicate critical information. These devices not only provide constant monitoring services, but have the ability to apply real time control as needed. In many cases, these automated, intelligent devices can respond faster than a human.

The power of human interaction remains

Automated device to device communication is powerful, however, the need for human interaction does not disappear. For crises that require the involvement of government, engineers or emergency services, IoT can speed up the delivery of critical information and ensure a timely response.

As IoT systems become increasingly intelligent and automated, the need for expert human intervention



becomes more important. Firstly, as machines get smarter the decisions people need to make get harder. Secondly, in an automated environment, decisions can fuel chain reactions of unintended consequences. These require human interaction to ensure hysteria does not occur.

IoT crisis management in the real world

A state government operated dam may have sensors placed inside the stone & metal walls to automatically alert engineers and local authorities if water levels rise too high, tailoring the communications based on severity level and the roles and responsibilities of appropriate workers.

In the medical industry, pacemakers can be fitted with sensors that relay information to a team of doctors and notify them via email, text and/or phone if anything requiring their attention arises. They can also send messages to the patient to let them know if they are exerting too much energy and should rest. This protects the individual but also manages the increasing pressure on A&E departments. By pre-empting severe changes in heart palpitations, the patient can be treated before their condition worsens and they need to visit the hospital.

A leading coffee shop brand uses a critical communications platform to manage brand reputation and crises. The platform allows the business to send quality assurance and emergency product recall alerts directly

to store POS systems so that store managers receive the alerts before opening.

Critical communications technology is widely used in the US. Eight of the 10 largest cities use Everbridge, the critical event communications platform, to communicate with citizens if an emergency arises. For example, the State of Florida used the platform to manage public safety in Hurricane Matthew. As residents were forced to evacuate their homes and counter unprecedented rainfall, wind, power outages, road closures and other incidents, The State of Florida encouraged citizens to sign up for evacuation instructions and critical information sent via the platform.

“According to Juniper Research, by 2020 there will be 38 billion IoT devices in the world. IoT is often considered from a consumer standpoint – think smart thermostats and fridges. However, governments can significantly benefit from IoT compatible critical communications.”

The States of Guernsey is the first UK roll out of direct government to citizen mass notification. It uses the Everbridge communications platform to co-ordinate its emergency response teams and enables residents to sign up to various communication threads such as fire-work display information for dog owners.

With today's unpredictable terror landscape, it is more important than ever that the UK Government considers the benefits of mass notification and the opportunities crisis communications platforms can provide when they are IoT compatible. No government or organisation can effectively prepare for every eventuality, so the ability to quickly and effectively communicate with key stakeholders in any circumstance is essential in effective crisis responses. ■

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Taking advantage of container technology

Joe Kim, SVP and Global CTO at SolarWinds says government organisations can improve efficiency, optimisation and security by using container technology

Container technology has been discussed with excitement for quite some time. More and more enterprises are seeking to familiarise themselves with a burgeoning IT trend that promises so much, supposedly offering improved efficiency, optimisation, and security.

Such benefits should also be music to the ears of the government IT professional, especially as networks grow. A lack of clarity over what container technology actually is and does is inhibiting its adoption. However, there are signs that the public sector is set to embrace container-based technology. For example, the UK [Government Digital Service](#) is turning to containers to develop Gov.UK Pay.

In this article, we will take a closer look at container technology and explore how your government organisation could make the most of its potential, ensuring that when the time is right, you'll be ready to reap the benefits.

What are containers?

"Container" seems like an improbably vague term for an IT solution, though it is actually an accurate description of what it does: it keeps a piece of software in a complete file system that contains everything needed to ensure the software always runs the same, regardless of the environment. Essentially, it keeps everything within a container, undisturbed by outside influence. This containerisation of a "whole system" could be for a specific application and infrastructure service or the entire application.

As an example, let's imagine you're building an application to support online transactions. Users will log in, click on the item they so desire, and then go through the familiar checkout process before finishing the transaction.

What containers will allow you to do for such an application is to ensure that, if any one of these different sections fail, the application does not. By isolating each service into "microservices" across different containers, you can be comfortable in the knowledge that the application won't be disrupted. Instead, if there is a failure of a container or the system running it, the services will simply revert to alternative systems, where the job will be completed.

Legacy technology, on the other hand, would see this as a tiered application, with a failure in one of these tiers resulting in a degraded application or worse, downtime.

By separating each section into its own package, a container is more reliable and safe. This approach ensures each container is responsible for its own unique task. You've heard the phrase "jack of all trades, master of none"? Well, containers ensure that each task is carried out by a master of one, rather than a jack of all.

Reasons to adopt

Now, given the example I provided is more suited to the enterprise IT pro, you may be wondering how your government organisation could benefit from containers' functionality. Look closer, however, and their attributes prove to be a wonderful fit for the public sector.

First, containers are lightweight, with their individual nature meaning that they focus solely on one task, using very few resources. Coupled with the fact that they are based on open source technology, this means they can be run anywhere, regardless of the environment, offering government IT pros a low-maintenance solution that's cost effective and easy to set up.

Also, their individuality makes containers more secure. Due to containers being isolated from other tasks and



processes, they can remain untouched by outside influences and, as a result, are more secure than non-containerised solutions.

Indeed, the majority of benefits that containers represent are due to their small size and stand-alone nature. For these reasons, they are extremely scalable, using a minimal amount of memory or disk resources, while their flexibility enables you to scale across distributed providers.

Getting started

So, how do you get started? As much as we'd like to think this article provides a one-stop shop for all your container needs, the reality is that some due diligence is required before jumping in with both feet. Due to the fact that containers are open source, it's very easy to access an enormous amount of information on how they work, and how you can reap these benefits for your own government agency.

Once you've educated yourself and understand what you're looking for, resources should be set aside to train government IT pros in the intricacies of containers and

"microservices." While they are simple to use in theory, overconfidence can be the downfall of IT pros, who should familiarise themselves with these services and understand where to best implement them to improve efficiency.

Essentially, you need to prepare for containers' arrival. By educating yourself and the rest of the government agency's IT team, you can be sure that when containers do arrive, you're not wasting time figuring out how to apply them to your own environment. Instead, you can begin devising a strategy to make the most of what could be an extraordinarily useful addition to your organisation. ■

Joe Kim
SVP and Global CTO

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Rapid response: Using mobile technology to tackle disasters

Jessica Gibson, Project Manager, West Yorkshire for Innovation at West Yorkshire Police shares how mobile technology can help services during an emergency

When disaster strikes, time is of the essence. Whether it is a terrorist attack or a natural disaster, the emergency services must be able to respond quickly and effectively. To do this, they need detailed insight into a situation as it develops, as well as the ability to coordinate their response with the general public.

Faced with limited resources and personnel, it's a challenge for the emergency services to be first-on-the-scene when a disaster strikes. Traditionally, it has fallen to the public to notify the emergency services and to provide the first-hand intelligence needed to coordinate an effective response.

In the UK, this has traditionally taken the form of citizens phoning 999 and relaying as much as they can to an operator. This operator then keys the intelligence into a computerised incident response system that feeds the data to the relevant service (police, fire, ambulance, mountain rescue etc.), before instructing the caller on what to do next. While this system has proved its worth down the years, the process is labour-intensive and the utility of the information provided depends upon the witness' ability to recall details.

Fortunately, in today's always-connected, app-powered age a civilian with a smartphone can open a two-way channel between the public and the authorities and



Image: © Flynt | Dreamstime.com

offer a plethora of data to be used in the event of a crisis. However, two important barriers remain: how are emergency services going to access this information and, how can they turn the weight of available data into coherent and actionable insight?

Protection through collaboration

In [Project ATHENA](#), West Yorkshire Police, SAS and other partners have developed a mobile app and control platform. It allows emergency services to collaborate with the public to gain insight into developing crises. Using the app, citizens alert emergency services to ongoing incidents and provide invaluable information by submitting written reports, video recordings and pictures from the convenience of their phones. Equipped with this insight, the police distribute advice en masse to those in jeopardy by sending targeted warnings to app users in the vicinity, coordinating public and police activity for a better response.

The advantages of the mobile platform are clear. Compared to relayed information communicated over the phone by an operator, the app facilitates a direct and instantaneous dialogue. Video footage and photography, unlike details that have to be remembered and then clearly explained, is similarly unaffected by time or the memory of the civilian, providing instant and accurate information. If appropriate, police can even

ask citizens to report any sightings of suspects or vulnerable people – engaging in a productive two-way dialogue with the public to foster closer collaboration.

However, beneath any successful mobile app such as this resides a strong core of data analytics. In the ATHENA app, submitted reports and recordings are automatically analysed by SAS Text Miner to determine the urgency and severity of the situation. The SAS Information Retrieval Studio then allows the police to scan massive amounts of social media data for more insight into the situation. As new reports flow in after the initial crisis, SAS Content

Categorisation detects whether the information concerns a new or existing crisis before categorising it. These processes speed-up and automate what would otherwise be a series of laborious tasks for personnel, and buy precious time to formulate strategy and save lives.

Rapid response

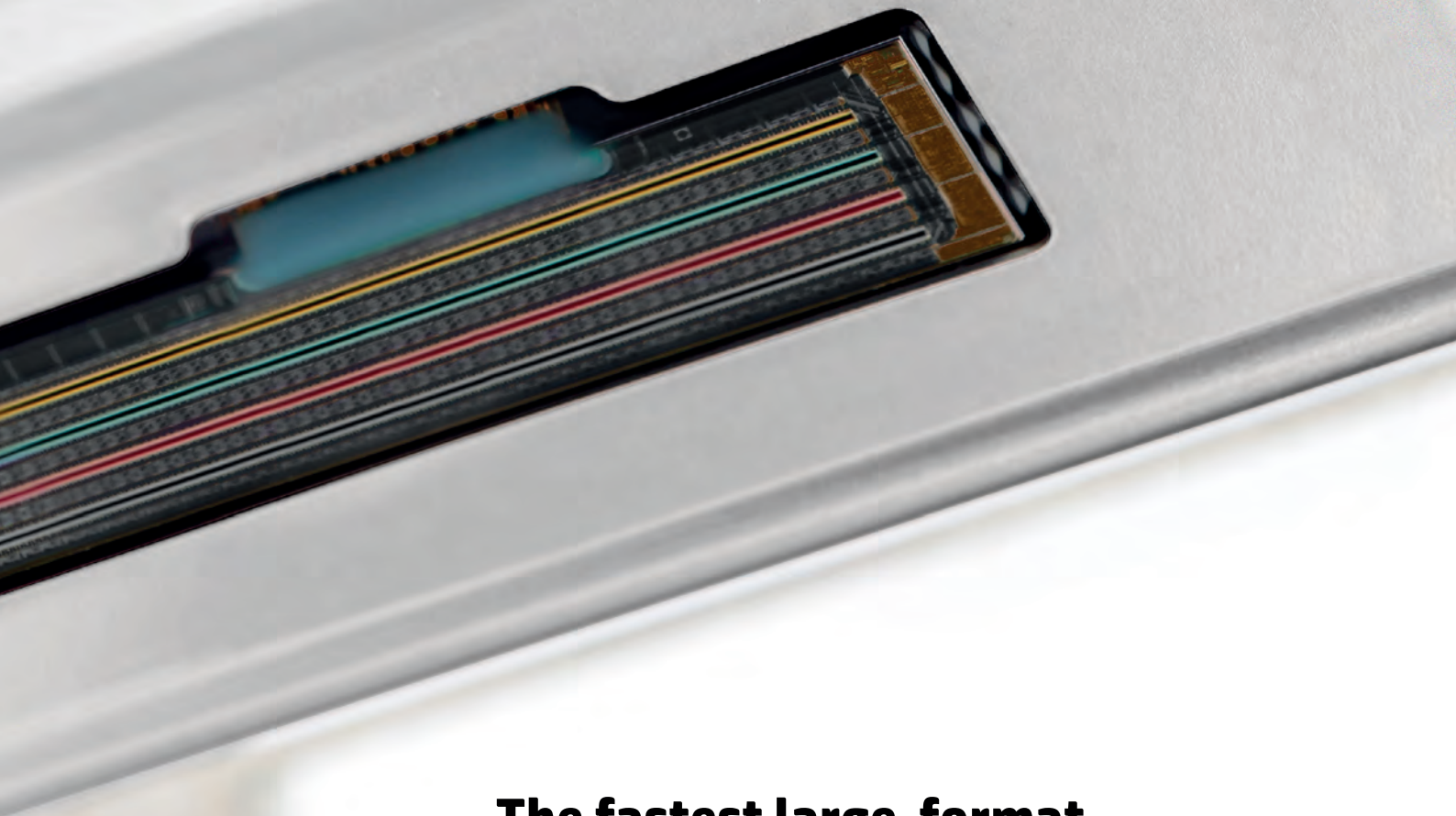
Though still in their infancy, prototype solutions such as ATHENA could radically improve disaster response and the quality of collaboration between the authorities and public. Using smartphone technology and data analytics, these applications can lay the foundations for superior intelligence gathering and response synchronisation. Most importantly, this approach saves time and could be the difference between life and death. ■

Jessica Gibson

Project Manager – West Yorkshire for Innovation

West Yorkshire Police

www.westyorkshire.police.uk



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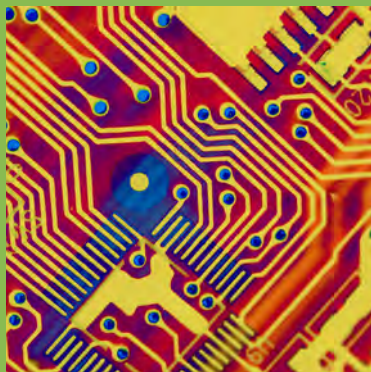
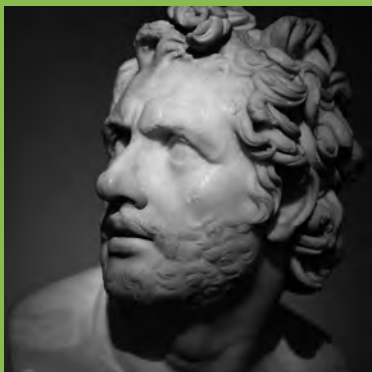
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Brexit should not impact the disaggregation of IT services

Littlefish's Dave Aspindle explains why it is important the disaggregation of IT services should continue, irrespective of the political landscape

The recent reports that Brexit will lead to government organisations rolling-over on existing IT contracts and simply renewing, is hugely disappointing as it could significantly impact the government's digital and innovation agenda.

In the last few years, the Government's Digital Strategy (GDS) has made great strides by invigorating the skills and desire of government IT organisations to enable change and do things differently.

This is apparent within the new [Government Transformation Strategy 2017 to 2020](#) policy paper:

"The imperative is to change, therefore – and to do so at pace and at scale. This is the meaning of transformation. It is in essence a change of working, of culture and of disposition – changes that are made possible by digital technology. That technology is not change itself; it enables the change that is so transformative," said the Rt Hon Ben Gummer MP, Minister for the Cabinet Office and Paymaster General.

The key here being transformation, not transition.

Now more so than ever with the advent of Brexit (and also the snap General Election), government departments should carry on regardless and continue to lead the charge on transformation. One of the key enablers to transformation is making sure your own house is in order. That means securing a solid, agile, disaggregated IT service, enabled through the supply chain with transition to new, enthusiastic, flexible, and specialist service providers.

Equally, with the well-documented skills gap in the public sector and the new IR35 legislation that impairs transformation, there is also a need for government



users of technology to continue to effectively deal with its supply chain to deliver best value whilst at the same time introducing the agility and innovation that will drive the transformation required.

A disaggregated approach

At the heart of this transition is Service Integration, and the Service Desk. The Government IT Strategy of 2012 stated that Service Integration and Management (SIAM) would help break the stranglehold the large outsourcers had on government and the wider industry. That was until Alex Holmes, the then Deputy Director and Chief of Staff in the Office to the CTO, announced in a blog in February 2015 that the [SIAM tower model](#) was no longer an acceptable approach to procurement for Whitehall departments.

But many government departments had already started with the SIAM approach and were well on the way to disaggregating the large outsourced contracts, with some success. Now, the terminology has moved on, but disaggregation, multi-sourcing and service inte-

gration remains an accepted approach, with tangible benefits to the status quo.

We are witnessing a plethora of government organisations starting to deliver the agility required to enable the transformational change mandated to them. Multi-sourcing or disaggregation achieves the combined goals of insourcing control, lowering cost and enabling change. Historic England is a recent prime exemplar of this.

“Now more so than ever with the advent of Brexit (and also the snap General Election), government departments should carry on regardless and continue to lead the charge on transformation.”

Today, there are a multitude of procurement frameworks – such as technology services (RM1058) and the Digital Marketplace – that support the disaggregated approach. Users can now procure the component services that used to make up the monolithic, inflexible, expensive, energy sapping, single-source IT service contracts. With a small hint of oversimplification, you can relocate your legacy equipment into the Crown Hosting Service, buy the managed infrastructure and application support services through Technology Services, whilst providing end user services as either two components, Service Desk and End-User-Compute or as a single service, procured again through technology services or G-Cloud. The take-on or onboarding is then simply a matter of transition, within a few weeks or at most months. ‘Quick wins’, immediate improvements, and more user-aligned services are now the norm, when it comes to transition outputs. The overall outcome is a set of building blocks that can flex and change as the digital transformation agenda gathers momentum and builds the new services from similarly procured standard components.

Service integration and the service desk remain pivotal to effective disaggregation and the government’s transition agenda here. With recent focus on a new business-led, accreditation scheme, Service Integration should be regarded as a set of common sense management practices, much as we regard PRINCE2/PMP, ITIL and ITSM.

There are many practicing organisations with real experience of delivery, and whilst the government strategy in the long-term is to insource service management and control, departments and users can procure consultancy and delivery services from the Digital Marketplace to assist and enable this journey.

Not often seen as a commodity service, the service desk can also be procured as a separate component of your IT service operation, with specialist providers offering 24/7, agile capabilities with a focus on quality and user experience in line with the transformation strategy. Transition is easy and the immediate benefit on user productivity and morale should not be underestimated. We have seen this for government customers such as the National Audit Office, Parliamentary Digital Services, The Pensions Advisory Service and Historic England.

Brexit should not stop progress

In summary, often, in uncertain times, the default response of government departments is to ‘stick with what they know’ and take the easy road. However, the current Government Transformation Strategy provides this generation with an opportunity to build upon the progress the sector has made in transforming and transitioning from large single-sourced monolithic relationships. The service desk is at the heart of this digital transformation agenda and will cushion the impact changes will have on users, whilst enabling organisations to insource key service management responsibilities with confidence.

Brexit is not an excuse for not getting the best value from your supply chain. Disaggregation or multi-sourcing is truly delivering agility, flexibility and innovation in IT service delivery – the benefits and ease, far outweigh the risk of simply rolling-over on existing IT contracts. ■

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Improving trust in computer systems using formal proofs

Dale Miller, Inria, Université Paris-Saclay, LIX, École Polytechnique, and CNRS highlights the role formal proofs can have in ensuring trust in computer systems

Computer systems are everywhere in our society and their integration with most parts of our lives is constantly increasing. This wide scale integration of computerised systems is accompanied by an increasing need to deal with their correctness in not only safety critical systems, such as those in cars, airplanes, missiles, and hospital equipment, but also general infrastructure systems such as financial databases, power grids, and telecommunication. Even in the area of consumer electronics there are growing concerns about many aspects of their correctness. For example, years ago, establishing the correctness of, say, desktop PCs, music players, and telephones was not urgent since rebooting such systems to recover from errors or bugs was mostly just a nuisance. But today, these same devices are tightly integrated into networks and, hence, must deal correctly and securely with their user's confidential information.

Security

As it is painfully clear today, connecting your computer to the internet is similar to submerging a submarine into the depth of the sea: if there is a crack in your system, it will be exploited quickly and with serious consequences. Attempting to establish some formal guarantees about software systems is no longer an academic curiosity. If we cannot provide basic guarantees of the correctness and security of our computer systems,

our future could resemble William Gibson's world in his novel *Virtual Light*, where network security was so bad that important data was transferred by bikers carrying hard-disks. In such a world, the development of all the new features and services arising from networking and sharing, and the concomitant increases in efficiency and productivity, that we all hope to see unfold would be greatly delayed.

Whilst it is possible to increase one's trust in software by employing various management techniques during the construction and maintenance of computer systems or by making use of standard, open source systems, current experience with these approaches still results in insecure software. There is, however, a growing interest in taking the extreme position of treating computer systems as mathematical structures and formally proving some correctness and security properties for them. While achieving mathematical certainty about some aspects of computer systems can go a long way to increasing trust in the correctness of such systems, obtaining formal proofs is a complex and difficult process with many moving parts, some of which must also be trusted. For example, programming languages, compilers, and machine architectures all need to have mathematical descriptions. One may need to prove properties (invariants) about the execution of any program. One needs to prove that a

compiler transforms a program in a high-level language to a block of machine code in such a way that the meaning of the original program is preserved. A number of other components of a programming environment may also need to be trusted, including, for example, parsers, printers, type checkers, verification condition generators, and linkers. Then, of course, there is also the infrastructure needed to support the activity of building formal proofs. While the world of proofs in mathematics are usually produced by humans for other humans to read and to learn from, the world of formal proofs involving computer systems are tedious, detailed, and long. Such proofs can only be checked by other computer systems called proof checkers. If we are not careful, we might have replaced the problem of trusting one's original computer system by a long chain of tools that all need to be trusted.

Researchers are, in fact, working on many different parts of this chain of tools in order to increase our trust in those tools. In the end, if one can really construct a formal proof that clearly proves some property holds of a computer system, then one does not need to trust the reputation of a particular compiler or some team of programmers. Instead, we can invoke the bedrock of trust that arises from the scientific method reproducibility by enabling any number of sceptics to implement proof checkers to check



the claim that a given formal proof does, in fact, prove the theorem claimed. If different programmers working with different programming languages at different times on different computer hardware are all capable of verifying a formal proof, then we can trust the theorems established by such proofs as strongly as we trust anything established by the scientific method.

“As it is painfully clear today, connecting your computer to the internet is similar to submerging a submarine into the depth of the sea: if there is a crack in your system, it will be exploited quickly and with serious consequences.”

While formal proofs and reproducible proof checking can provide a trustable framework for the development of trustable computer systems, state-of-the-art theorem provers, the major source of formal proofs, do not contribute to this framework for at least 2 reasons. First, there is a large number of different provers and they collectively build proofs in a wide array of

different formats. Such formats range from ad hoc designs used in specialised situations, to proof scripts that describe how to lead a particular interactive theorem prover to a proof, to any of the multitude of textbook formats such as resolution refutations, natural deduction, bi-simulations, etc. Second, in the case that a prover is willing to export their proofs, the actual format of their output is usually idiosyncratic and ill-defined.

ProofCert Project

Within the ProofCert project, which I have been leading for the past 5 years, we have turned to proof theory, a topic of mathematical logic that began in the 1930s and has been slowly evolving since then. Using proof theory, we have developed the foundational proof certificates framework for providing formal definitions of a wide range of proof systems. Given its roots in logic, this framework is both technology-independent and involves implementation techniques that have been well studied and analysed for the past few decades. Anyone interested in implementing a checker of proofs

defined using this framework can easily understand exactly what needs to be implemented, as well as find a rich literature describing all the necessary algorithms. The framework provided by the ProofCert project can now be exploited to make formal proofs universal and as trustworthy as needed. With this method of minting the basic coins of trust, the formal methods community can continue building the infrastructure that allows us to trust more aspects of more of our computer systems.



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Blockchain will have the biggest impact on the public sector

John Bertrand, Digital Value Engineer at SAP talks about the value of blockchain and how it can benefit government as well as local authorities

Blockchain seems to be everywhere and nowhere all at once. It is based on distributed ledger technology (DLT) – also known as a shared database or a shared ledger, and allows many participants in a network to see the system of record. This has the potential to radically change multiple industries especially the public sector. But while there are many blockchain ‘proof of concepts’ being floated, there are few concrete, industrial strength applications to draw on from any sector.

It’s by looking outside of the public sector where we can see applications which showcase blockchain’s strengths best. In the diamond industry for instance, the location of a stone can be tracked by this technology to help battle blood diamonds, or synthetic ones, from entering the system. Once a transaction is made, it can be added to the diamond’s history and cannot be edited without multiple checks. In this way, blockchain can also help reduce diamond fraud and safeguards the diamond supply chain against counterfeit goods, enabling trust, transparency and the security of the diamond business.

It is such properties and the high level of transparency that appeals to public sector institutions. Governments are already exploring ways of using the system to provide useful services. For example, the Isle of Man is using the [digital proof of identity required](#) for blockchain to make the gaming industry more resilient to fraud and money laundering. In this instance, the asset being tracked is a person, and this creates a people provenance and lineage capability for any government.

Up to date tracking

This ability to track a person’s status is particularly useful for public sector departments who need to securely deal with a person’s identity or status, perhaps for a process such as tax collection. Sweden is an

excellent example of a country currently using this, where everyone is given a personal identity number at birth. The system works so well that departments in the Swedish government now ask for a person’s number instead of their name.

“Organisations are still working out how to benefit from blockchain technology. What is clear, however, is that with its powerful ability to address fundamental issues such as fraud and identity, there are many applications for the public sector.”

In the UK the National Insurance number is currently used to identify someone’s status. This is now an out-dated system, and we’re still a way behind getting this to an efficient state – there are approximately 20% more numbers than there are people. Blockchain could prove to be an excellent solution for managing this process, removing duplication, giving people a provenance and making the process much more efficient.

This may soon change as the UK government has thrown its support behind blockchain technology research. In 2015, the Alan Turing Institute was opened to research how data science can change the world for the better. The UK’s Chief Scientific Advisor [published a ministerial-approved study](#) examining the range of benefits that DLT can have for public and private sector organisations. In the non-governmental sector, organisations like the Open Data Institute are actively supporting the development of policy frameworks to enable technology to increase competition and protect the information from distortion.

Overcoming fraud

Fraud in the public sector remains a significant challenge. With benefit and tax credit fraud [costing the UK £2.4 billion a year](#) and grant fraud estimated at [£2.7](#)



billion a year, applying DLT could have a substantial impact. The current system is vulnerable to breaches – information is often stored as a paper file and is accessible by only a few people. Blockchain would change that, automatically reconciling itself and flagging any adjustments with a full audit trail, providing forensic fingerprints should malpractice and deception have taken place.

“This ability to track a person’s status is particularly useful for public sector departments who need to securely deal with a person’s identity or status, perhaps for a process such as tax collection.”

Long term benefits of blockchain

Importantly, the technology isn’t necessarily a replacement for existing infrastructure. Instead it can sit alongside and strengthen the process. For example, general ledgers are already in place and blockchain can be used without distorting the books or giving away private information. This makes blockchain easier to implement, regardless of market sector. It is like a sidecar with a motorbike.

Organisations are still working out how to benefit from blockchain technology. What is clear, however, is that with its powerful ability to address fundamental issues such as fraud and identity, there are many applications for the public sector. With the onus to protect citizen’s personal data and ensuring taxpayers’ money is being responsibly and effectively used, the public sector would certainly feel the greatest impact of this technology. ■

John Bertrand
Digital Value Engineer
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www.sap.com/index.html

An insight into the impact of GDPR in a global world

How can your business prepare for changes to GDPR? Liz Fitzsimons, Partner, Privacy and Information Law, Eversheds Sutherland (International) explains

The General Data Protection Regulation (GDPR) comes into force across the EU member states from 25 May 2018. Notwithstanding Brexit, GDPR will still apply to the UK.

The GDPR is updated and upgraded data protection legislation to replace current 20-year-old EU data protection laws. It aims to future-proof laws against technological developments and new uses of personal data and hopes to help harmonise data privacy laws across the EU. A key goal is to rebalance the relationship between bodies using personal details and affected individuals, to be achieved through greater transparency and accountability obligations, supported by enhanced individual rights. Compliance will be backed by EU data protection regulators, like the UK's current Information Commissioner's Office, each having a powerful new range of enforcement powers. These include the ability to fine those in breach up to the higher of €20m, or 4% annual global turnover.

What effect will it have on organisations?

Regulators are adopting an enforcement regime similar to the competition law model and in many countries, including the UK, GDPR triggers a substantial increase in potential risk from non-compliance with data protection legislation. Many clients are addressing the issue at board level and including GDPR compliance on group risk registers.

The GDPR net is also spread more widely than under current laws, imposing direct compliance obligations and liabilities on service providers as well as their customers when handling personal information. In addition, its impact is not limited to those operating within the member states in the EU but has certain extra territorial reach. This will be particularly important for providers servicing customers and end users

in the EU, or organisations offering goods and services to individuals in the EU, or monitoring their behaviour in the EU, by on-line tracking or profiling for example.

Risk assessment and compliance planning should factor in that fines may be calculated at total group turnover level and could be triggered by a range of breaches, such as failing to provide an individual with a copy of their personal data when required, so fines are not restricted to security breach scenarios. There is no materiality threshold for breaches and the highest level of fines are reserved for breaches of individual rights. In addition, each affected individual can sue for compensation for breach – even if there is no financial loss. More practically, regulators can block the flow of data from Europe to other countries or prevent the ongoing use of an IT system, such as a CRM database.

GDPR will introduce new mandatory security breach reporting obligations and even if organisations and businesses do not report, they may be mentioned in third party reports. Regulators will make proactive spot checks (which may start remotely online) and there is also the risk of individual, union or works council complaints and whistleblowing, which should not be underestimated. Class actions are starting to be seen and media and privacy campaign groups are very active.

For the first time, organisations will be expected to know what personal data they are collecting and using, why it is needed, what it is used for, why that is lawful, how long it will be kept for and where it goes around the world. There will be a new legal obligation to have appropriate policies and to keep records to evidence how use of personal data by the organisation complies with GDPR requirements. Use of personal data will need to comply with mandatory privacy by design and default obligations and the outcome is that privacy



compliance will need to be front of mind, rather than an afterthought, with an appropriate privacy compliance culture embedded in your organisation.

How should organisations ensure they prepare for GDPR?

What you need to do will depend on the complexity of your organisation and use of personal details, as well as how compliant you are currently. The key thing is to start now. The following plan should help.

Reconsider what you use personal details for and whether you use more details than you really need, or keep them for longer than needed. Challenge yourself.

Securely delete or destroy unnecessary details as soon as possible.

Find out where you interact with people, how you collect their personal details and what you tell them when you do. Make sure you can deal with all these interfaces and update your privacy notices and consents, unbundling them from contract terms.

Make sure that you are aware of individuals' rights, that your staff are aware of them and that they and your systems are able to recognise and properly deal with such requests within the set deadlines.

Ensure when entering contracts now for systems and services which you will use after May 2018, you have made sure they comply with new GDPR rules on privacy by design and default and new obligations when using service providers (on both parties).

“The GDPR net is also spread more widely than under current laws, imposing direct compliance obligations and liabilities on service providers as well as their customers when handling personal information.”

We are supporting many clients with their GDPR compliance strategies and implementation. Do get in touch if you have queries or need help. ■

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www.eversheds-sutherland.com/global/en/index.page

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iStorage introduce the most secure hard drives ever made

iStorage Limited reveal their new diskAshur range, which consists of the most secure hard drives and solid state drives on the market

iStorage, the award winning and trusted global leader of PIN authenticated, hardware encrypted portable data storage devices, has announced the launch of their new range of USB 3.1 Hard Disk Drives (HDD) and Solid State Drives (SSD). This consists of the diskAshur², diskAshur² SSD, diskAshur PRO², diskAshur PRO² SSD and the diskAshur DT² all of which are designed, developed and assembled in the UK.

“The GDPR, which comes into force on 25th May 2018, compels organisations who process or hold personally identifiable information of EU residents, to implement adequate security measures to protect personal data loss or face tough fines.”

The new drives feature Enhanced Dual Generating Encryption (EDGE) technology making them the most secure HDD/SSD and desktop drives currently on the market.

EDGE™ Security Features:

One of the unique and underlying security features of the GDPR compliant diskAshur range is the dedicated hardware based secure microprocessor (Common Criteria EAL4+ ready), which employs built-in physical protection mechanisms designed to defend against external tamper, bypass laser attacks and fault injections.

Unlike other solutions, all the drives within this range react to automated

hacking attempts by entering the deadlock frozen state, which renders all such attacks as useless.

In plain and simple terms, without the PIN, there's no way in!

With software free set up and operation, the diskAshur range is platform/device independent and works across all operating systems including all versions of MS Windows, macOS, Linux, Android, Chrome, Thin Clients, Zero Clients and embedded systems. In fact, the drives will work on any device with a USB port!

The diskAshur PRO² USB 3.1 portable hard drive is available in a stylish graphite housing and is the ultimate secure data storage device. The diskAshur PRO², diskAshur PRO² SSD portable drives and diskAshur DT² desktop hard drive are designed to be FIPS 140-2 Level 2 and 3, NCSC CPA Foundation Level, Common Criteria and NLNCSA government certified. The diskAshur range consists of the diskAshur² and diskAshur PRO² portable HDDs (both available up to 2TB), diskAshur² SSD and diskAshur PRO² SSD (both available up to 1TB) and diskAshur DT² desktop hard drive (available up to 8TB).

About iStorage Limited

iStorage is the trusted global leader of award winning PIN authenticated, hardware encrypted data storage devices. Delivering the most innovative

products to securely store and protect data to military specified encryption levels; safeguarding valuable business information whilst ensuring compliance to regulations and directives.

About the General Data

Protection Regulation (GDPR)

The European Union will have the power to fine companies €20 million or 4% of their global turnover if they are found to be in breach of the new government legislation. The GDPR, which comes into force on 25th May 2018, compels organisations who process or hold personally identifiable information of EU residents, to implement adequate security measures to protect personal data loss or face tough fines.

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WHAT ABOUT
YOUR DATA?

i “£150,000 fine for insurance company that failed to keep customers’ information safe.
An ICO investigation looked at the theft of a hard drive device containing **59,592 customers’** details.”

(Source by ico.org.uk)

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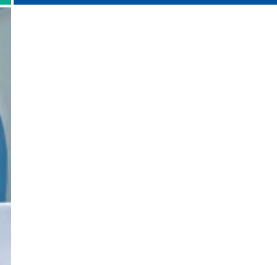
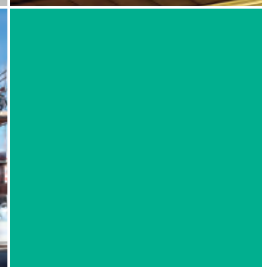


Use promo code AG10 to get 10% off your purchase on all of iStorage's encrypted flash, hard & SSD drives
(Promotion ends on 30th of June 2017).

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