CELEBRATING RESEARCH IMPACT

TO HAVE AN IMPACT IS TO MAKE A DIFFERENCE.

At Surrey, we achieve this by working together with our partners to research real-world issues and challenges, bringing benefit to those living in our local, national, and international communities. While the impact of some of our research is evident immediately, for other research, it takes years, or even decades, before the true impact is apparent. In all cases, our impact stands in testament to the determination of our academic community to realise the benefits of their research in the service of our communities.

CONTENTS

WHAT OUR BODIES NEED

Groundbreaking research projects in vitamin D absorption and iodine deficiency have led to new government guidelines – and prompted change in the way food products are formulated.

VITAMIN D DEFICIENCY

In Surrey's Department of Nutritional Sciences, researchers have been studying the fundamental impact food and nutrition have on human health for over 50 years – a hugely impactful body of work recognised with a Queen's Anniversary Prize in 2017.

For Head of Department Professor Susan Lanham-New, vitamin D deficiency has been a key focus for over a decade. Lack of vitamin D means that our bodies cannot absorb calcium, which is a major cause of osteoporosis, costing the NHS around £2bn a year.

However, up until 2016, government nutritional scientists considered that sunlight exposure during the spring and summer was sufficient to sustain our vitamin D levels during the winter months.

As a result of research by Professor Lanham-New's group, the first-ever vitamin D Reference Nutrient Intake was established, which shaped new national guidelines. Sales of vitamin D supplements increased by a third, and food manufacturers including Yakult and Warburtons reformulated their products to incorporate vitamin D.

IMPACT OF IODINE

While severe iodine deficiency during pregnancy is known to impair foetal brain development, the effects of mild-to-moderate deficiency were less well known. This led Professor Margaret Rayman and Dr Sarah Bath to conduct the first ever research into the link between mild-to-moderate deficiency and lower child cognition – which can set children on a trajectory for poorer outcomes in terms of school attainment, exam grades and employment opportunities.

Since milk is the main provider of iodine in the UK, the researchers were also concerned about the trend towards plant-based alternative milks, which have a significantly lower iodine content.

The team's research clearly showed that women with mild-to-moderate iodine deficiency were more likely to have children with lower verbal, reading and comprehension skills at 8-9 years old. As a result of their work, the market-leading pregnancy supplement increased its iodine content, while popular milk alternatives have been fortified with iodine, and the iodine content of organic milk has been increased. UK policy for monitoring iodine status in the general population has also been changed, and awareness of the impact of iodine deficiency has been raised among the public – particularly women of childbearing age – and health professionals.

SALES OF VITAMIN D SUPPLEMENTS INCREASED BY A THIRD, AND FOOD MANUFACTURERS INCLUDING YAKULT AND WARBURTONS REFORMULATED THEIR PRODUCTS TO INCORPORATE VITAMIN D.

DARK MATERIALS AT THE NANO-SCALE

Research in nanoelectronics at Surrey has enabled advances in carbon materials, opening up groundbreaking applications in the aerospace sector.

> THE VANTABLACK™ BRAND HAS TRIPLED IN VALUE SINCE 2014 AND WAS WORTH £30M IN 2020.

Headed by Professor Ravi Silva, the NanoElectronics Centre within Surrey's Advanced Technology Institute – and spin-out company Surrey NanoSystems – explores materials at the nano-scale, with exceptional results.

Working with carbon nanotubes, which allow electrons to travel through them at ballistic velocities, the Centre has developed Vantablack™ – the blackest material on earth. This is used not only in disaster monitoring and space applications but has also become a cultural artifact, and was showcased at both the 2018 Winter Olympics and 2019 Frankfurt Motor Show. The Vantablack™ brand has tripled in value since 2014 and was worth £30 million in 2020.

In another project, Professor Silva has collaborated with Airbus Defence and Space to develop a novel carbon fibre coating process which provides an effective moisture barrier for satellites. This research has led to further commercial success in the aerospace industry, with Airbus announcing a commitment of €10 million to develop patented solutions based on Surrey's research for future European Space Agency missions.

The Hyundai Pavilion at the 2018 Winter Olympics used Vantablack™ to create a striking visual effect of stars appearing to float in mid-air.

RESETTING THE BODY CLOCK

Experts in circadian rhythms have improved the lives of blind people by showing – for the first time – the impact that melatonin can have on our body clocks.

Our bodies operate on a 24-hour cycle, with light giving us cues about when to wake up and go to sleep. However, because they are unable to experience these light-dark signals, most totally blind people suffer from a cyclic sleep disorder, with periods of very poor sleep and tiredness.

Professor Debra Skene, Chronobiology Section Lead, has investigated a treatment for this disorder which has proved highly effective. Melatonin (a hormone that is naturally produced by the body) tells the body that it is night-time, and her studies demonstrated that giving melatonin in daily tablet form was effective in synchronising blind people's disrupted sleep/wake patterns, and resetting the body clock.

The research has now been commercialised with the launch of tasimelteon (HETLIOZ®), a melatonin-like drug which is the first licenced treatment (approved by the Food and Drug Administration and European Medicines Agency) for the treatment of cyclic sleep/wake disorder.

> **BUILDING ON THIS RESEARCH, WE CAN NOW TEST THIS TYPE OF TREATMENT IN OTHER CIRCADIAN RHYTHM DISORDERS CAUSED BY JET LAG AND SHIFT WORK, AND ON PEOPLE WHO HAVE VERY DELAYED SLEEP.**
>
> *Professor Debra Skene*

A BREATH OF FRESH AIR

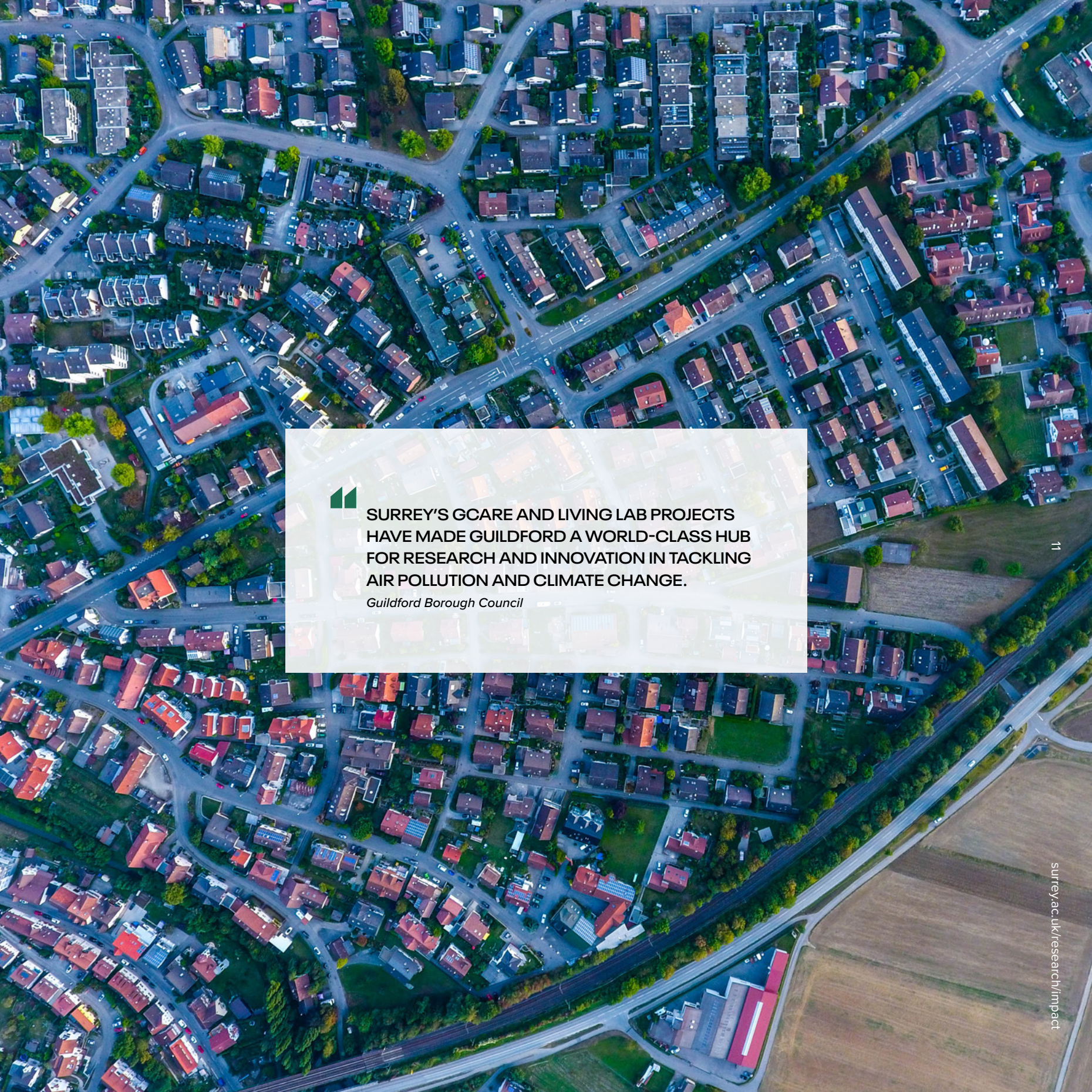
With its mission of 'clean air for all', Surrey's Global Centre for Clean Air Research (GCARE) is playing a vital role in improving human health, not only in the UK but across the world.

The effects of air pollution are devastating and deadly, resulting in over seven million premature deaths worldwide annually. Professor Prashant Kumar and his GCARE team are dedicated to creating a world in which we can all breathe easier. Their research into air pollution exposure and mitigation measures is influencing government policy, while their freely available guidelines and toolkits are making a significant difference to air quality at grass roots level.

The true impact of Professor Kumar's research rests on its practical approach. The solutions he and his team have developed to mitigate air pollution include identifying which types of tree and vegetation are most effective – and should therefore be planted at the sides of the road. This led to GCARE's contribution to the Greater London Authority report, 'Using Green Infrastructure to Protect People from Air Pollution', which has become best practice for urban planning departments and contractors.

Another area of research has focused on what can be done to mitigate exposure to traffic pollution in and around schools, based on a series of studies carried out with local schools. GCARE's guidance booklet on this topic has not only been widely used in the UK, but also translated into 20 different languages to meet global demand.

While contributing to policy change is important, Professor Kumar sees galvanising the public to take action as crucial in combatting air pollution. Through GCARE's 'Guildford Living Lab' programme, researchers are working with the local community to measure pollution levels, and engaging with schools through practical workshops – helping to empower the next generation to preserve the health and wellbeing of our planet.



> SURREY'S GCARE AND LIVING LAB PROJECTS HAVE MADE GUILDFORD A WORLD-CLASS HUB FOR RESEARCH AND INNOVATION IN TACKLING AIR POLLUTION AND CLIMATE CHANGE.
>
> *Guildford Borough Council*

2-IN-1 SOLUTION FOR SWIMMING POOLS

> IF WE HADN'T GONE DOWN THIS ROUTE, WE REALLY WOULDN'T BE HERE TODAY.
>
> *Peter Adlington, Managing Director of Plastipack*

Surrey's expertise in photonics has led to a collaboration which has transformed the global swimming pool cover industry.

A traditional swimming pool cover is either opaque to prevent the growth of algae or transparent to allow solar heating to reduce need for expensive heating.

Dr Steven Clowes and Professor Stephen Sweeney based in the Advanced Technology Institute and Department of Physics have worked with Plastipack (a specialist manufacturer of swimming pool and water storage cover materials) to successfully develop a 'best of both worlds' solution.

The pair used their knowledge of the optical properties of materials to develop a cover which enabled maximum water heating from solar radiation while inhibiting algae growth by selectively blocking regions of the solar spectrum. Working with Plastipack on Knowledge Transfer Projects they have taken the solution all the way from prototype to mass-production. A new version of Plastipack's EnergyGuardTM was launched in 2015 and resulted in a fourfold sales increase for the company within three years. There are now over two million square metres of this material covering pools across the world resulting in a positive environmental impact through a reduction in the use of chemicals and energy for sanitising and heating swimming pools. The research collaboration between Surrey and Plastipack won an Institute of Physics Business Innovation award in 2018.

A NEW DAWN FOR VOTING

Computer scientists have succeeded in 'squaring the circle' when it comes to electronic voting – providing proof that votes are correctly cast while also preserving secrecy.

When citizens cast their votes electronically in the Victorian State Election in Australia in 2014, it represented a world first, and was thanks to the research of Professor Steve Schneider, Director of the Surrey Centre for Cyber Security.

Electronic voting has many benefits including convenience and accessibility for those who are visually or mobility-impaired, or live in remote areas. However, there are challenges in terms of cyber security and trust: electronic systems can be subject to attacks from external hackers and internal threats.

Professor Schneider has combatted this issue by developing novel verification techniques based on cryptography.

This enables voters to see and confirm that their vote is correct but, crucially, the vote itself remains secret. In addition to being successfully run for the first time in a live state-wide election, this technology has been trialled by Civica Election Services, while the research has also led to verifiability being recommended in an independent review of electronic voting by the UK Trades Union.

> PROFESSOR SCHNEIDER HAS COMBATTED THIS ISSUE BY DEVELOPING NOVEL VERIFICATION TECHNIQUES BASED ON CRYPTOGRAPHY.

GIVING LGBTQ+ COMMUNITIES A VOICE

Research highlighting the lack of understanding about LGBTQ+ people's concerns when it comes to social housing has led to the launch of the UK's first scheme to support inclusivity.

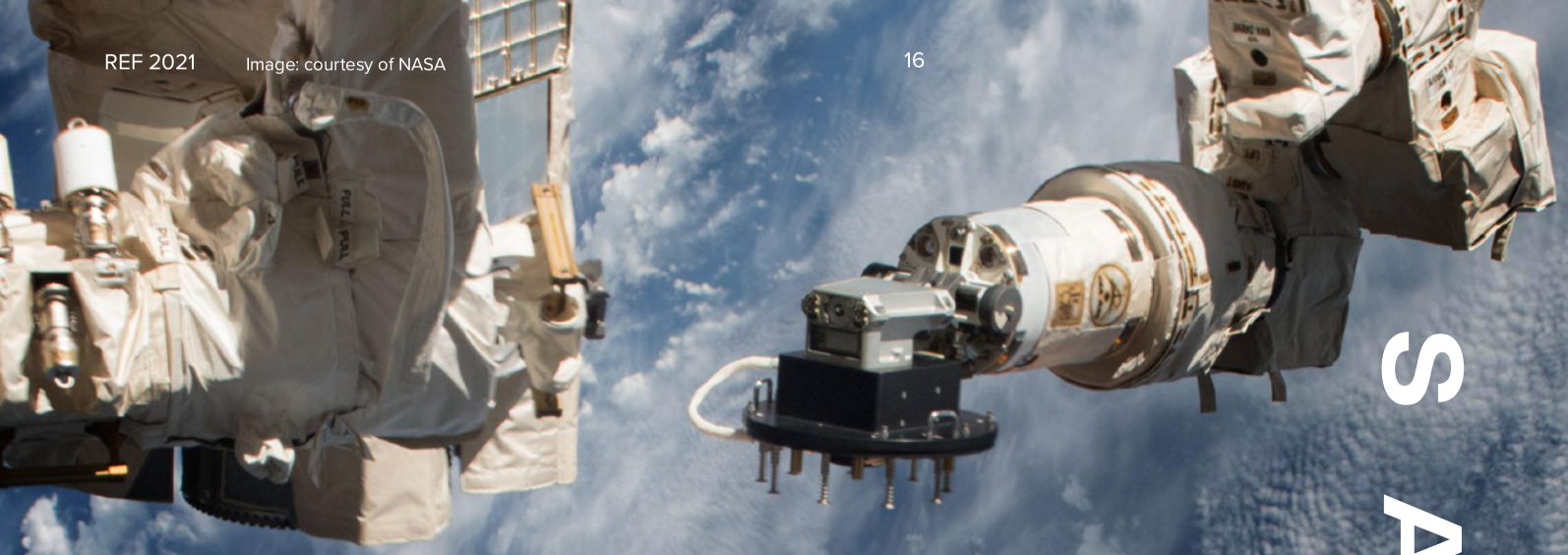
With three to seven per cent of the UK population identifying as lesbian, gay, bisexual, transgender or queer (LGBTQ+), there is an urgent need to understand and actively address their needs in relation to housing.

Professor Andrew King (Department of Sociology) has led two research projects which demonstrate that LGBTQ+ people have major concerns about safety, belonging and community, and often feel marginalised or ignored by housing and support agencies. On the back of this research, he has developed and implemented the UK's first LGBTQ+ housing equality charter, the HouseProud Pledge Scheme, which enables LGBTQ+ residents to have an input in decision-making and secures a commitment to staff training, among other objectives. To date, 15 social housing organisations have signed up to the Scheme, representing 1.5 million residents and one million housing units.

Professor King's research has also provided an evidence base for LGBTQ+ organisations including Stonewall Housing, Opening Doors and Tonic Housing, as well as social housing providers across the sector.

> **WE LOOK FORWARD TO WORKING WITH RESIDENTS, ALLIES AND PARTNERS ACROSS THE SECTOR TO RAISE AWARENESS OF THE PLEDGE AND MAKE SURE ALL LGBTQ+ RESIDENTS IN SOCIAL HOUSING HAVE THE SUPPORT THEY NEED.**
>
> *Clare Miller, CEO of Clarion Housing Group (UK's largest social housing provider)*

Image: courtesy of NASA



SAVING SPACE

Researchers in Surrey Space Centre (SSC) have pushed the boundaries of space engineering to clean up dangerous debris in orbit, as well as developing advanced Earth Observation (EO) satellites which monitor and improve our environment on Earth.

With the exponential increase of space technology and the launch of mega-constellations, satellites in Earth's orbit face the constant risk of collision with fragments of debris. Professor Guglielmo Aglietti and Professor Craig Underwood have developed creative solutions to this problem which are making space a safer place. In 2017, they led the InflateSail mission which, for the first time, successfully de-orbited a satellite using an inflatable drag sail, and led to the first commercial use of this technology. The subsequent RemoveDEBRIS mission demonstrated that space junk can be safely captured and removed by deploying a net and harpoon.

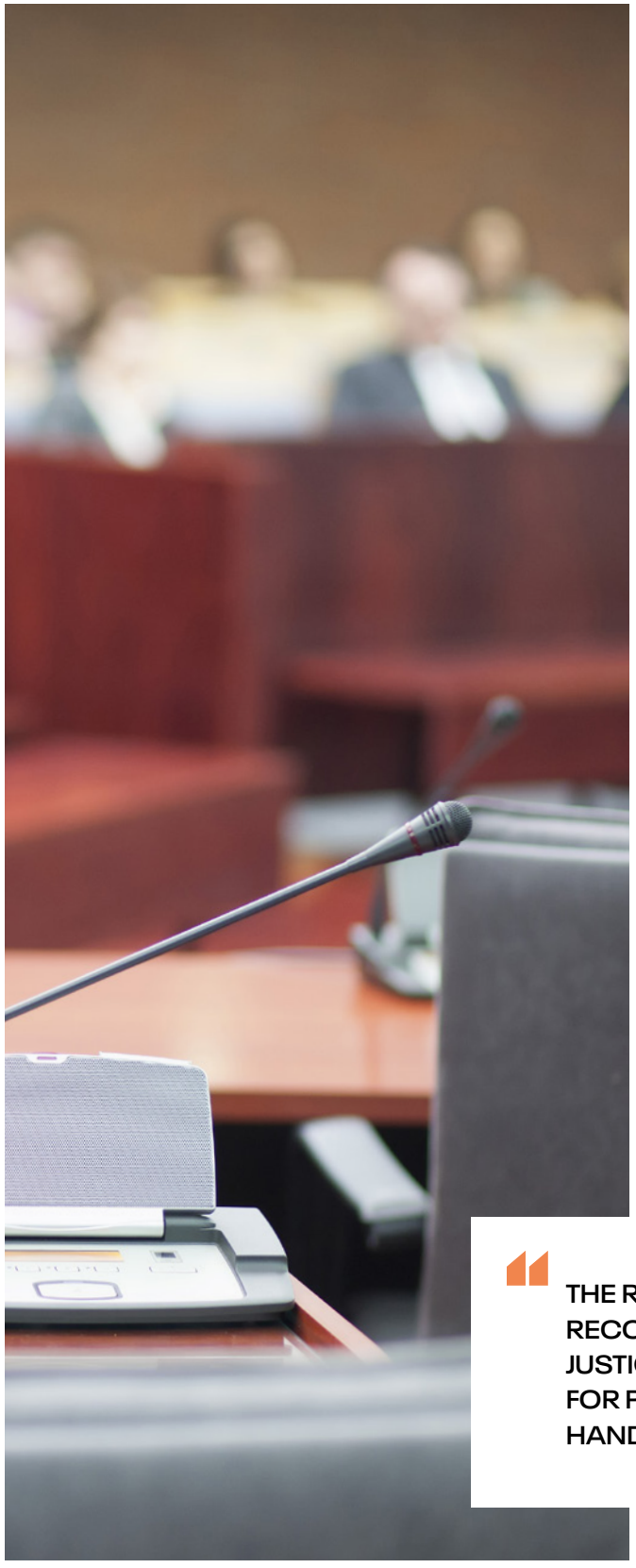
In addition to widespread media coverage of the RemoveDEBRIS mission – with televised footage watched by 3.5 billion viewers – the programme was awarded the 2019 Sir Arthur C Clarke Award and the Aviation Week Network 63rd Annual Laureate Award 2020.

A CLEARER PICTURE

Today, what we can see from space has an important bearing on Earth. SSC has been instrumental in commercialising high-resolution imaging from EO satellites which are used in disaster response, agriculture and urban planning. A specific issue tackled by the SSC team is micro-vibrations which arise from mechanical disturbances on board spacecraft and adversely affect image quality. The Centre's research on these micro-vibrations and development of innovative control techniques has enabled Surrey Satellite Technology Ltd (a Surrey spin-out company now owned by Airbus) to produce satellites with the required stability for high-resolution imagery.

This technology has subsequently been employed on two commercial EO satellites, the TripleSat/DMC3 Constellation and SSTL-S1, and has also informed engineering practice standards for spacecraft development.

> THE DE-ORBIT SAILS PROVIDED BY SSC HELPED US RESPONSIBLY DE-ORBIT OUR SPACECRAFT DEPLOYERS AFTER COMPLETING THE RECORD-SETTING SSO-A MISSION. SPACEFLIGHT IS COMMITTED TO BEING A RESPONSIBLE STEWARD OF THE SPACE ENVIRONMENT AND SSC IS A KEY PARTNER IN HELPING US PUT OUR WORDS INTO ACTION.
>
> *Mission Director at Spaceflight.*



INTERPRETING THE VALUE OF VIDEO-LINK

Working with stakeholders in the UK, EU and US, Professor Sabine Braun has raised awareness globally of the challenges posed by using video-mediated interpreting (VMI) in the legal system.

Interpreting by video-link is increasingly used in legal proceedings around the world in order to speed up and improve access to justice and save costs. However, prior to 2008 there had been little research into how the use of video affects interpreting quality and whether it brings a risk of miscarriages of justice for people in linguistic minority groups.

Professor Braun, Director of the Centre for Translation Studies, was the first to examine the quality and viability of VMI in legal proceedings, conducting two surveys with European legal interpreters and justice sector institutions. These indicated that while interpreters found VMI to be more difficult and stressful than on-site interpreting, justice sector institutions had little awareness of the challenges. Subsequent studies comparing VMI and on-site interpreting found that accuracy was worse and interpreter fatigue more likely with VMI.

The research has provided vital evidence for recommendations by the European Directorate for Justice for cross border videoconferencing, and for policy documents such as the UN Refugee Agency Handbook for Interpreters in Asylum Procedures.

The Californian Federation of Interpreters has cited the findings to support its argument that caution needs to be exercised when VMI is used in courts.

> THE RESEARCH HAS PROVIDED VITAL EVIDENCE FOR RECOMMENDATIONS BY THE EUROPEAN DIRECTORATE FOR JUSTICE FOR CROSS BORDER VIDEOCONFERENCING, AND FOR POLICY DOCUMENTS SUCH AS THE UN REFUGEE AGENCY HANDBOOK FOR INTERPRETERS IN ASYLUM PROCEDURES.

BRIDGES ACROSS CULTURAL ISLANDS

Academics in the International Guitar Research Centre have brought together diverse musical styles and cultures to enrich the future of the world's most popular instrument.

There are an estimated 780 million modern guitars in the world, and the instrument – and its close relatives – are integral to many global music cultures. However, the focus on preserving individual guitar styles has often led to the prevention of valuable cultural exchange.

Against this backdrop, Professor Stephen Goss and Dr Milton Mermikides developed a simple but ambitious plan: to create bridges between these cultural islands by exchanging technical, pedagogical, analytical and compositional ideas. Partnering with guitar foundations in the US, Canada and China, the Centre has co-hosted conferences and festivals around the world, disseminating the research to the wider public through recordings, broadcasts, performances and collaborative works.

Dr Mermikides says:

IT'S THROUGH THIS DIVERSITY OF STYLE AND APPROACH THAT WE CAN CAPTURE THE GUITAR'S GLOBAL PRACTICE, AND HELP THE INSTRUMENT FLOURISH IN THE 21ST CENTURY.

THE CARTONERA

PUBLISHING PROJECT

THE TRANSFORMATIVE POWER OF TRASH

Surrey's experts in Latin American Studies have placed 'Cartonera' – a socially-engaged publishing movement sparked by Argentina's 2001 economic crisis – on an international stage with a project that tackles Sustainable Development Goals from the grassroots.

Cartonera began when artists and writers collaborated with waste-pickers to create low-cost handmade books using discarded cardboard ('cartón'), with the aim of making literature accessible beyond the cultural elite: a sustainable publishing model that soon spread across and beyond Latin America.

Inspired by this phenomenon, Dr Lucy Bell (School of Literature and Languages) launched the Cartonera Publishing Project, which has explored how the Cartonera model can help to transform the lives of vulnerable and marginalised communities. Contributing to the UN's Sustainable Development Goals, researchers from Surrey and the University of Durham have worked with publishers, writers, artists, curators and librarians, and with Cartonera partners on the ground in Argentina, Mexico and Brazil. The team has co-designed programmes aimed at empowering communities facing exclusion, stigma and violence, and delivered writing and book-making workshops to diverse communities – including indigenous and rural groups, homeless people and imprisoned women.

The project has generated impact on both local and global scales. At local level, it has inspired over 1,000 people to write, publish – and change – their life stories through collective book projects. These include *Mutirão (Task Force)*, a book by homeless people and housing activists, which exposes the very serious problem of homelessness and inequality in São Paulo (Brazil). Another publication, *Wind & Mirrors*, is a reflection by nine female prisoners in Jalisco (Mexico) on their lives and futures, which inspired the first UK Cartonera programmes at HMP Nottingham (2019) and HMP Downview (2021).

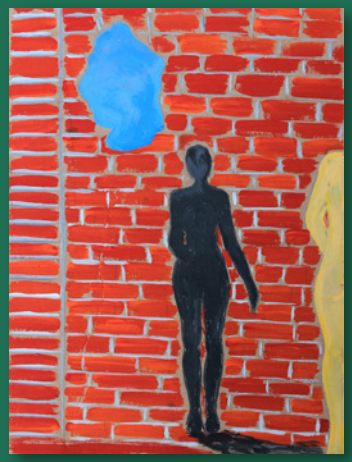
Globally, the project has amplified the voice and reach of Cartoneras through the largest Cartonera exhibition to date in São Paulo, and the world's second largest Cartonera book collection across three UK libraries: the British Library, Senate House Library and Cambridge University Library. Both were activated through hands-on public events which have in turn led to new international collaborations, building capacity for more resilient, sustainable communities in the 2020s.

Activating the Arts in Guadalajara, 2019.

British library workshop, 2019.

> IMPLEMENTING ARTS-BASED ACTIONS HAS MADE A PROFOUND DIFFERENCE TO THE WOMEN IN THESE PRISONS, PROVING THAT CULTURAL PATHWAYS CAN BE USED TO MAKE PROGRESS FOR JUSTICE, EDUCATION AND COMMUNITY-BUILDING.
>
> *Dr Lucy Bell*

Wind & Mirrors book launch at Puente Grande Women's Prison, 2019.
Photograph courtesy of Puente Grande press team.



The books featured in the photographs are by the five main project partners with whom researchers Lucy Bell, Alex Flynn and Patrick O'Hare collaborated between 2017 and 2022: three Mexican collectives, La Cartonera (Cuernavaca), La Rueda Cartonera (Guadalajara) & Viento Cartonero (Ecatepec de Morelos); and two Brazilian collectives, Dulcinéia Catadora (São Paulo) & Catapoesia (Belo Horizonte).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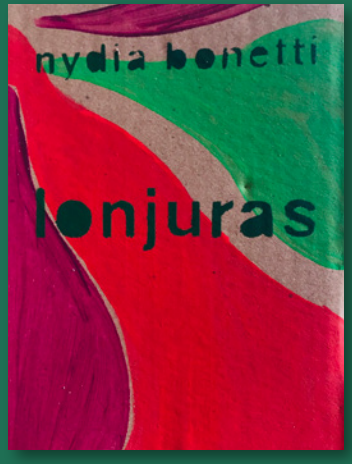
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MORE FUN WITH LESS STUFF

Is it possible to have a successful economy that's not built on growth? Professor Tim Jackson, head of the Centre for the Understanding of Sustainable Prosperity, has pioneered a radical vision which aims to support a fairer, greener way of life.

Image: courtesy of Olga Berrios / flickr.com (CC-BY 2.0)

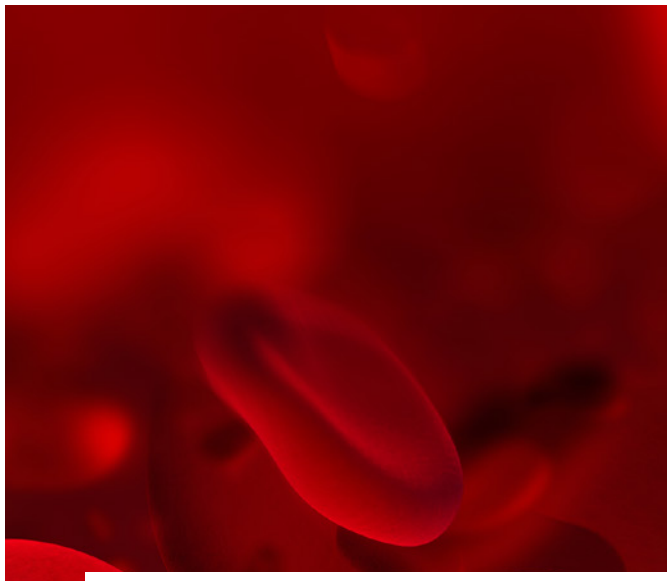
> **ONE OF THE THINGS WE'VE LEARNED DURING THE PANDEMIC IS THAT THE FOUNDATION FOR OUR PROSPERITY IS HEALTH RATHER THAN WEALTH. AND WHEN WE THINK ABOUT HEALTH, IT'S LARGELY DRIVEN BY A CONCEPT OF BALANCE.**
>
> *Professor Tim Jackson*

In our consumerist society, a healthy economy depends on growth: having more and more material things. But these things affect our climate, have a negative impact on biodiversity, and devastate our planet. Since he published his seminal work *Prosperity without Growth* in 2009, Professor Jackson has been conducting research which confronts this conundrum of our times, and most recently shared his ongoing work at COP26.

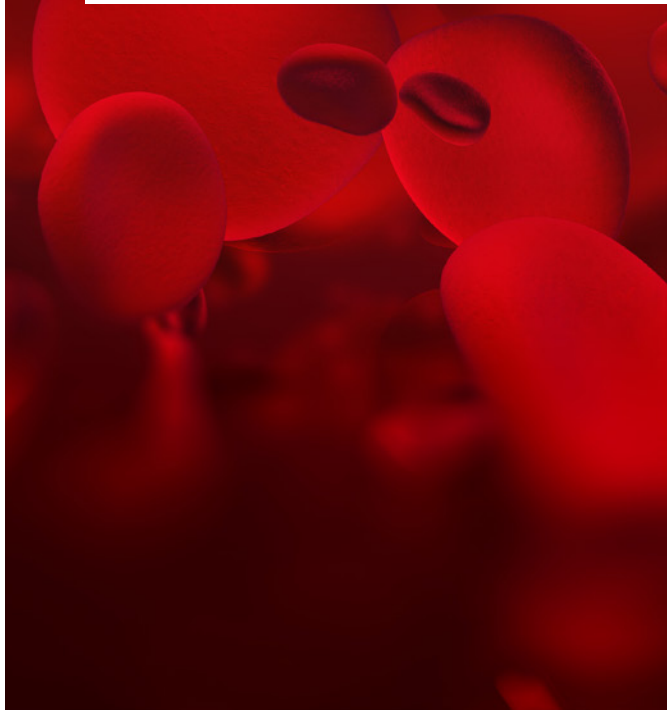
Professor Jackson says: "We have built our identities, our relationships and even our sense of meaning and purpose around the idea that we can have more and more, and in the process we've undermined our sense of happiness and satisfaction. The challenge is to discover how we can have 'more fun with less stuff'."

One strand of his work has been to pioneer the concept of 'post-growth economics' which challenges the idea that endless economic growth is measured by the Gross Domestic Product. He has developed dynamic macroeconomic models to help identify how to achieve full employment, financial stability and social equality in a non-growing economy.

Professor Jackson's work has had a profound effect on government and business, changing the narrative away from a one-dimensional measure of growth towards a holistic view of progress that encompasses prosperity, wellbeing and social inclusion. His research has been presented at, or contributed to, debates by the UK and European Parliaments, UK All Party Parliamentary Group on Limits to Growth, German Environment Agency and New Zealand Treasury, while he has also advised financial institutions on their response to the challenge of post-growth economics. Through his books and media activity, including appearing in the award-winning documentary *System Error* in 2018, Professor Jackson has inspired broader society to take a different view of what success could look like.



> THIS HAS RESULTED IN NEW DRUGS WHICH REDUCE HYPOGLYCEMIA (LOW BLOOD SUGAR EPISODES) AND DECREASE LIKELIHOOD OF WEIGHT GAIN – ENABLING MILLIONS OF PEOPLE WITH DIABETES TO LIVE A MORE NORMAL LIFE.



SMARTER TREATMENT FOR DIABETES

Research by Professor David Russell-Jones has led to a breakthrough in insulin drugs, improving quality of life for millions of people with diabetes around the world.

Globally, over 450 million people are affected by diabetes. Insulin replacement therapy is a daily reality for all people with Type 1 diabetes and is also used by a quarter of Type 2 patients for part of their lives. Crucial for maintaining close to normal levels of blood sugar, these drugs help to minimise long-term damage of the eyes, kidneys, nerves and blood vessels.

In 2004, Professor Russell-Jones began a collaboration with King's College London to explore a hypothesis: he believed that because the drug Levemir® made by Novo Nordisk was bound to albumin (the main protein in the bloodstream), it must have more access to the liver than to peripheral tissues.

Studies using mass spectrometry techniques proved Professor Russell-Jones' hypothesis to be correct, and he joined an international consortium of academics and clinicians focused on optimising the biological effects of insulin analogues. This has resulted in new drugs which reduce hypoglycemia (low blood sugar episodes) and decrease likelihood of weight gain – enabling millions of people with diabetes to live a more normal life.

ENGAGING THE PUBLIC IN COMPLEX SCIENCE STORIES

Through his broadcast career, Professor Jim Al-Khalili has had an impact on millions of people around the world, and he has most recently used his public platform to communicate the fascinating topic of quantum biology.

Professor Al-Khalili has forged an international reputation in theoretical nuclear physics for over three decades. However, over the past few years, it is his research into the fascinating interdisciplinary field of quantum biology – which uses the laws of quantum physics to understand processes taking place inside living cells – that has underpinned his public engagement activities.

One of the world's best-known science communicators, Professor Al-Khalili is presenter of BBC Radio 4's long-running *The Life Scientific* and TV documentaries that have been watched by more than 20 million viewers since 2013. He has brought the concept of quantum biology to new audiences through his 'Science Live' lecture series for A-Level students, a TEDGlobal talk at the Royal Institution (viewed 2.5 million times) and the first popular book on the topic, *Life on the Edge: the coming of age of quantum biology*.

> IT IS THANKS TO PEOPLE LIKE JIM THAT THE SCIENTIFIC LANDSCAPE HAS CHANGED TO ONE WHERE WE, AS SCIENTISTS, CAN EFFECTIVELY ENGAGE WITH THE PUBLIC TO THE BENEFIT OF BOTH.
>
> *Professor Paul Hardaker, Chief Executive of the Institute of Physics*

THE EARLY-YEARS EVIDENCE

There's a widely-held and logical assumption that free early-years education has a positive long-term effect, improving children's learning outcomes, closing development gaps and increasing social mobility. But is this actually true?

Free nursery provision is a flagship UK government policy which cost £2bn in 2014. Aiming to replace assumptions with evidence which could inform future policy decisions, Dr Jo Blanden and Professor Sandra McNally of the School of Economics conducted the first ever study which directly investigated the long-term learning outcomes of children in England who had received free early-years education.

What they found was surprising. Free provision was shown to have little impact when other factors were taken into account, and any improvement in learning outcomes was short-term: children did better aged five but not at seven or 11. The research showed that offering free nursery education changed take-up among parents very little, with three quarters of free places taken up by children who would have attended without the policy. It also overturned another widely held assumption about 'high quality' nursery education, finding that there was no real evidence that the presence of a graduate among nursery workers had any impact on children's outcomes.

The research has been disseminated through a presentation to the Department of Education and via wider debates in the media including BBC Radio 4's Woman's Hour and national newspapers. While the UK government has continued to invest in free nursery places, the research has led to a shift in its understanding about the goals of the policy, with the emphasis moving from supporting child development to providing financial assistance to families.

In spring 2020, the closure of schools due to the Covid pandemic prompted Dr Blanden to conduct new research, this time examining the impact of school closures on both parents and children.

Dr Blanden said: "What we found was revealing: mothers had worse mental health outcomes when their children were out of school but this didn't tend to affect fathers. In children, not surprisingly, social and behavioural outcomes were adversely affected from being out of school."

Free nursery provision is a flagship UK government policy which cost

£2BN IN 2014

Dr Blanden said:

WHAT WE FOUND WAS REVEALING: MOTHERS HAD WORSE MENTAL HEALTH OUTCOMES WHEN THEIR CHILDREN WERE OUT OF SCHOOL BUT THIS DIDN'T TEND TO AFFECT FATHERS. IN CHILDREN, NOT SURPRISINGLY, SOCIAL AND BEHAVIOURAL OUTCOMES WERE ADVERSELY AFFECTED FROM BEING OUT OF SCHOOL.

UNLOCKING ECONOMIC SUCCESS IN LATIN AMERICA

Academics in Surrey Business School have worked in two key areas which will bring significant economic benefits in Latin America: maximising the potential offered by digital technology to transform government, and reducing prohibitive import tariffs in Argentina.

REALISING A DIGITAL GOVERNMENT TRANSFORMATION

In Latin America, regional governments face pressure to improve both access to and efficiency of public services, and to become more transparent in their practices. Research led by Dr Carla Bonina of the Centre of Digital Economy has been focused on understanding and implementing digital technologies to help transform policies and practices for these governments.

Dr Bonina worked closely with the Organisation for Economic Co-operation and Development to develop an impact tool to assess its digital government directives – and this tool has also been used by the Colombian government to improve its digital government strategy. In addition, her research contributed to mobilising the agenda of open data and transparency in the region, including a passage of new legislation in Costa Rica, training more than 300 public servants in the region and actively engaging the participation of the private sector in the open data strategies in the City of Buenos Aires. In Argentina, Dr Bonina has acted as a direct advisor to government and worked with the World Bank to develop a stronger open data policy at national level.

CUTTING IMPORT TARIFFS IN ARGENTINA

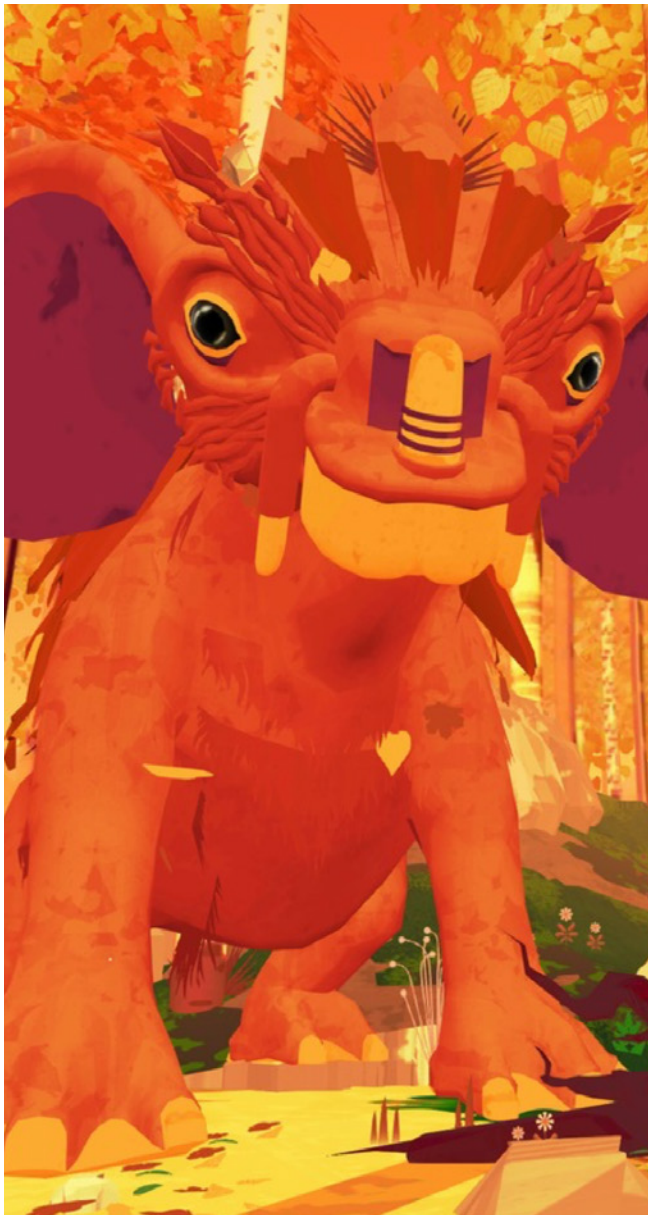
Import tariffs in Argentina are four times higher than the international average, and have prevented the country from benefiting from globalisation. In his year's tenure as Director of Research with Argentina's National Foreign Trade Commission, Professor Juan Carluccio (Surrey Business School) was uniquely placed to understand this challenge.

Conducting extensive research into the way imports affect firms, workers and consumers, he developed a proposal for import-tariff reform which has transformed trading in the region. He proposed that the Common External Tariff of MERCOSUR (the Argentina, Brazil, Paraguay, Uruguay trading bloc) be revised, which resulted in savings of £100 million a year for firms. He also suggested unilateral tariff reductions from 19 per cent to around five per cent for 10 key classes of manufactured goods, which enabled further savings of over £50 million a year and the negotiation of trade agreements between the EU and MERCOSUR, which has facilitated one of the world's biggest free trade areas.

SAVINGS

unilateral tariff reductions from
19% TO AROUND 5%
for 10 key classes of manufactured goods, which enabled further savings of over
£50M A YEAR

the average tariff for chemical sector products being reduced from
10% TO 2%
resulting in savings of
£100M A YEAR



‘The Turning Forest’. Image courtesy of the BBC

BOUNDLESS SOUND

Surrey’s spatial audio research is enabling next-generation technologies which will change the way we experience sound, and sparking collaborations with entertainment giants such as the BBC and Bang & Olufsen.

In the Centre for Vision, Speech and Signal Processing, academics led by Professor Adrian Hilton and Dr Philip Jackson are pioneering research which pushes sound to its very limits. In the brave new world of spatial audio, listeners are enveloped within ‘sound zones’ which enable them to listen to personalised content in the same room as others, without headphones.

In the five-year EPSRC-funded S3A project in collaboration with the BBC, the research team has developed tools which give listeners at home the experience of ‘being there’ at live events such as concerts and football matches, which would previously have required a complex set-up of speakers.

Surrey’s research in spatial audio is already changing the way sound is experienced in the real world. The sound zone technology has been commercialised by Bang & Olufsen, the world-renowned producers of high-end audio products, with the BeoLab 90 – a highly innovative loudspeaker – launched in 2015.

The researchers have also worked extensively with the BBC to create new user experiences to engage the public including ‘The Turning Forest’, the broadcaster’s first publicly released Virtual Reality experience, and the ‘Vostok K Incident’, a groundbreaking use of spatial sound across multiple consumer devices, launched on the BBC Taster platform in 2018. More recently, the team has run a pilot episode of *Casualty* which offered enhanced speech accessibility for people with hearing impairment.

CAN A MACHINE BE AN INVENTOR?

For the first time, patents for AI-generated inventions have become a reality, thanks to research by Professor Ryan Abbott.

Until now, the law has assumed that only human inventions are patentable, which means that there is no protection for the AI-generated inventions which have proliferated in tandem with rapid technological advances in recent years.

Professor Abbott (School of Law) has looked at the legal, regulatory, industrial and societal impacts of this gap in protection. He argues that allowing AI-generated inventions to be patented would facilitate innovation, advance the commercialisation of important advances such as AI-designed pharmaceutical drugs, and preserve the integrity of 'human inventorship'.

As a result of his research, patents have been filed for two inventions by the AI machine 'DABUS'. The UK Intellectual Property Office has conducted two legislative consultations, partly in response to the case, and suggested that there is a need for a change in the current law. In the UK, a denial of the patent applications was upheld last year by a divided Court of Appeal, and a discretionary appeal is now pending before the Supreme Court. The patents were issued in South Africa in July 2021, and days later Justice Beach in the Federal Court of Australia issued an extensive reasoned decision holding that an AI could legally be a patent inventor. The applications are pending or the subject of judicial appeals in numerous countries around the world.

Professor Abbott's work has sparked an international dialogue on how new technologies are challenging existing legal standards. His recent book, *The Reasonable Robot: Artificial Intelligence and the Law*, published by Cambridge University Press in 2020, highlights the negative and unintended consequences of the law treating behaviour by an AI and a person differently, and argues that it would be better for people if policymakers adopted a principle of legal neutrality. The book, which was launched last summer in the House of Lords, has been published in Chinese (and soon Portuguese) and as an audiobook, and was the subject of a symposium by the Jerusalem Review of Legal Studies.

CHANGING TIMES

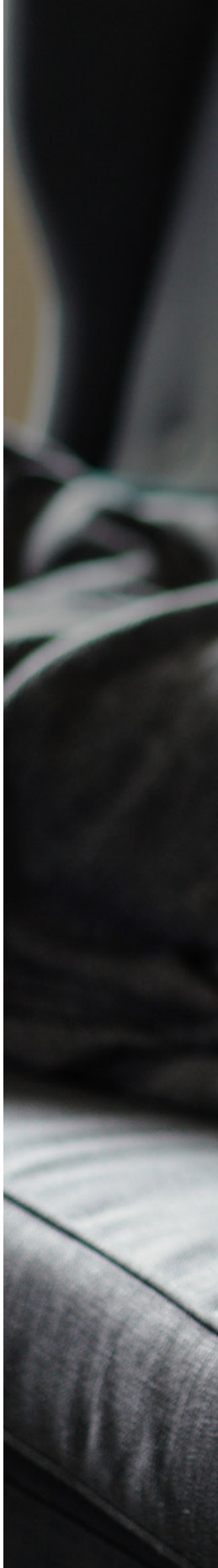
Electric light and screen use has disrupted our natural sleep-cycles, but mathematical modelling is throwing light on our bodies' needs, informing policy on school start times and permanent daylight saving.

Once, the 24-hour light-dark cycle regulated our circadian rhythms so that we went to sleep a few hours after dusk and woke at dawn. But access to electric light has disrupted this cycle, resulting in reduced or mistimed sleep which is associated with an increased risk of diabetes, obesity and cardiovascular disease, as well as impaired vigilance and cognitive decline.

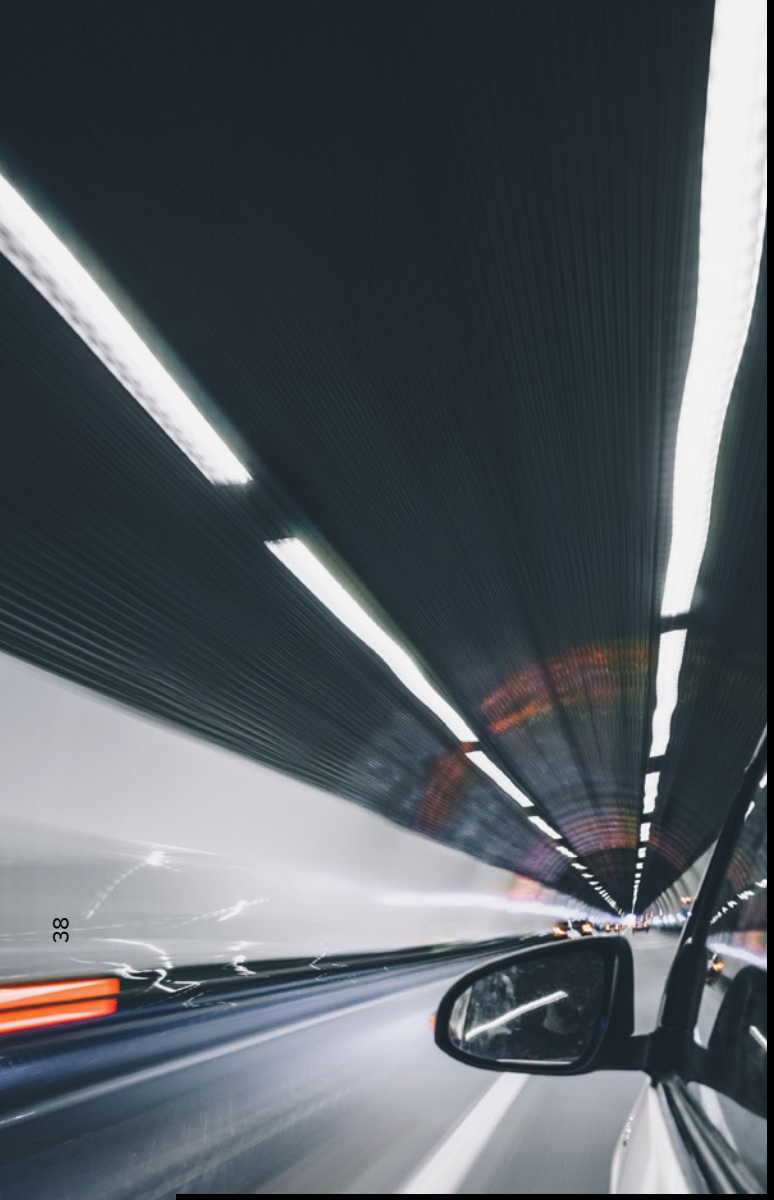
In order to better understand the impact of the modern light environment on sleep timing, Professor Anne Skeldon of the Department of Mathematics in collaboration with Professor Derk-Jan Dijk, Director of the Surrey Sleep Research Centre, have created the first quantitative mathematical framework to combine the biological mechanisms regulating sleep with primary external drivers (the light environment) and social constraints (such as getting up for work or school).

This framework has informed two important public policies. First, in both the UK and USA there have been calls for secondary schools to start later to better accommodate adolescents who typically go to bed late and struggle to wake early. The mathematical model showed that managing light exposure in the evening may be more effective than delaying school start times, which in fact may lead to a further delay of bedtimes for adolescents. Surrey's research has informed a Californian State Bill on school start times and been cited during a parliamentary debate in the UK. The UK Department for School Standards has decided against delaying school start times.

The second public policy relates to the move to abandon the biannual clock change. In 2018, the EU voted to stop moving the clocks forward in the spring and back in the autumn. In the USA, 19 states have voted to move to permanent daylight saving time, but the clocks continue to change because federal approval has been withheld. Here, physiology and mathematics agree that permanent daylight saving would exacerbate misalignment of our body clock with the working day. Surrey's work continues to inform the debate and contributes to the USA decision not to approve a shift to permanent daylight saving time.



> THE MODEL SUGGESTS THAT AN ALTERNATIVE REMEDY TO MOVING SCHOOL START TIMES IN THE UK IS EXPOSURE TO BRIGHT LIGHT DURING THE DAY, TURNING THE LIGHTS DOWN IN THE EVENING AND OFF AT NIGHT.
>
> *Nick Gibb, Minister for Schools Standards*



GEARING UP FOR NEXT GENERATION ELECTRIC CARS

With electric vehicles on the rapid rise, Professor Aldo Sorniotti is focused on developing advanced controllers which enhance safety, reduce energy consumption and improve comfort for drivers.

Global sales of electric and hybrid cars reached 3.2 million in 2020 – an increase of 43% on the previous year – but the driveability and performance of these vehicles depends on a new generation of dedicated controllers.

For the past decade, Professor Sorniotti and his team within the Centre for Automotive Engineering have been developing technologies which solve key challenges for future electric vehicles, including a first-of-its-kind anti-jerk control concept which combines wheel speed input and motor speed.

These technologies have been adopted by major automotive companies including McLaren, Elaphe and Tenneco, translating into more cost-effective design development and improved vehicle performance. As a result, the electric and hybrid cars of tomorrow promise to be more energy efficient, offer improved safety through better stability control and shorter stopping distances, and deliver a more comfortable drive.

> THEY HELP US TO QUICKLY DEVELOP PROTOTYPE VEHICLES USING OUR IN-WHEEL POWERTRAIN SETUP THAT CAN BE SHOWCASED TO OUR INTERNATIONAL PARTNERS AND CUSTOMERS.
>
> *Elaphe Propulsion Technologies*

FEEDBACK THAT WORKS

How students engage with feedback is just as important as the feedback itself: a Surrey research finding that's prompting education institutions across the world to revise their strategies.

There is a growing awareness that the true impact of feedback is not the comments given, but how students engage with and use this information. Professor Naomi Winstone, Director of the Surrey Institute of Education, has spearheaded research of this phenomenon, which sits at the intersection of education and psychology, and built the first evidence-based framework for developing students' skills to engage with feedback effectively.

Professor Winstone's framework has now underpinned the design of the freely available 'Developing Engagement with Feedback Toolkit' (DEFT), which has been downloaded nearly 10,000 times to date, and the 'Feedback Engagement and Tracking System' digital tool. One or both of these tools is now being used in over 100 universities, colleges and schools.

Challenging conventional ideas of feedback best practice, Professor Winstone's research has informed national and international educational guidelines, with the DEFT incorporated in Advance HE's 'Transforming Assessment Framework' guide 2020 and recommended by the Quality Assurance Agency.

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OUR IMPACT STANDS IN TESTAMENT TO THE DETERMINATION OF OUR ACADEMIC COMMUNITY TO REALISE THE BENEFITS OF THEIR RESEARCH IN THE SERVICE OF OUR COMMUNITIES.

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