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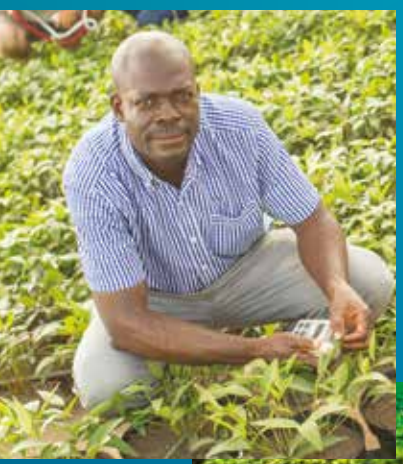




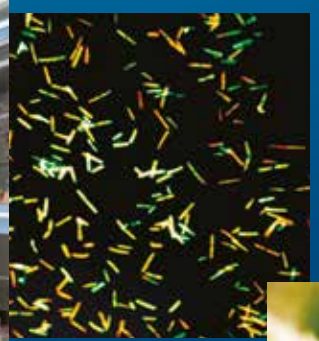



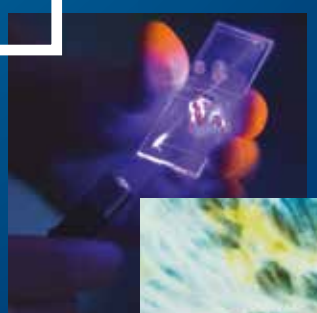








People are at the heart of our strategy

Our research vision
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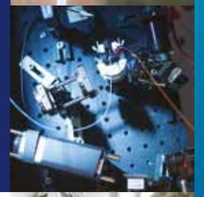

Discovery is in our DNA

Professor Dame Jessica Corner
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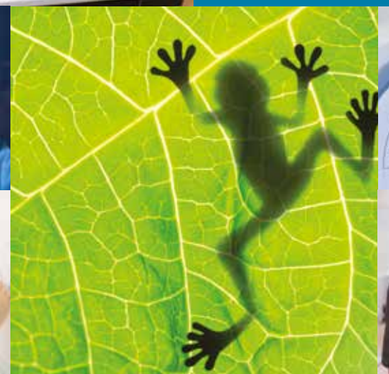

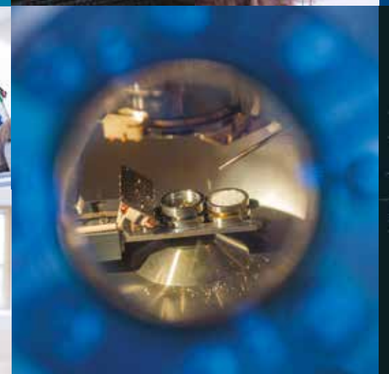

World-class science drives our approach

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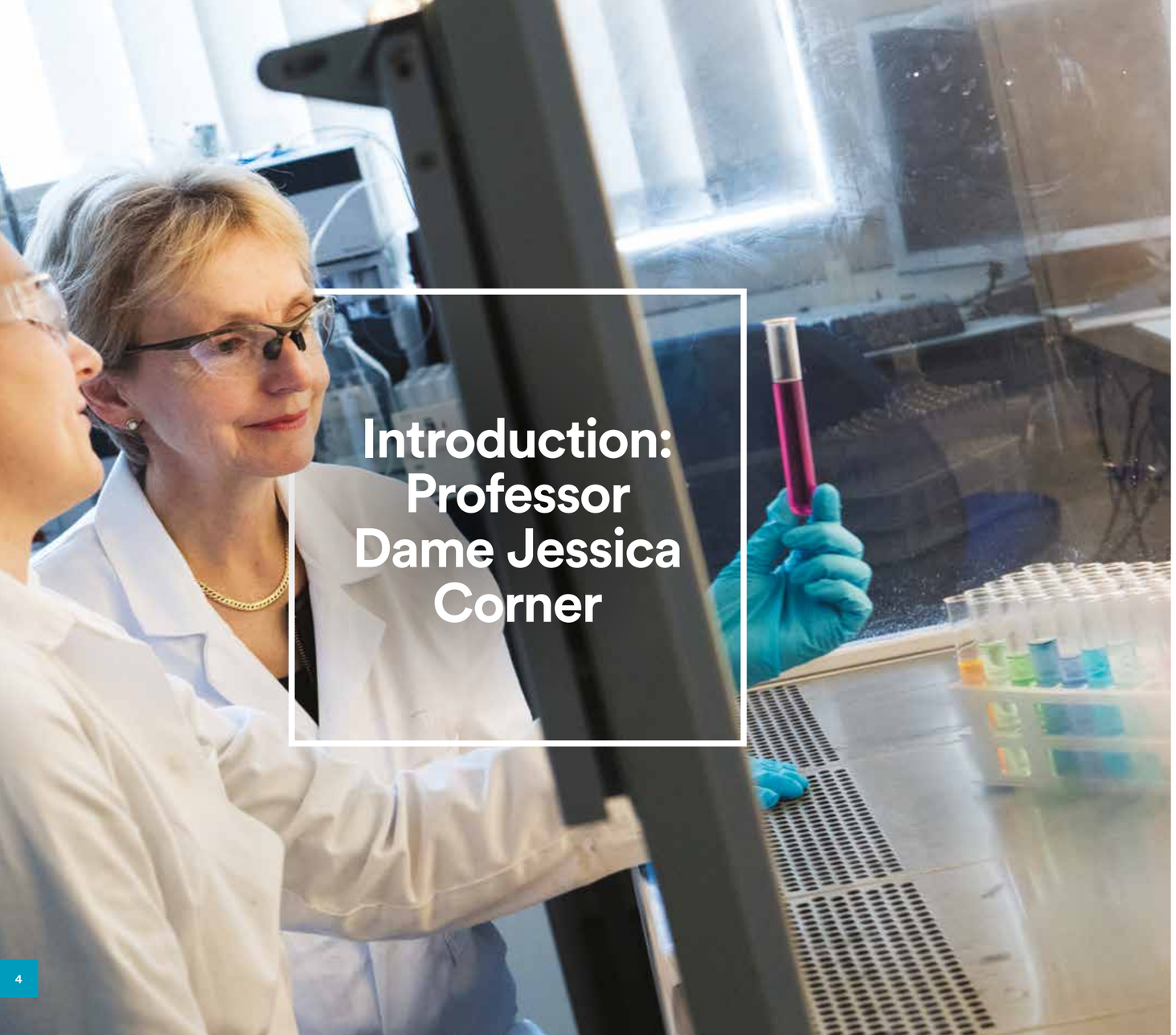


Introduction: Professor Dame Jessica Corner

Research excellence to transform the world

Our research is inspiring. It brings together talented, passionate and dedicated people as they strive to make discoveries that have a real impact on lives and societies across the world.

Here at the University of Nottingham we have a long-standing reputation for transformative, world-class research. Our pioneering, multidisciplinary and collaborative approaches deliver sustainable solutions to global challenges.

We are poised to build on this reputation with an unprecedented investment in our research and people. This will further enhance our international standing as one of the UK's powerhouses for transformative research.

Investing in people

We are committed to developing our research ecosystem as a model of excellence, generating even more research outputs that are recognised internationally as world-leading and of the highest calibre. We are investing in our people and expanding our prestigious research fellowship schemes to bring more of the world's best and brightest to Nottingham.

By attracting and retaining talent, we unlock potential and create teams and global networks with the collective power to transform lives.

We are continually improving our digital resources and infrastructure to match the scope of our researchers' ambitions. Our commitment to world-class facilities underlines our passionate belief in supporting the discoveries that will secure a more sustainable and resilient future.

What also makes us stand out is our ability to bring experts together from across disciplines, allowing an agile and multi-faceted response to complex and intriguing problems.

Our new Beacons of Excellence will build on our world-leading reputation in the fields of human rights, healthcare, agriculture and food, advanced materials and transport, bio manufacturing, and smart industries. All are driven by the need for sustainable solutions to key global challenges, and all are characterised by our transdisciplinary ethos.

These Beacons of Excellence support our goal of raising the profile of research at Nottingham. While remaining part of a robust and diverse research base, they will provide a model approach to attracting increased funding, strengthening international partnerships and accelerating the impact of our innovation.

Discovery is in our DNA. It inspires our people and is in the fabric of who we are.

Professor Dame Jessica Corner is Pro-Vice-Chancellor for Research and Knowledge Exchange at the University of Nottingham. Dame Jessica, Director of the Centre of Cancer and Palliative Care Studies at the Institute of Cancer Research, London, for 12 years, was awarded a DBE in 2014 for services to healthcare research and education.

A worldwide vision for groundbreaking research

We are committed to delivering research of truly global significance

We work to define what research can do today, making groundbreaking discoveries and developing powerful solutions to global challenges.

At the heart of our strategy are people: academics and researchers, postgraduate students and support staff. By coming together, we can realise our collective potential to deliver bold, innovative and excellent research that makes an impact.

We are one of the UK's leading universities, ranked eighth in the country for the quality and quantity of our research. More than 97% of research at the University is recognised internationally and more than 80% is ranked in the highest categories (world-leading and internationally excellent). We are in the top 75 of universities worldwide and our research portfolio has a value of £600m.

To achieve our goals, and continue to thrive in a globally competitive environment, we will raise the level of ambition as we work with funders, partners and stakeholders to tackle the global challenges we face.

At the heart of our strategy are people: academics and researchers, postgraduate students and support staff.

Our goals

Join the **top 60 global universities**

Become a **top five UK university for research power**

Increase our **research portfolio to £700m**

Investing in the exceptional

The University has a diverse research base of the highest quality in terms of funding, impact and reputation.

We aim to further our excellence in these fields by investing in the following key areas to ensure we achieve the vision, aims and goals of our Research Strategy:

- Developing world-class researchers
- Research infrastructure and support
- International collaboration
- Beacons of Excellence

We are committed to attracting and retaining the highest-quality researchers. World-class individuals, working in multidisciplinary teams and with inspiring leaders, are at the heart of capturing new ideas and translating these into world-changing solutions.

We empower research leaders to lead, and teams to work in highly productive ways. We develop careers and build a culture of high-performance research across the University. Our faculties, together with Global Research Themes and Research Priority Areas – developed to encourage transdisciplinary research – focus this investment. This research ecosystem enables more agile and proactive responses to research funding opportunities.

Investment in additional academic staff allows our high-performing researchers the time and space to make discoveries.

We continually invest in world-class facilities, infrastructure and digital systems to comprehensively support our researchers. As a result, we've seen a substantial increase in research rated at the highest level and research impact.

World-class support for our researchers

Continuous investment in a robust infrastructure underlines our research ambition.

World-leading facilities and equipment, libraries and professional services are dedicated to supporting researchers and translating their discoveries into impactful applications.

We are committed to a significant enhancement of our digital and support infrastructures. In doing this, we will stand apart from our peers, and remove barriers to conducting transformative research.

Investment in the Nottingham Research and Impact Accelerator will add momentum to the work of the Beacons of Excellence, and act as a model for emerging areas of research. Our challenge-led research means that our outputs are aligned to government and funder strategies, boosting our access to investment.

World-leading facilities and equipment, libraries and professional services.

Strengthening international connections

An international outlook is fundamental to everything we do. The establishment of our campuses in Malaysia in 2000 (the first to be established overseas by a UK university) and China in 2004 reflect our pioneering international outlook.

We passionately believe that international challenges are best addressed globally. This is accomplished by collaboration and knowledge exchange between our far-reaching international partners.

We actively encourage our researchers to seek collaborations with the best institutions in the world. Our international fund will support their mobility and interactions, underpinning our reputation as a global institution. Our three campuses are united as a family, with a common purpose and shared ideas.

As global landscapes evolve, we constantly seek new opportunities and partnerships, and respond proactively to international funding and collaborations, wherever they are generated.

These international collaborations are generated at every level. Early career researchers and PhD students benefit from a range of awards and funds designed to promote networks across the world.

Our investment in a world-class digital research environment will mean better connectivity with colleagues, wherever they are based.

Propelling excellence through our Fellowships

We nurture researchers and support staff across the University at every stage of their career, whether individually or in specialist teams.

As a research-led institution, we recognise the value and contribution of early career researchers in delivering our ambitious, high-quality research strategy. Their insights are invaluable, and we will enhance this vital aspect of our research network by recruiting 100 Nottingham and Anne McLaren Research Fellows by the end of 2020.

Case study

Dr Geertje van der Heijden

Dr van der Heijden, an Anne McLaren Research Fellow, is an ecologist based in the School of Geography.

"I'm interested in the influence of climate change on tropical forests and how they in turn influence climate change. My focus is on lianas, woody climbing plants. They use the trees to support their biomass to reach the canopy, but are detrimental to the trees they infest.

We're asking how do lianas affect the carbon balance and carbon cycle of these forests. As growing trees take up carbon from the atmosphere and release carbon back when they die, tropical forests are important for the global carbon balance and cycle. Lianas may affect this as trees that are infested with lianas grow less and die sooner. Lianas are increasing, at least in the Neotropics, and we're finding out if this something to worry about in terms of the global carbon balance and climate change.

I'm collaborating on a large-scale experimental removal study in Panama where we have removed all lianas from a certain area to compare with forest where lianas are still present to test this.

But I am also using other more observational approaches to answer these questions. Further funding would allow us to extend the liana removal project to Malaysia and Costa Rica.

From being very little in the Netherlands, I always wanted to go to the tropical rainforest. I studied biology and wanted to do a project in the tropics – that was lianas in Guyana and I got hooked. The first time I walked into the rainforest and thought 'Wow, I can die happy now'.

What drew me to Nottingham was the opportunity to do three years of independent research and then go into an academic position. Normally, if you start as a lecturer or assistant professor your teaching can put research on the back burner for a while. With my Anne McLaren Fellowship, I can set up my research programme first and teaching responsibilities follow later.

The other tropical researchers based here in the School of Geography, as well as in Life Sciences, were a big draw. I have always been interested in applying remote sensing techniques to my research and expertise here makes this possible and will broaden my research scope. We work with images from satellites, planes and also drones.

These images offer wider spectral responses and access to information on a bigger scale. It's another means of collecting data – a different view on the world; I'm on the ground and they're looking from above. It's great to combine expertise: we've discovered a wealth of possibilities together.

I have to say that the University support is amazing. The Centre for Advanced Studies (CAS) helps with grants and gives so much support. The biggest grant I'd had was the Anne McLaren Fellowship and I'm now writing grant bids for 10 times that amount!

The magic hasn't worn off, especially if you get a chance to go to a whole new area. I'd never been to South East Asia before so to go to Malaysia last year, to see how the forest there differs from South America, was great. My plan is to extend my liana project over South East Asia, but one step at a time! Being at Nottingham in a way has opened-up a whole new continent for me."

I really enjoy it here, I love the Fellowship, I love the work.


8th in UK for research power
An inspiring research portfolio worth £600m
97% of research recognised internationally
Over 3,000 researchers
World-class facilities
Global networks and collaborations
In the top 1% of universities worldwide

Beacons of Excellence

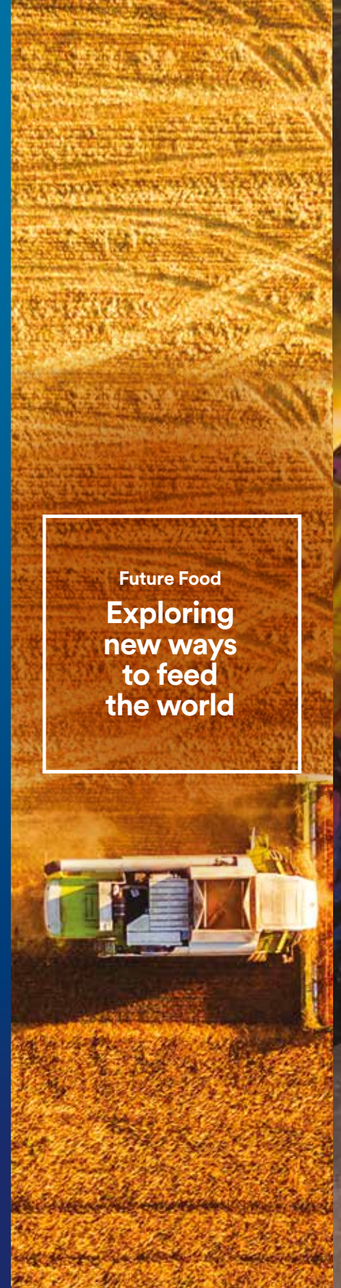
Our ambition is for the University of Nottingham to be recognised as among the very best in the world. Our Beacons of Excellence are at the core of this global vision.

The Beacons will champion our field-leading responses to global challenges. They will drive significant inward investment in to our internationally renowned research areas, and support our ambitious vision by increasing collaboration, strengthening networks and partnerships, attracting diverse funding, and raising the reputation of our world-changing research.

Powerful, transdisciplinary discoveries can only be achieved as part of a vibrant research ecosystem. With the Beacons embedded into our research base, our resources will be more diverse and fertile than ever before.

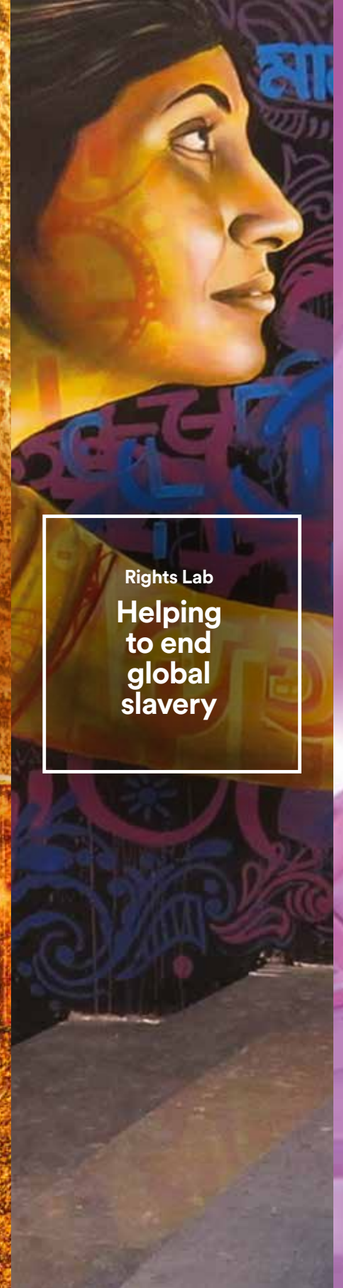
Our Beacons are just part of a significant investment in the resources, people, infrastructure and environment essential to delivering our world-leading discoveries.

> Our commitment is to all researchers, in all disciplines, who are committed to excellence.



Future Food

Exploring new ways to feed the world

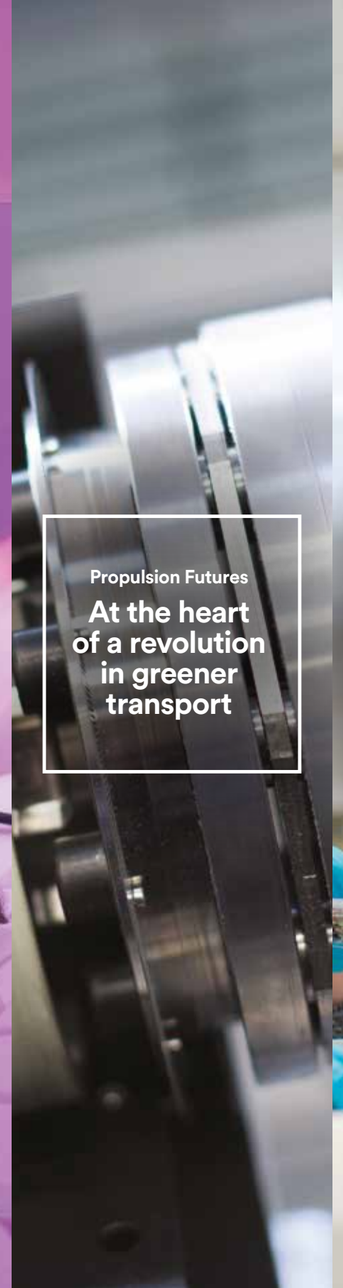


Rights Lab

Helping to end global slavery

Precision Imaging

Transforming healthcare with pioneering imaging



Propulsion Futures

At the heart of a revolution in greener transport

Green Chemicals

Securing the low carbon bio-economy of the future

Smart Industrial Systems

Towards smart production of smart products

Beacon of Excellence:
Future Food

Exploring new ways of feeding the world

In the face of climate change we must develop new, resilient crops. Yields must also increase to feed the additional two billion people expected by 2050.

Future Food addresses the challenge of feeding a growing population in a changing world.

In the face of climate change we must develop new, resilient crops. Yields must also increase to feed the additional two billion people expected by 2050. Better access to healthier, safer, more nutritious food is needed in all countries due the growing prevalence of pollutants, nutrient deficiencies and over-processed foods.

All these challenges must be met in sustainable ways that do not put additional strain on the planet.

Our researchers have expertise across the food chain – from molecule to meal – to deliver solutions to these global challenges.

We will:

- Increase food diversity by introducing new crops and genetic variants to breeding programmes and agriculture
- Enhance resilience by improving the yield and quality of crops in the face of environmental challenges such as climate change
- Improve nutrition by creating healthier foods, supporting innovation in food processing and raising understanding of the choices made by consumers.

World-class science drives our approach across this food production to consumer pipeline. With the UK's biggest group of plant scientists, we identify crop and food-related targets for intervention and deliver plant and crop science to engineer such interventions. By ensuring delivery of the appropriate technology to the farmer, food industry and consumer our research will translate into solutions to the challenge of feeding the world in healthier and more sustainable ways.

Researchers at Nottingham have expertise across the food chain – from molecule to meal – to deliver solutions to these global challenges.

Beacon of Excellence:
Rights Lab

Helping to end global slavery

Our research is helping to end contemporary global slavery in our lifetime.

There are 46 million people enslaved around the world today. Yet we are at a tipping point: there is a global political commitment to ending slavery by 2030.

We are delivering the world's first large-scale research agenda for defeating slavery, which places Nottingham at the forefront of the UK's pledge to lead this global fight.

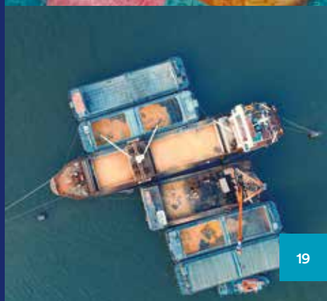
Our challenge-led approach fuses cutting-edge research with real world application. We work with governments and NGOs to achieve a Freedom Dividend: the global benefits of ending slavery for economies, rights, health, peace and the environment.

We are home to the world's leading experts on contemporary slavery. Our research has underpinned antislavery with an advanced research agenda for the first time in the 230-year history of antislavery action and was named one of the "world-changing discoveries of the past 50 years" by the Association of British Universities.

We are discovering slavery's full nature and extent, explaining its causes and consequences, designing research-led interventions that pilot innovative new approaches to combating slavery, and evaluating antislavery efforts. Our work is survivor-engaged, shaped by people who have lived through slavery, and adopts a 'rigorous morality' approach that fuses cutting-edge research with advocacy.

Our transdisciplinary research fuses methods, tools and techniques across disciplinary boundaries. This means we can map slavery from space with the world's first Geospatial Slavery Observatory; redesign supply chains to help businesses ensure they aren't using slave labour; pioneer a unique programme of therapeutic care for people coming out of enslavement; and estimate slavery's prevalence country by country, among many other projects.

We are the global leader on research-led strategies for ending slavery.



Beacon of Excellence:
Precision Imaging

Transforming healthcare with pioneering imaging

Our advances in medical imaging will drive the development of personalised therapies in mental health and other chronic diseases.

The University of Nottingham is the home of MRI and has an internationally leading position in biomedical imaging research. We aim to establish the University as a powerhouse for imaging in precision medicine.

We will drive the discovery and translation of new imaging tools, which will transform diagnosis, improve the prediction of outcomes for patients and better evaluate the success of medical interventions.

We will design new techniques to address key global healthcare challenges and translate these discoveries into improved care and treatment of patients across the world.

We will focus on diseases that have the biggest impact on health and societies and lack adequate treatments, including treatment-resistant depression and chronic pain. Our research and continuing advances in MRI offer the prospect of new understanding and revolutionary treatments for mental illness.

> We will change how people at risk of disease are identified, how they are selected for intervention and how they are treated.

Beacon of Excellence:
Propulsion Futures

At the heart of a revolution in greener transport

Our discoveries in sustainable materials and technologies will drive the vehicles of the future.

Propulsion in transport is on the cusp of a revolution and societies are being challenged to think differently about how we move people and goods.

Greener, electric transport will be at the heart of this revolution.

We are driving the discovery and translation of new materials, components and technologies needed for this new age of sustainable transport.

Our world-leading expertise in sustainable materials and transport technologies will place us at the forefront of this challenge and secure huge economic and strategic benefits for the UK.

Our mission

We will develop the next generation of high power density and low-loss electrical machines that are able to drive the propulsion systems of the future, underpinned by innovative sustainable materials.

The form of these new aircraft, ships and land vehicles will evolve over time. But all will require propulsion systems that exceed the performance of today's vehicles, without putting strains on our environment and resources.

By helping to deliver vehicles that no longer have such a destructive impact on the environment, we will benefit societies across the world, making unprecedented advances in fuel savings and carbon-neutral travel.

We will define and deliver the propulsion system of the future.

Beacon of Excellence:
Green Chemicals

Securing the low carbon bio-economy of the future

We will spearhead the transformation of energy-intensive economies into low carbon societies.

Our research delivers a technology platform enabling low carbon chemical processing.

A technological revolution in synthetic and computational biology has created transformational opportunities in providing cost-effective and more sustainable processes for the chemical industries. In addition to economic benefits, these opportunities offer elegant solutions to UN Sustainable Development Goals.

Today, many products are manufactured from fossil fuels using energy-intensive petrochemical technologies. In the age of the genome, many products will stem from cell factories.

We will pioneer in this multi-disciplinary field, integrating world-leading expertise in metabolic engineering, process development and sustainable chemistry. Our innovations will re-imagine the processing of carbon feedstocks outside the food value chain towards a more sustainable supply chain.

Facing up to global challenges, our research will have transformational impacts on agriculture, industry and health.

Beacon of Excellence:
Smart Industrial Systems

Towards smart production of smart products

In our new industrial age, smart factories will deliver highly personalised goods and services.

This demands profoundly new approaches to how we create, manufacture and use products, while redefining our relationships with technologies and each other.

Our vision is to establish a programme of far-reaching fundamental and transformative discovery and to deliver responses with a speed and agility that matches the unprecedented pace of change in our digital world.

By bringing together expertise from informatics, creative design and industrial technologies, as well as the social sciences, our discoveries will enrich personal experiences, build better-connected societies and provide exciting opportunities for business in a skills-rich UK economy.

We will deliver:

- **Smart, interactive products:** New approaches to interactivity and design will customise mass production and deliver unique user experiences
- **Smart production processes:** Data, humans and systems will seamlessly interact – instead of programmed, passive machines, manufacturing will be truly dynamic
- **A connected industrial infrastructure:** By delivering models for the digital marketplace, taking in the whole system lifecycle, we will make UK industry a world leader in this new industrial and consumer landscape
- **An ethical framework:** Complex questions arise from heightened interactivity and richer user experiences. We will explore how such innovations will affect us and how they might adapt with us over our lifespan

The University is commited to fundamental discovery and its application in key UK sectors including aerospace, automotive, consumer and the creative industries. We will position Nottingham as a world-leading research and innovation centre for digitally enabled industrial systems and enhance the UK's productivity and global competitiveness.

Case study

Transdisciplinary research

Modelling antimicrobial resistance in the real world

The rise of microbes resistant to antibiotics is a global threat to human and animal health.

Dr Dov Stekel, a biological modeller in the School of Biosciences, led a successful bid for a £1.5m grant to study how antimicrobial resistance might develop in agricultural slurries and manures.

Dr Stekel, who is based at the University's Sutton Bonington campus, explains that its working dairy farm offered an exciting opportunity for transdisciplinary research into how farmers and vets can reduce the risk of spreading antimicrobial resistance in farm waste while maintaining animal welfare.

"This research came about through a happy accident. I asked Stephen Ramsden, the farm director, for a tour of the farm here at Sutton Bonington and I got really excited when I saw the three-million-litre slurry tank – that volume is part of what is needed to store the slurry from a medium-sized dairy herd. It is in effect an enormous fermenter containing not just slurry but bacteria – some of which could be exhibiting anti-microbial resistance characteristics. The dairy and in particular the slurry tank were an ideal environment to gain a greater understanding of anti-microbial resistance and its causes.

The funding call from research councils on the theme of antimicrobial resistance in the real world matched everything we had been thinking about and we received this £1.5m grant from the Antimicrobial Resistance Funders' Forum (a national body coordinating research) in a scheme run by the Natural Environment Research Council (NERC).

> My own research group does modelling, which is the business of quantifying risk. We were able to say that there could be more than one way of controlling the spread of anti-microbial resistance – not just by limiting antibiotic use, but by looking at how the waste is handled.

The University has over 50 people engaged in a range of projects in antimicrobial resistance and agriculture, with Biosciences, Sociology and Social Policy, Veterinary Medicine and Science, Geography, Pharmacy, Engineering and Mathematical Sciences all involved, as well as colleagues at the universities of Birmingham and Warwick. It's a very diverse set of skills and that's critical – AMR is an enormously complex problem. The research culture here is very multidisciplinary – people are open to collaboration and react positively to shared ideas.

I'm very interested in developing approaches to modelling resistance in the environment. Understanding social and economic factors is going to be central in dealing with this in the future. Our partners cut across sectors – farming, the veterinary sphere, the policy sphere – Defra, the Food Standards Agency and the water industry. It's vital that as we get results that we engage with the community and communicate those results as a conduit into practice and policy. We're also working with international partners in China, South Africa and India towards further funding calls."

Industrial collaboration

Cutting through the noise to help pregnant mothers

In 1987, Barrie Hayes-Gill, Professor of Electronic Systems and Medical Devices in the Faculty of Engineering, and his colleague Professor John Crowe were working with a PhD researcher who was looking at ways of detecting the faint foetal heartbeats within pregnant mothers.

Case study

Professor Barrie Hayes-Gill and Professor John Crowe

Thirty years on, their novel foetal and maternal monitoring product has been acquired by GE Healthcare and will help pregnant women across the world. Professor Hayes-Gill takes up the story.

"Ultrasound – the traditional method of trying to find the foetal heartbeat – picks up its mechanical beating. But it quite often picks up the mother's heartbeat rather than the baby's.

So we thought we'd see if we could detect the foetal heartbeat electronically. This was a challenge – it's an incredibly small electrical signal in the foetus, between one and 20 microvolts, whereas the signal of the baby's mother's heart is about 1000 to 5000 microvolts.

So we needed to address the issues of electrical noise and signal processing, to remove 'noise' and then understand the signals: were they the mother's heartbeat, the baby's, or something else? After several years of research and refinement, we developed a solution, to accurately detect not only the foetal heartbeat but also the maternal heartbeat.

Originally, this was a single-channel sensor, but this involved the midwife repositioning it to where the baby was lying. We developed a three-channel sensor to pick up the signal wherever the baby was lying.

This was patented in 1999, along with a signal-processing pattern recognition algorithm.

For three years, we attempted to license the technology. But industry said it was too early-stage – though we had over 500 recordings. Small grants allowed us to bring back former PhD researcher, Carl Barratt, who focused on the commercialisation side and how to set up a company. In 2002 a second patent was filed to further strengthen the IP (intellectual property).

In 2005 we decided to establish a University spin-out business. Carl was appointed as Chief Executive and we recruited another former PhD researcher, Jean Francois Pieri, whose PhD work formed the 1999 and 2002 patents. Jean Francois became the Chief Technical Officer. One of my ex-collaborators at Oxford Medical, Dr Terry Martin, joined as Chief Marketing Officer.

With the University's technology transfer team, we secured £650,000 from Catapult and Lachesis along with a EU Marie Curie grant. We worked on refinements and finding suppliers who could manufacture it to our specification.

Products need to be reliable, robust and durable and finding a solution that the customer and patient is happy with takes a lot of work, improvement and testing. Regulatory approval processes can complicated – I now know the EU's Medical Devices Directive inside out, and also the equivalent FDA 510k approval processes in the USA, where we secured clearance in 2011.

By getting our early products into the marketplace, we proved there was demand. The big companies started to take notice and in 2015 we signed a distribution deal with GE Healthcare for our Novii Wireless Patch System. This is a wireless Bluetooth system which provides patients with mobility in labour using the original patented noise reduction and signal processing techniques. The demand in the USA grew rapidly which greatly enthused our GE distribution team. GE bought Monica outright in March 2017 and we can now fulfil our ambition of using it to help pregnant women across the world.

It's been a very long journey. Over 30 years ago it was just an idea but I knew that if we could cut through the noise in detecting foetal heartbeats, we could produce something that would be better than the competition. The University, along with all the funders, researchers, and the many other supporters should all feel very proud of what they have achieved by working together and believing that this technology could make a big impact globally."

> "We can now fulfil our ambition of using it to help pregnant women across the world."

University of Nottingham
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For research enquiries contact:
t: +44 (0) 115 951 5151

research@nottingham.ac.uk

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