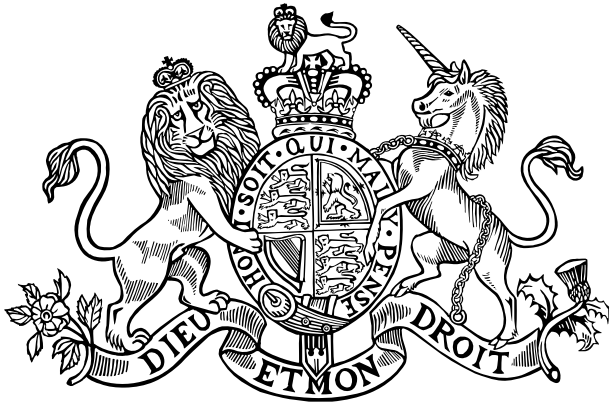


IMPACT!

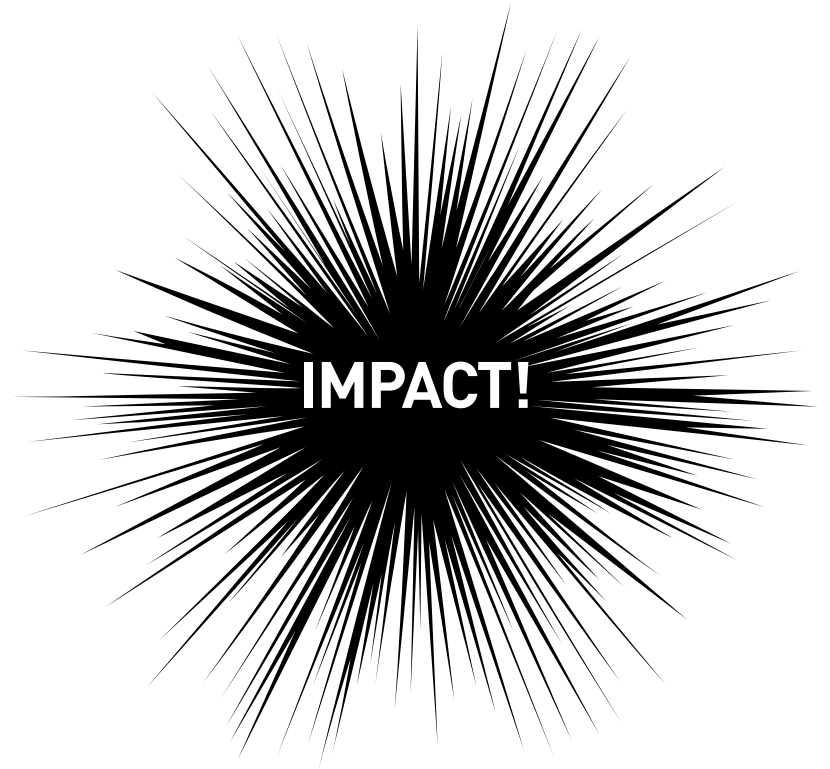




Royal College of Art

Postgraduate Art and Design

NESTA Making
Innovation
Flourish



EPSRC

Engineering and Physical Sciences
Research Council

INTRODUCTION

IMPACT! exhibition is an experiment. It has fused leading UK research groups with British design talent to explore the impacts, implications and possibilities created by pioneering science.

Each of the sixteen design projects has been created by designers from the Royal College of Art (RCA), and are based on a research project or research centre supported by the Engineering and Physical Sciences Research Council (EPSRC).

The research included in the exhibition spans the broad spectrum of engineering and physical sciences. It ranges from renewable energy devices and security technologies to the emerging fields of synthetic biology and quantum computing.

Sixteen leading designers and design teams have worked with the researchers to understand and explore this science.

The mixed-media design projects they have created bring a new perspective to the research. They do not seek to predict the future, or show design applications of science, but offer a creative interpretation of the potential impacts of these new scientific ideas.

Through this work, we are invited to stop, to think differently about science and engineering: the part it plays in our lives, and our aspirations for the part it will play in the future.

IMPACT! exhibition is a collaboration between EPSRC, RCA and NESTA.

FOREWORD

The world of scientific research and that of design may appear vastly different. However, scratch the surface and many links and similarities are revealed.

Great science teamed with innovative industrial design has delivered some of the world's most important technologies. It is this combination that elevates the purely functional or aesthetic to the status of iconic. Our attachment to the Mini, the iPod or any one of Brunel's bridges is testament to this.

Each creates opportunities for the other. Design has made technologies portable, ergonomic and acceptable. Scientists and engineers have created new materials and new manufacturing techniques that open up exciting design possibilities.

But conceptual design and science also share similarities and each can enhance and inspire the other. That is what this exhibition seeks to celebrate.

Both break new ground, challenging perceptions and allowing us to interact with our world in new and fantastic ways.

Together, EPSRC researchers and RCA designers have brought new and unexpected perspectives to the research.

Our hope is this collaborative project provokes the audience to consider the importance of engineering and the physical sciences, and of design: their astonishing potential and the impact they can have on all our lives in the future.

Professor David Delpy
EPSRC Chief Executive

CREATIVE COMMUNICATIONS

Demonstrating the impact of engineering and physical sciences research is one of the greatest challenges for EPSRC and our community.

The impact of the work we fund is often hidden or difficult to explain. And yet it is vital to engage the public and help create a society which is aware, involved and excited about research, and supportive of government investment in the science base.

Research can transform society. New technologies save lives; fundamental science helps develop cures; pioneering research discoveries generate whole new industries and fuel economic growth.

Our IMPACT! campaign is revealing how seemingly abstract and complex projects affect our everyday lives and how they can create a prosperous, healthy, and sustainable future for us all.

Creative collaborations, such as this one between EPSRC and the RCA, are a powerful way to communicate these ideas – to explore the boundaries between science and society, and to provoke, inspire and involve the public.

David Burrett Reid
Chair, IMPACT! exhibition Project Board
Head of Marketing & Communications, EPSRC

BETWEEN REALITY AND THE IMPOSSIBLE

What happens when you decouple design from the marketplace, when, rather than making technology sexy, easy to use and more consumable, designers use the language of design to pose questions, entertain and provoke – to make us think.

Design can shift discussions about the impact of science on our daily lives away from abstract generalities to concrete examples grounded in our experiences as members of a consumer society. It can facilitate debate about different technological futures before they happen, create dialogues between different publics and the experts who define the policies and regulations that will shape the future of technology, and help ensure that we pursue the most desirable futures and avoid the least desirable.

The design projects in this exhibition offer an alternative view of how science could influence our future. The purpose is not to offer prediction but to inspire debate about the human consequences of different technological futures, both positive and negative.

There are no solutions here, or even answers; just questions, ideas and possibilities. They probe our beliefs and values; they challenge our assumptions; and they help us see that the way things are now is just one possibility, and not necessarily the best one.

Professor Anthony Dunne
Head of Department, Design Interactions, RCA

1

HAPPYLIFE

James Auger

**Prof Reyer Zwiggelaar
Dr Richard M. Turley
Dr Bashar Al-Rjoub**

Concealing contraband isn't just a serious crime. It's also a test of sheer nerve. Even in our high-tech age, a cool head remains a key ingredient in the smuggler's art. The ability to look innocent even when very guilty can boost the chances of deflecting the attention of customs officials and other border control agents.

But what if involuntary, almost imperceptible body movements gave the game away? What if technology could identify the likelihood of guilt from the smallest changes in facial expression or the slightest alterations in body temperature?

This research project is probing the technical and operational viability of just such an approach. Investigating the potential to detect physiological processes that could indicate guilty intentions, it plans to develop new anti-smuggling techniques for trial at real-life border controls.

In the context of national security, invasive technology is accepted because the worst-case scenario would be infinitely worse. These technologies though often filter into everyday life where their application has a far more questionable presence. What would it mean to introduce such technology into the family home: when an electronic device can know more about your partner's state than you do? Or can predict an incoming bout of misery through statistical analysis of accumulated data.



'Happylife' thermal image #142893. Occupant 3 at 18:31, 21/06/2013.
A+0.06°, B+0.5°, C+0.08°, D+0.02°, E+0.09°



If rogue mobile factories could produce custom high-tech goods, what would the black market of 'special orders' look like?

2

FABULOUS FABBERS

David Benqué

Prof Marc Desmulliez
David Topham

A revolution is coming. In the way products are designed. In the way they are made. In the capabilities of the products themselves.

Ripping up the rulebook, this research has set itself an ambitious and formidable objective – to transcend the limitations that current microelectronic techniques impose on the manufacturing industry, in terms of what can be manufactured and what can be imagined.

Vigorously pursuing their bold philosophy of dynamic change, the research team have developed new manufacturing techniques that have successfully produced a range of radical, three-dimensional miniaturised 'smart' products. They include a multi-functional health-monitoring sensor for use on aircraft and a groundbreaking integrated biological processor. Collectively, these pioneering products provide just a glimpse of the new horizons beckoning technology-centric industries as diverse as aerospace, telecommunications and medicine.

Factories are moving away from the fringes and coming to town! Advances in micro-scale engineering point to a global-scale revolution where local, disposable factories produce high-tech goods on our very doorstep. What form might this new way of 'making things' take within our urban landscape? From garage-workshops to circus-like structures, from street vendor stalls to vagabond encampment, these new factories could also bring back ownership of the tools of production.

3

DOES IT SMELL LIKE FAIR TRADE?

Nicolas Myers

Dr Apurba Kundu

Dr Ian Brown

Dr Dorothea Kleine

Dr Ann Light

It's a familiar dilemma for shoppers. How do you know exactly what you're buying? Where supposedly ethically produced goods are concerned, how can you tell precisely where your hard-earned money goes and how much ends up with the producer?

'Fair tracing' digital tagging systems could provide the answers. It may soon be possible to access the back story of any product, simply by pointing your mobile phone at a special barcode. Instantly, a world of data would be dispatched to your mobile, covering every stage of the chain linking producer and consumer – and enabling you to make genuinely informed purchasing decisions.

This research hasn't just underlined the viability of such technology. It has also identified the kinds of data that producers in developing countries can realistically provide.

If the surface of a product could react and reveal its composition, how would it tell its story? What is it made of, where has it been? Inspired by the way the natural world communicates, this design project envisions an alternative to labels and packaging: a living skin, translating consumer information into patterns, smells or textures. In the same way a fruit tells us about its nature, could products themselves inform us of their ethical credentials in an immediate and physical way?



Colour, smell, texture – could products communicate their ethical credentials in an immediate and physical way?



A Civil Defence V-700 Geiger counter measures radiation emitting from the 'yellowcake'.

4

NUCLEAR DIALOGUES

Zoe Papadopoulou

**Prof Francis Livens
Dr Neil Hyatt**

The search is on for a new generation of scientists, a new breed of experts with the skills to turn 21st century visions of nuclear energy into a reality. Safe energy. Reliable energy. Climate-friendly energy. An energy supply that can help propel the UK into the future with optimism and confidence.

From nuclear materials science to radioactive waste management, harnessing the potential of nuclear fission technology will demand specialist expertise of world-leading calibre.

The Nuclear FiRST (Fission Research, Science & Technology) Doctoral Training Centre is determined to reverse the UK's shortage of nuclear scientists. Its radical approach, embracing cross-disciplinary training and the historical / political context of nuclear research, is designed to develop a family of talent that will play a pivotal role in our re-energised nuclear industry.

This project is motivated by the gulf between nuclear power and the people using the energy it produces. Using the inviting setting of a tea party and the sharing of 'yellowcake', (both the colloquial name of a type of uranium powder, and a treat containing predominantly radioactive ingredients), it features discussions about nuclear power and its by-products. These by-products, such as excess heat and hot water, can be utilised in the design of microclimates and in wildlife preservation.

5

THE 5th DIMENSIONAL CAMERA

Anab Jain
Jon Ardern

Prof John Rarity
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Dr Simon Benjamin

Quantum mechanics is an extraordinary branch of science. It's a field where the boundary between fantasy and reality can start to blur. Imagine, for instance, a device that makes modern supercomputers look obsolete. It's called a quantum computer.

Quantum computers aren't with us yet. But if and when they arrive, the impact could be colossal, reaching into every corner of our lives. From totally secure communication to new medical sensors that revolutionise healthcare and complex modelling that could engineer powerful new drugs to defeat pandemics – the possibilities are endless.

This research is helping the UK stay at the forefront of the race to develop these remarkable machines. That means comprehending quantum mechanics' most fundamental properties – and exploring the possibility of parallel universes that they imply.

Intimidating or liberating? Or both? To explore the impact this mind-blowing science could have on our sense of place and purpose in the universe, 'The 5th Dimensional Camera' is a fictional device that captures glimpses of parallel universes suggested by quantum physics. How might we seek to interact with these other worlds? Would we become jealous of our parallel selves? What would happen to our sense of morality if we knew that we had committed inconceivable acts in another world?



Above the sprawling city, a young man sets up The 5th Dimensional Camera, anxious to peer into his parallel lives.



An apron to collect and capture phosphate from urine, which crystallises in its front chambers and forms kidney stones.

6

ASTRONOMICAL BODIES

Michael Burton

Dr Terence Kee

Establishing how life first appeared here on earth continues to tax minds and imaginations the world over. Undeniable progress has been made in explaining how life's precursors developed billions of years ago. But the processes enabling biomolecules to emerge from this chemical chaos remain shrouded in shadow.

Developing a convincing theory on the origins of life remains one of science's greatest goals. Such a theory will have to be creative and multidimensional, as well as scientifically plausible and comprehensively testable.

This research is investigating the key role phosphorus may have played as a building block of life. Moreover, the team are exploring the intriguing possibility that the type of phosphorus needed to kick-start life, here and perhaps on other worlds, arrived in a meteorite.

Did life on earth emerge from key chemical elements received from outer space? If so, the universe can be seen as bio-friendly and life as a natural part of the universe. If we think of ourselves as astro-biological products of galactic composition, should we continue to colonise space with life? What if we collect phosphate from our urine and kidney stones, and create meteorites? These could be sent into space to seed life on other habitable planets, initiating a process of self-assembly and evolution.

7

POLICING GENES

Thomas Thwaites

**Prof Gloria Laycock
Dr Hervé Borrión**

At some time in our lives, many of us will fall victim to crime. For some people, awareness of this potential vulnerability can seriously undermine their quality of life.

The key to combating crime and defusing the deep anxieties it creates isn't just to keep pace with the criminal mind. It's to stay one step ahead. That's where science can make a crucial contribution, devising ingenious new security technologies, dissecting crime's socio-economic context and penetrating the hidden depths of human behaviour.

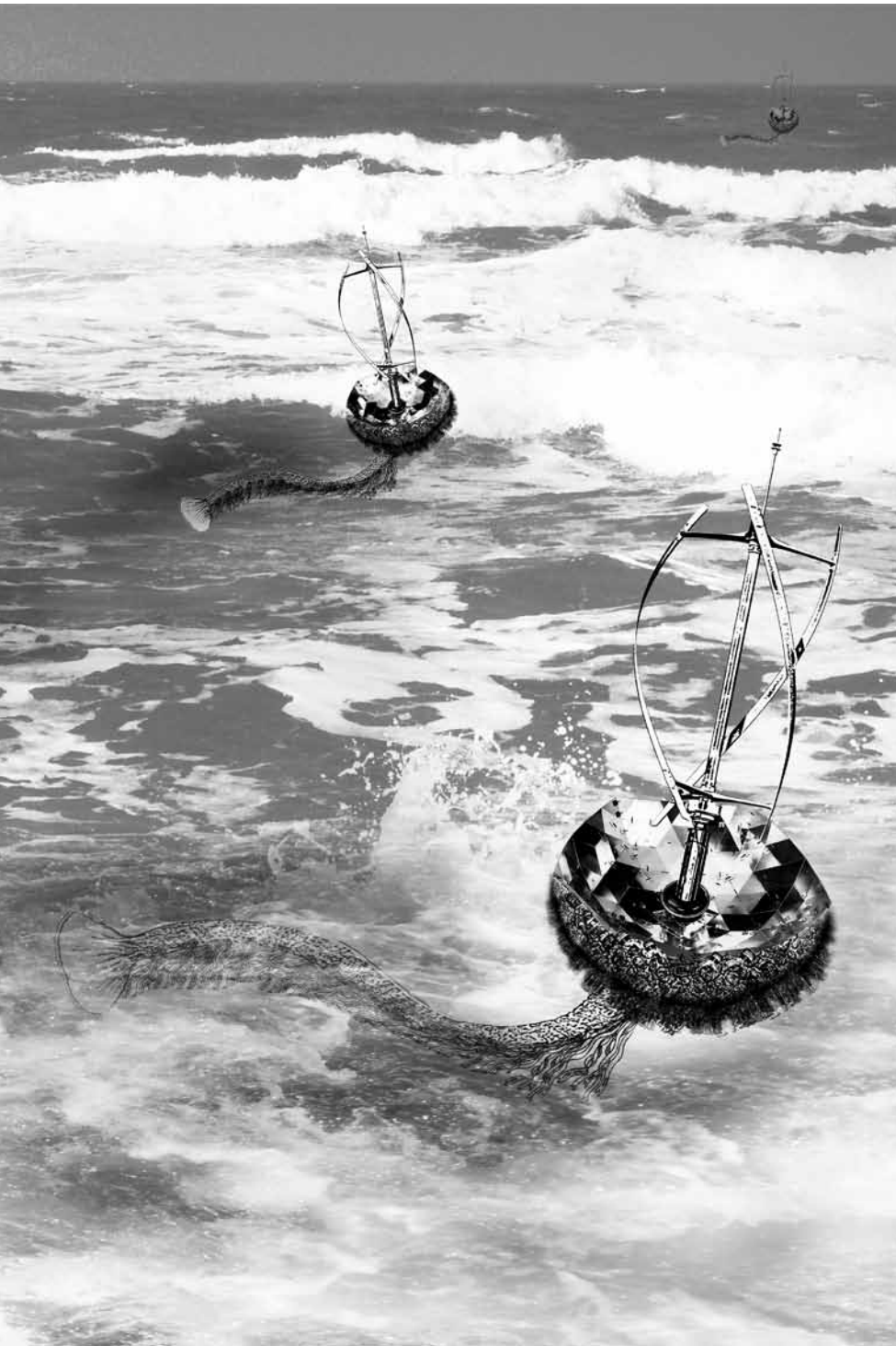
SECReT (the Security Science Doctoral Research Training Centre) aims to develop the security specialists of tomorrow and equip them with an unprecedented understanding of crime science. Its approach is rooted in a passionate commitment to innovative, transformative thinking and crime-fighting methods that don't come with an unacceptable social or ethical price tag.

Plants genetically engineered to produce vaccines are currently undergoing field trials. This technology promises to allow pharmaceutical companies to economically harvest useful drugs.

'Policing Genes' speculates that, like other emerging technologies, it will find a use outside the law, with narcotics and controlled pharmaceuticals grown in innocent looking garden plants. It proposes a police response that uses the natural behaviours of bees to monitor the genetic make-up of pollen in an area.



A surveillance apiary, used to monitor the genotype of plants growing in the area.



Energy_Animals: distributed drifting energy farm. Energy is everywhere; we can harness its many forms and provide various services.

8

ENERGY_ANIMAL

Cesar Harada

Dr Valentin Heller

The animal kingdom is a rich source of inspiration for engineers and scientists. From swimsuits based on shark skin to termite mounds that may hold the key to self-cooling buildings, the natural world offers secrets that could transform virtually every facet of human life.

Now a 150m rubber snake could be set to get a bite of the energy market. This revolutionary wave-power device is designed to generate low-cost electricity from the sea. It achieves this by harnessing bulge waves that form inside the device – waves similar to those produced in mammals' arteries by pressure pulses from the heart.

Research is now focusing on questions that must be answered if arrays of this marine energy converter are to be anchored to our sea beds.

The Energy_Animal combines wave, wind and solar energy in a single composite energy converter. Our drifting module generates energy off the grid, whatever the weather. The Energy_Animal is not only a renewable source of energy, but the convergence of environmental, safety-at-sea, aquaculture and communication functions through a network of devices. The device would become part of a large bio-architectural superorganism, an entirely new class of habitable ocean architecture.

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UNKNOWN UNKNOWNNS

Onkar Kular

Prof Denis Smith
Dr Moira Fischbacher

Globalisation is here. As holiday makers, business travellers and an astounding volume and variety of goods pour in and out of countries all over the world, the potential terrorist threat facing ports, airports and other entry points has never been greater.

This unwelcome fact highlights the whole issue of crisis management and risk analysis, especially in the context of contingency planning for worst-case scenarios.

This research project examines the challenges confronting security and emergency services at UK entry points. By developing a detailed understanding of the vulnerabilities, the aim is to identify the best way of minimising them. A key focus is the role played by entry points' own dynamics in shaping vulnerabilities that can also extend into the cities and towns where the entry points are located.

'Unknown Unknowns' is a multimedia research library for an imaginary film. The film revolves around the worst-case scenario of a mid-air collision over Wembley Stadium on FA Cup Final day. The library consists of texts for auditions, location analysis and stunt coordination, as well as computer simulations of flights, supporting photographic studies and objects. The library provides a platform to probe key themes and techniques that characterise the complex nature of crisis management and risk analysis.



David Spero, Aircraft Series, Untitled #1.



Still from 'If We Never Meet Again'.

10

IF WE NEVER MEET AGAIN

Noam Toran

Prof Stephen Hailes

For decades, if not centuries, the potential for machines to move and work together, independently of man, has fascinated not only scientists and engineers, but also artists and writers.

Within just a few years, swarms of autonomous, unmanned mini-helicopters, equipped with cutting-edge sensing equipment, could take to the skies above us – on search and rescue missions, to monitor pollution, to assess flood damage and to help disaster relief efforts. Capable of collaborating, self-organising and reacting to events unfolding around them, these futuristic machines would not operate under direct human control.

The research team behind this work are tackling the many challenges involved in creating and controlling such extraordinary vehicles. From artificial intelligence to wireless networking and data fusion, their expertise is being applied across a whole array of intricate and demanding technical disciplines.



'If We Never Meet Again' is a film shot from two perspectives - a man's and a machine's. Focusing on the encounter of two men on a deserted road, the dual imagery invites multiple readings of a single scene. The work considers how media produced by machines might alter an audience's perception of the cinematic. What might a 'cinematography of devices' produce when the subject is fictional?

11

NOT YET HEARD

**Gunnar Green
Bernd Hopfengärtner**

**Prof Mark Plumbley
Dr Andrew Robertson**

Sound is so much more than just a scientific phenomenon. Fundamentally shaping the way we interact with our world and with each other, it can be a source of both joy and despair.

But our relationship with sound could be about to change forever.

Technology has never matched the incredible capabilities of human hearing: the ability to recognise sounds, to pick one out from a jumble of noise, to interpret tone and other characteristics. Yet the benefits could be far-reaching, from better hearing aids to improved security at airports.

This research project aims to enable computers not just to hear sounds but also to analyse them, form judgements and then take appropriate action. And a technique called 'sparse representations', could unlock the potential.

A person programmes a device to recognise a certain constellation of events by its sonic properties. The device is installed at a particular place, listening and waiting for the situation to occur, which would result in a photograph being produced. Once in a while the person passes by to check if their imagined situation has become real.

By making us aware of the events we programmed being recognised, how will Machine Listening influence the way we form our personal realities?



Hunting for sounds yet to be catalogued – expanding the rational realm of Machine Listening into the poetic and unexpected.

12

SHOCKING

**Andrew Friend
Sitraka Rakotoniaina**

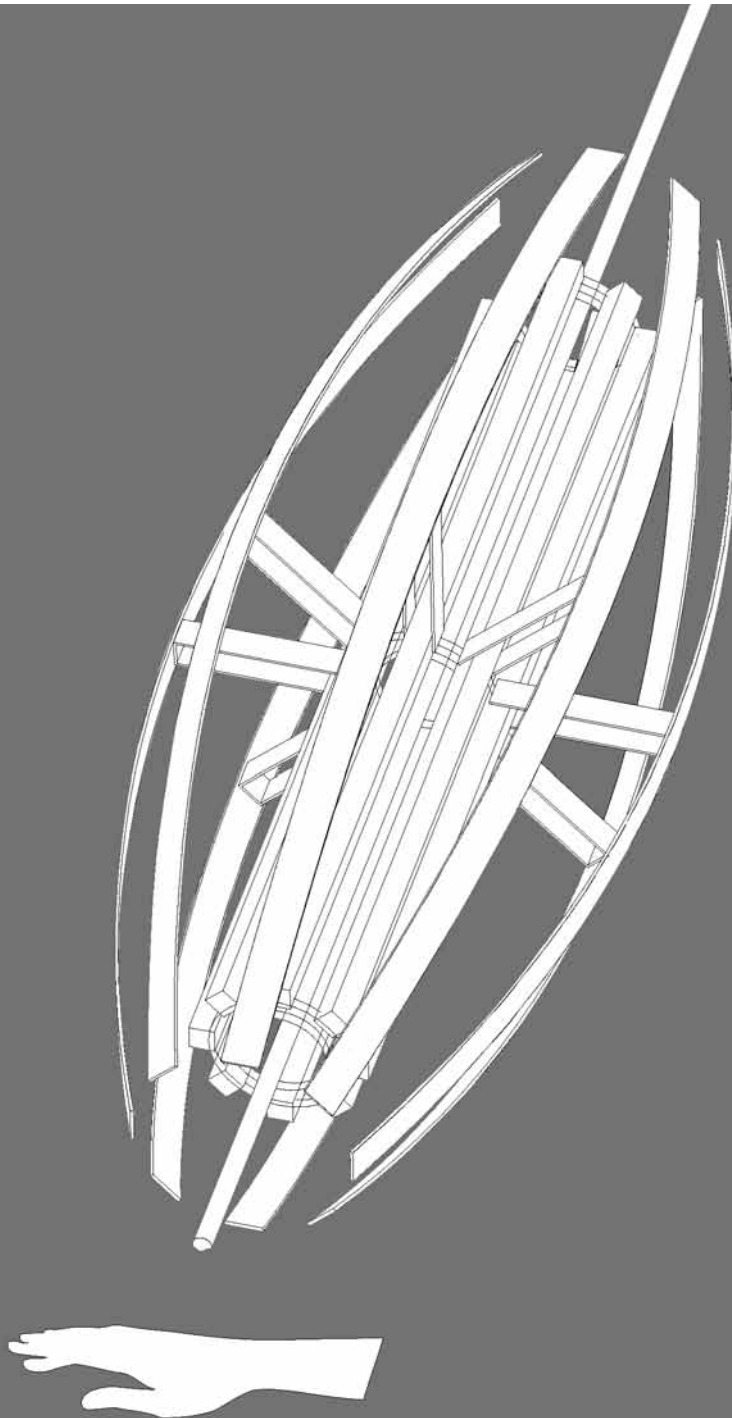
**Dr Yanqiu Zhu
Dr Arthur Jones**

Big things can happen at the smallest scale. Take the tiny particles of tungsten disulphide whose amazing shock-absorbing properties are making huge waves in the scientific community. They may have a diameter a thousand times less than that of a human hair, but they could be the key to providing our soldiers and police with bullet-proof vests and personal armour that offer better protection than ever before.

Incredibly, nanoscale tubes made from the particles are five times stronger than high-tensile steel. And, as the research team investigating their capabilities are demonstrating, the best way to harness these particles' enormous potential could be to incorporate them into strong yet light-weight ceramic materials.

The team are dedicating themselves to developing these life-saving materials and to understanding the fascinating but complex science that underpins them.

If you could safely experience high-impact shock, would you? Development of new nano-composites opens up new realms of experiential possibilities, pushing both physical and psychological limits. However, despite the rigorous scientific testing and stringent safety precautions, how much faith would you put in this technology? Where do the boundaries between thrill, fear and science lie? Our device offers individuals the chance to test these limits for themselves, capitalising on these new and fantastic materials' qualities.



Self-testing mechanism, spring detail.

13

SYNTHETIC IMMUNE SYSTEM

Tuur Van Balen

**Prof Richard Kitney
Prof Paul Freemont
James Chappell**

Biology – the science of life itself. Engineering – the application of science to practical ends. Both are indispensable. But can they also combine into a single, powerful discipline with potential to deliver exceptional benefits? That's the aim of synthetic biology.

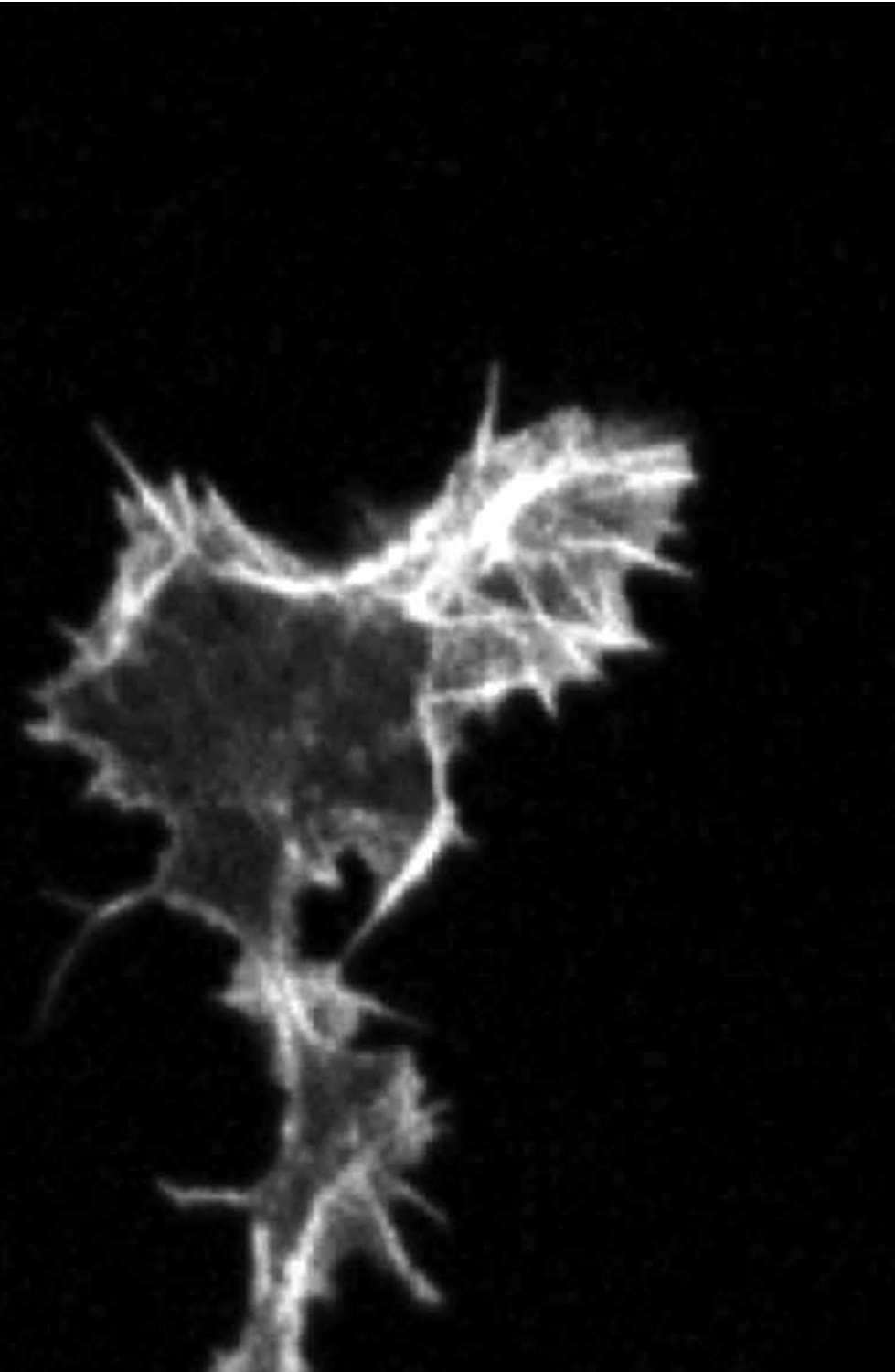
Applying engineering approaches to the world of biology, this fast moving field is reaching beyond nature to develop biologically based devices that simply don't exist in the natural world. Yet they could have an astounding impact in biomedicine, bioenergy and many other spheres.

The Centre for Synthetic Biology and Innovation is at the vanguard of this leap forward. From innovative biosensors for disease detection to re-engineered bacteria for drug manufacture, it is accelerating synthetic biology's industrialisation and its capacity to deliver remarkable solutions for our rapidly changing world.

Synthetic biology's potential to make healthcare more personal and participatory could allow us to become our own doctors and pharmacists; constantly monitoring and tweaking our body. It might even allow us to externalise our immune system by outsourcing metabolic processes to external micro-organisms. These micro-organisms, for instance yeasts, sense and diagnose anomalies in our body to produce and deliver chemicals accordingly. Such a Synthetic Immune System would be tailored to one's genetic predisposition, age, lifestyle and anxieties.



Prototype of interface with Synthetic Immune System.



Neuronal growth cone action by Timo Betz, Institute Curie.

14

PHANTOM RECORDER

Revital Cohen

**Prof James Fawcett
Dr Richard Eva
Dr Stephanie P. Lacour**

When a limb is lost, the mind often develops a phantom sensation. The phantom owner is suddenly endowed with a unique and personal appendage, invisible to others and sometimes capable of extraordinary hyperabilities. As strategies for repair focus on practical solutions, they tend to overlook poetic functions of the body, but what if one could record and keep one's phantom sensation, to be awoken on request?

A novel peripheral nerve interface allows regenerating axons to grow into microchannels incorporating embedded electrodes. This neural implant enables sensations to be inserted into the device, or for activity to be recorded from movements. Could we use this technology to record illusions of the mind? What if our imagination could be captured through our nerves?

The Phantom Recorder system projects a cold and damp sensation onto the skin surface, triggering the brain to hallucinate a phantom. As the phantom movement stimulates the peripheral nerves, its activity is captured by the neural implant and external wireless machinery.

When a prosthetic has been fitted, digital data of the recorded phantom sensation can be transmitted to the implant, allowing the nerves to recreate the sensation of a telescopic phantom hand, a fourth foot or a split arm.

15

CELLULARITY

James King

Prof Cameron Alexander

Prof Lee Cronin

Prof Ben Davis

Dr Natalio Krasnogor

What is life? More specifically, what differentiates a living thing from something that isn't alive? It's a question of huge scientific significance and profound moral, philosophical and religious importance too.

Yet a scientifically robust definition of what life actually is continues to elude us. Even if life really is simply a result of particular biochemical processes, we're still a very long way from understanding exactly how the small yet vast leap from lifeless to living matter is made.

This research is developing 'chells' – artificial, chemical cells that mimic properties of biological cells – and could push our understanding of these fundamental questions further forward. Could 'chells' respond to biological signals as natural cells do? Could they even imitate some of the signals used by natural cells?

Is biology technology? Are we ready for industries and products based on organisms and cells? To deal with questions such as these we need a new understanding of how living and non-living things differ from one another. The Cellularity Scale is intended to be a first draft of a definition of life that is applicable in a future where we no longer ask whether something is dead or alive, but instead, how alive it is.



Model of a minimal cell at 50% on the cellularity scale.

16

PATHOGEN HUNTER

Susana Soares
Mikael Metthey

Prof Calum McNeil
Prof Colin Harwood

Ever since their discovery, bacteria have held both scientific and creative minds in their thrall; nor are the public immune to an obsession with these microscopic yet high-profile life-forms.

The disconcerting truth is that bacterial infections remain a major cause of illness and mortality. Our hospitals are at the frontline of this ongoing battle with bacteria. The need to rapidly pinpoint patients infected by, or carrying, harmful bacteria has never been greater.

This research aims to plug a very real gap in our defences by developing a radical combination of man-made device and biological system that can detect tell-tale proteins on the surface of bacteria. Fast, accurate, inexpensive – this solution really could tick all the boxes from a health-care perspective and tip the scales in our favour.

This design project explores how disease monitoring might change our perception of health etiquette. Surveillance personnel – Pathogen Hunters – would be trained to use very particular tools to manage infectious outbreaks. But no matter how clean we are or how healthy we feel, we still carry billions of microbes on our bodies.

Will we change our behaviour to prevent the spread of pathogens to others? What will the consequences be for our social conventions?



Sampling devices will be used for microbe colonisation self-monitoring, evolving from professional use. They will become part of our daily hygiene routines. Pathogen Hunter devices will be used to track down microbes.

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The work of the department's students, graduates and staff has been exhibited at the Museum of Modern Art in New York, The Wellcome Trust in London and the Science Gallery in Dublin.

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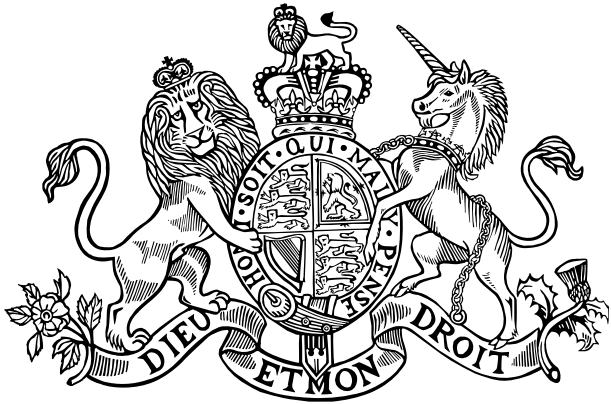
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