
The research commercialisation office of the University of Oxford, previously called **Isis Innovation**, has been renamed **Oxford University Innovation**

All documents and other materials will be updated accordingly. In the meantime the remaining content of this Isis Innovation document is still valid.

URLs beginning www.isis-innovation.com/... are automatically redirected to our new domain, www.innovation.ox.ac.uk/...

Phone numbers and email addresses for individual members of staff are unchanged

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# Isis insights

Issue 73 Autumn 13

# Innovation with Impact

## Reliving Isis' inaugural Technology Showcase



The latest innovations, collaborations and technology transfer

UNIVERSITY OF OXFORD
ISIS INNOVATION

Ii
Issue 73
Autumn 2013

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Ii is produced by Isis Innovation Ltd, the technology transfer company owned by the University of Oxford.
 To receive your free copy of Ii, email innovation@isis.ox.ac.uk
**www.isis-innovation.com**

# Newsflash

**Isis is a research and technology commercialisation company owned by the University of Oxford.**

## Isis on show

'Innovation with Impact', a technology showcase, was hosted at the Saïd Business School in Oxford by Isis this summer. It was a great occasion, with distinguished participants from industry, presentations of many exciting technologies in both the physical and life sciences, and an exhibition featuring both projects available for licensing and those already spun-out. Presentations and videos from the event are available online at www.isis-innovation.com/news/showcase/schedule.html.

## The Isis Software Incubator 'inventions factory'

The Software Incubator continues to nurture new products and services, with major achievements for a significant number of the incubatees in recent months. Esplorio, which enables users to record their activities and travels by gathering materials posted on Facebook, Twitter, Flickr etc. received good media coverage at launch. LovesVouchers, an app from incubatee OxGeos, was featured on BBC radio. Oxford Bio-Chronometrics, offering new levels of online identity management, won an international start-up competition sponsored by Ernst & Young.


## Client incentives

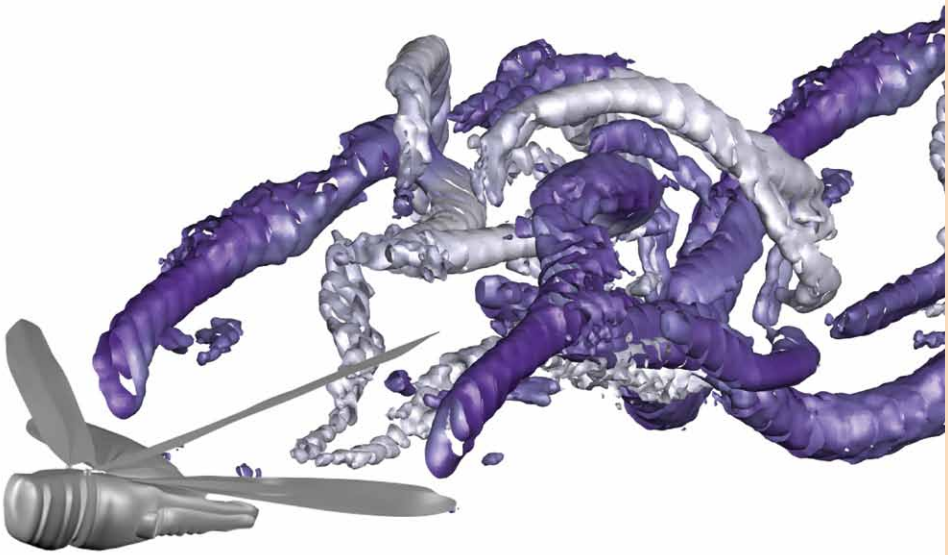
Two new initiatives were launched to make it even more attractive for clients to engage with Isis. An easy-to-use Materials Evaluation Agreement was launched by Isis, Imperial Innovations and UCL Business, to help companies evaluate new materials from the research laboratories of these three universities. Isis also launched its SME Smart IP Scheme (SSIPS) which offers greater flexibility and reduced business risk for SMEs accessing Intellectual Property (IP) from Oxford University. SSIPS ensures that, whatever the ultimate route to market, the SME that invested in the development will earn a share of future revenues. Furthermore, Isis works with SSIPS partners to access support initiatives such as TSB Smart Awards and R&D tax credits.

## Spanish expansion

Torus Software Solutions, a client of Isis Enterprise, won the UKTI Spain Technology Competition which aimed to help Spanish businesses expand into the UK. The award recognises Torus' novel technology with two products, Java Fast Sockets and Fast Java Messaging, launched during the period of Isis Enterprise's involvement. IE consultants were involved at every stage of the commercialisation of the two technologies and helped with ensuring that these products reach their full market potential.

# Enterprising Consultancy

## News from Isis Enterprise and Oxford University Consulting



### High flying consultants

Experts based in the Oxford Animal Flight Group are in great demand to act as academic consultants. This is because while their research tackles problems from a biological perspective, their approach shares much in common with engineering and the group is known for the strong interdisciplinarity of its outlook.

"Animals have been swimming and flying for several hundred million years, and through this time have been exquisitely tuned by natural selection to optimise performance," says Professor Adrian Thomas. "These animals demonstrate systems optimised for speed, efficiency, sensitivity, endurance, agility, manoeuvrability, stability and robustness and our understanding of this can help us find novel solutions to corresponding engineering problems. In addition to our basic research, we are interested in targeted technology and knowledge transfer to relevant industries, and welcome enquiries from interested parties."

The group's specific areas of expertise include: biological sensors and actuators, low-speed aerodynamics, flapping flight, passive flow control and acoustic noise reduction. OUC has worked with the group to provide their advice and expertise to a number of clients in the last year. These range from a film production company needing studio support to better handle insects being filmed for a 3D documentary on insect flight, through to aerospace companies seeking to learn lessons from nature in the area of flight dynamics.

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### IE supports Maltese entrepreneurship

**Isis Enterprise (IE) is working with the University of Malta, building and supporting the local innovation ecosystem by consolidating a Knowledge Transfer Framework and launching a formal training programme in Technology Entrepreneurship. The overall goal of the programme is to assist the University of Malta in transforming itself into an entrepreneurial University.**

A roadmap of activities and support was agreed to develop the Knowledge Transfer Framework around the themes of business collaborations, consultancy services, technology transfer and business incubation.Together these strands will deliver support to business by providing research, innovation and skills, support to the University and its individual researchers by making their expertise and resources more accessible and support to the economy by creating business growth through licensing and formation of new companies.

The programme in Technology Entrepreneurship accepted its first group of students in July, with those qualifying gaining credits which can also be used towards a Masters in Entrepreneurship.

Isis Enterprise consultants use extensive experience of building innovation ecosystems and processes to enhance university-business interactions worldwide.


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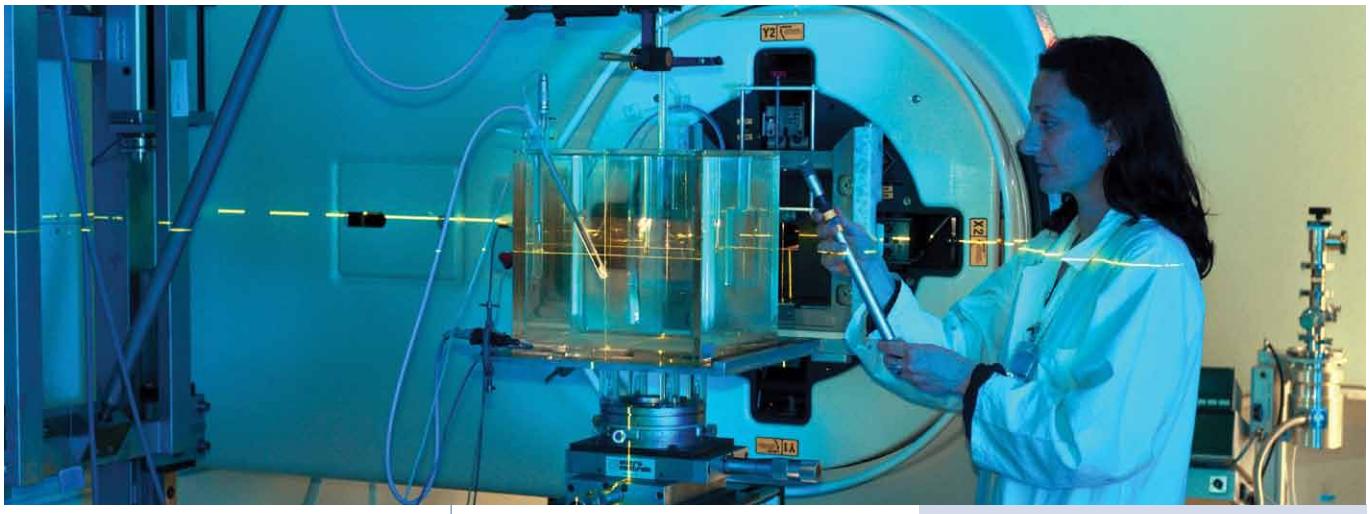
# The portfolio

## The latest **spin-out** and **investment** news

### Nano-medicine for cancer



**Isis is seeking to raise capital to form a spin-out company dedicated to the development of a nanoparticle technology for enhancing the anti-cancer effect of radiotherapy in the treatment of deep-tissue solid tumours.**

The technology consists of rare earth ion-doped titanium oxide nanoparticles, which effectively absorb and convert medical X-ray energy into anti-cancer free radicals. It is supported by pre-clinical data from the Stanford School of Medicine, where growth of a radiation-resistant lung tumour-xenograft model was effectively halted by co-treatment with nanoparticle therapy. A control tumour treated by standard radiotherapy alone increased in volume by around 130 percent (P-value significance = 0.0025).

### Status

An exit by trade sale to a major pharmaceutical company may be sought on completion of scale-up and pre-clinical testing, or the company may invite further funding for phase I and II clinical trials. The spin-out will benefit from an exclusive license to background Oxford IP.

Two other materials are currently being developed as nanoparticles to absorb X-ray energy and increase free radical load to a tumour: gold and hafnium oxide. However, these rely on free radical generation from the surface of the particle only, whereas the Oxford technology is able to utilise free radicals generated from the entire particle structure.

The global market for cancer treatments is expected to exceed $90bn by 2015. A typical successful oncology drug can achieve sales of over $1bn per annum. The overall anticancer nano-medicine market reached $28bn in 2011 and is expected to reach $46bn by 2016.

### Financial requirements

The company will require £1.1m seed capital to fund manufacturing optimisation and extension of pre-clinical investigations. Follow-on funding of £3.5m will be invited in mid-2015 to complete manufacturing scale-up and toxicity evaluations prior to submission for Investigational New Drug status to the US Federal Drug Agency (anticipated by end 2017).

### The technology

- Developed in the Department of Engineering Science at the University of Oxford
- Subject of patent applications in national phase in the major markets (US, EU, China, Japan)
- An add-on technology to enhance standard radiotherapy; co-treatment with nanoparticle therapy will not require any changes to clinical infrastructure or major alterations to treatment protocols

### Overcoming limitations

- Free radical generation after X-ray absorption is the basis of conventional radiotherapy
- Nanoparticles absorb vastly more X-rays than tissue
- Free radical generation is more efficient and results in higher incidence of tumour-cell death

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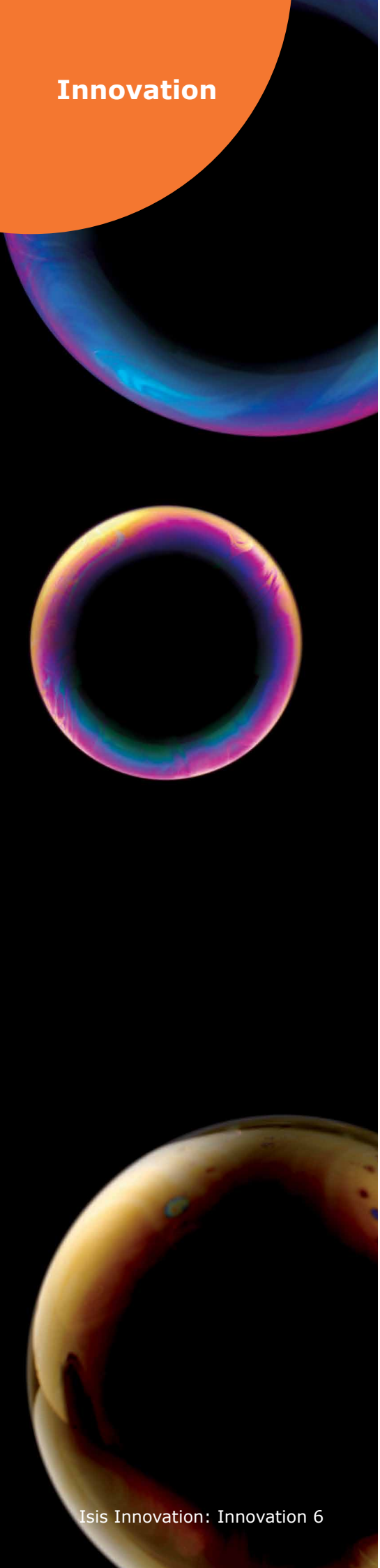

HGF Harrison Goddard Foote LLP
Incorporating grant spencer

**Harrison Goddard Foote LLP** is one of the UK's leading firms of patent and trade mark attorneys. As well as looking after the interests of multinationals, large companies and SMEs, HGF represents thirteen of the Russell Group universities (including Oxford University), as well as other universities from the UK and further afield. Partner Dr Chris Moore gives an overview of how HGF can help university researchers and spin-outs.

**As University knowledge transfer professionals know all too well, there is a link between science and technology. Science is often seen as the theoretical underpinning, technology the practical embodiment of science. Indeed, they have been described as a pair of dancers, both of whom know their steps and have an ear for the rhythm of the music[1].**

With research impact assessment being at the forefront of the funding bodies analyses, having a practical deliverable from research science will be an increasingly important factor in obtaining funding. Those deliverables will often require protection, usually by way of patents.

As awareness of the value and need for intellectual property protection increases amongst academics (as well as in the broader business community) knowledge transfer professionals will inevitably face the challenge of having to sift more requests and invention disclosures but will likely not have the concomitant increase in their IP budget to match the requirements. The challenges will inevitably include seeking more patent protection, instituting more spin-outs and seeking increasing numbers of commercial partners for out-licensing.

## How then to maximise the return on investment for university IP budgets?

The first step is to identify patent and other IP professionals that have an established track record in helping University clients and the associated spin outs. For example, the challenges presented when extracting technological information from draft scientific papers are not those which

[1] Introduction: The Geneses of Civilizations ("A Study of History," 12 vols. [New York, 1962],I, p. 3, n. 1)

[2] See http://www.praxisunico.org.uk/news/member-detail.asp?ItemID=1527

[3] See http://www.praxisunico.org.uk/news/detail.asp?ItemID=1395

patent attorneys typically deal with in their day-to-day practice. Of course it is also necessary to ensure that the selected patent attorney can engage scientifically with the academic or researcher. It may also be appropriate to consider a patent attorney firm which has had significant experience of commercialising, or helping to commercialise, university-derived research, perhaps as part of a recipient business.

A further aspect to be considered is the add-on services provided by the patent attorney firm. At HGF, as well as the usual provision of seminars and clinics, we look to provide something different, an added service which is of direct value to our university clients. For example, we have recently sponsored the interior design of a university Business Incubator[2], helping to make the facility attractive to potential incumbents and have sat on an expert drug review panel for a Russell Group university to provide commercial input.

As has been recently aired at a Praxis Unico conference at GSK[1] , there is a gap between what industry wants from academia and what academia may be able to deliver. Much has been written about the so-called "valley of death" from TRL 3 to TRL6. In order to help universities maximise the chance of out-licensing, and/or their spin-outs negotiating the valley, it is essential that robust IP positions are taken with an eye on the future as to potential commercialisation routes.

Because of our unique mix of university clients, a desire to deliver beyond what is usual, attorneys with commercial in-house experience and licensing and commercial negotiation skills, we believe that we are uniquely placed to help our university clients.

From offices in Aberdeen, Birmingham, Edinburgh, Glasgow, Leeds, London, Manchester, Oxford, Sheffield and York, HGF advises on all aspects of intellectual property including: invention identification; branding; patent and trade mark filing and prosecution; design registration; portfolio creation and management; licensing; litigation and dispute resolution. HGF is consistently highly ranked by the major ratings agencies, and we number many top ranked and highly noted individual attorneys.

### Why work with us

- We represent 13 of the Russell Group Universities
- Specialists in leading technologies
- Commercial in-house experience
- Commercial negotiation skills

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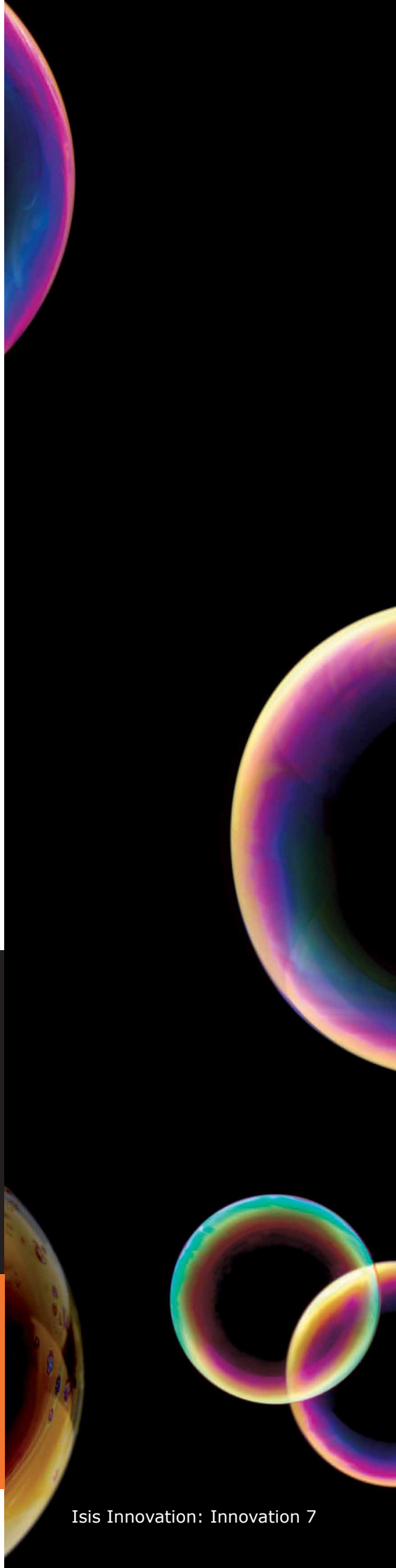

# Innovation with Impact

**25th June 2013**

Saïd Business School
University of Oxford



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NISSAN
EPSRC
GUIDANCE NAVIGATION
MOBILE ROBOTICS GROUP
DEPARTMENT OF ENGINEERING SCIENCE


MRG OXFORD


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# Going through the gears

The details of how Oxford University's technology innovation is being boosted by an award from the **Engineering and Physical Sciences Research Council (EPSRC)**.

**In late 2012 the University was awarded £3.6m from EPSRC's Impact Acceleration Account (IAA) programme. The funding support, announced by Business Secretary Vince Cable, is helping the most pioneering scientists and engineers amplify impact from their research by de-risking technologies, transferring knowledge and engaging with businesses and end-users**

Investment of over £700,000 from Oxford's IAA Strategic Fund has been instrumental in securing over £7m in capital investment from the EPSRC's Great Technologies stream for three high profile projects. The grants support work on ground-based mobile robotics led by Professor Paul Newman and Dr Ingmar Posner in the Department of Engineering Science that includes the development of self-driving cars, a new research infrastructure to enable efficient and fast development of metallic alloys that can withstand extreme environments (for use in aerospace, energy generation and a range of other fields), and a collaboration with Imperial College London that aims to tackle the challenge of storing energy on a large scale, at the level of the national grid.

Isis is supporting the University's IAA in a number of ways. Tom Hockaday, Isis Managing Director, sits on the University's IAA Steering Group, chaired by Professor Tom Melham, Professor of Computer Science,


and Isis seed fund manager Andrea Alunni is on the decision-making Technology Fund Panel, reviewing applications. Isis technology transfer staff are shaping impact roadmaps and enabling a robust transition from outcome to impact.

The IAA is supporting activities in three areas: secondments, a technology fund and business engagement activities.

Secondments will facilitate the transfer of knowledge at different points in the research and innovation process and promote a culture of greater focus on user needs and applications.  A small grant awarded to Professor Daniel Kroening's lab in Computer Science has already led to a licensing deal for the University.

Technology Development Grants aim to advance outputs towards the point where they are suitable for commercial investment ('challenge fund readiness').

Impact Delivery Grants offer support for projects where the technology or software involved may produce

financial or commercial benefits to a user company, but is not suited to commercial licensing by the University to the company, or for projects which are not commercially exploitable by the University, for example in the development of technology where the patent is held by a third party (e.g. previous industrial partner) and so cannot be exploited by anyone else.

For more general business engagement activities, the IAA will fund industry days and events. There are already some successful examples within Oxford (e.g. an established series run by the Department of Computer Science). The IAA will identify and share best practice, and support development of new events in disciplines and sectors currently less active in terms of user engagement.

Oxford's IAA has four primary objectives:

- accelerate impact from existing EPSRC-funded research
- accelerate impact from future EPSRC-funded research through increased engagement with research users and greater awareness of impact mechanisms
- accelerate the commercialisation of EPSRC-funded research by bridging the gap between invention and investment
- increase the exploitation of EPSRC-funded research where any commercial benefits will accrue to a third party, rather than to the University, or where the impacts are non-commercial in nature

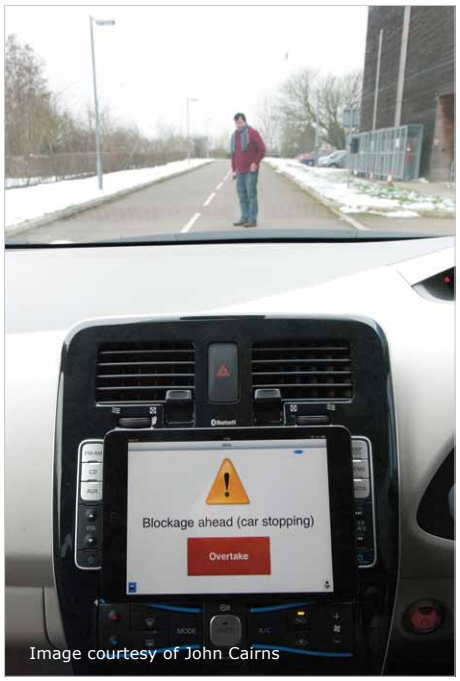

Image courtesy of John Cairns

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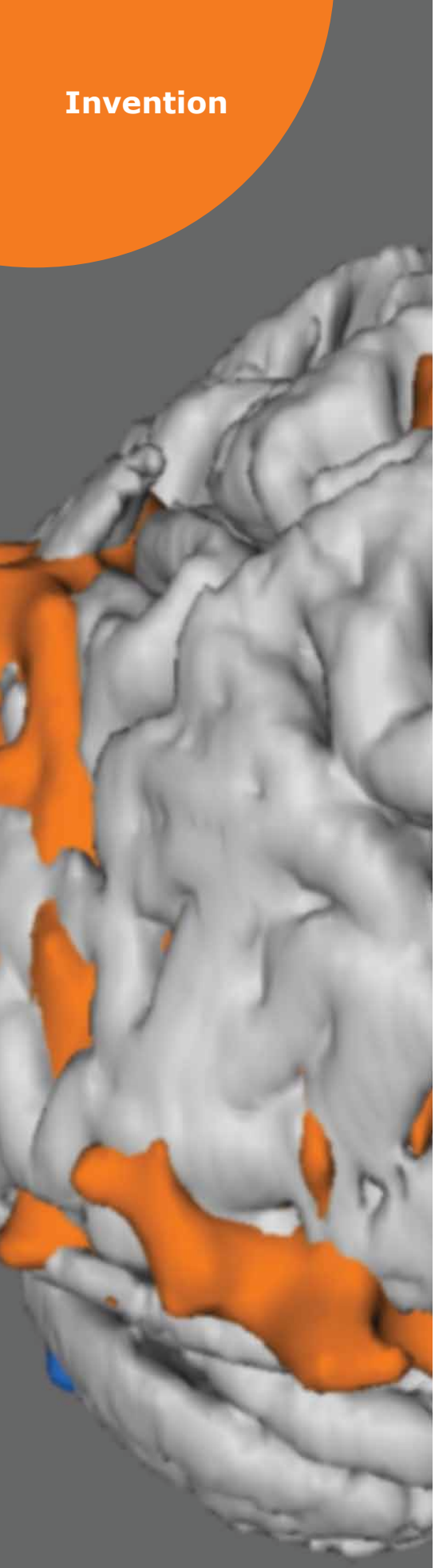

# Imaging insights

To coincide with the launch of version five of the FMRIB Software Library (FSL), **Dr Fred Kemp** charts the 15-year success story of the analysis resource developed at Oxford's neuroimaging facility.

**Understanding the revolutionary potential of fMRI combined with structural and diffusion MRI, the University of Oxford opened a multidisciplinary neuroimaging facility (FMRIB) in 1998, bringing together scientists and clinicians involved in all aspects of brain imaging research. To assist researchers in the often complex and labour intensive analysis of MRI data, an innovative team, led by Professor Steve Smith, began developing the FMRIB Software Library (FSL). Their algorithms worked robustly on a wide variety of real data; but, at the same time, they generated leading-edge mathematical theory to feed into what was rapidly becoming a powerful standalone analysis pipeline.**

Using multiple fMRI (functional MRI) 'snapshots' to track brain activation, together with high-resolution structural MR images and diffusion-weighted MR images, FSL can produce an array of images showing the brain's structure, functional activity and connectivity patterns. Pharmaceutical studies, which look at how the anatomy and function of different brain structures are affected by drug treatment or disease, are consequently improved. FSL also provides a way to measure how much the brain has changed over time – a very useful capability for evaluating the effectiveness of a drug in patients. FSL was released in 2000 and has received over 2,500 citations. The latest version has been downloaded over 10,000 times and is used in nearly 1,000 hospitals and university labs.

This success has been hard earned. For over ten years the core team (each experts in their own right) has continually developed, refined and extended FSL, as well as creating extensive documentation and training packages (with over 1,000 attendees since 2002), and maintains an active user community through its email support list.

Add an easy to use graphical interface and a high degree of automation to this robust, powerful and flexible analysis pipeline and it is perhaps no surprise that it is the de facto standard in academia for multi-modal MRI analysis. Moreover, it is commercially licensed to seven of the top 10 global pharmaceutical companies and a plethora of other companies, ranging from drug discovery and clinical trials to neuromarketing, and even an iPhone app developer!

The team are by no means resting on their laurels with version 5, accommodating new areas of interest

## The latest version of FSL has been downloaded over 10,000 times and is used in nearly 1,000 hospitals and university labs

such as Arterial Spin Labelling and Chemical Exchange Saturation Transfer, as well as significantly improving the modelling of brain blood perfusion and the analysis of connectivity data, playing a significant role in the Human Connectome Project. In this way, the FSL team continue to lead the vanguard of fMRI research and act as standard bearers for the successful commercialisation of University-developed scientific software.

### Neuroimaging – a history

Functional MRI is one of the most recently developed forms of neuroimaging but the idea underpinning the technique – inferring brain activity by measuring changes in blood flow – is not new at all. Dating back to the 1890s, here's one description of an early experiment:

"The subject to be observed lay on a delicately balanced table which could tip downwards either at the head or the foot if the weight of either end were increased. The moment emotional or intellectual activity began in the subject, down went the balance at the head-end, in consequence of the redistribution of blood in his system…"

The reported success of this method may only have been wishful thinking, but the suggestion that blood flow is coupled to neural activity was insightful – not until 1948 was it confirmed that blood flow in the brain is regionally regulated by the brain itself, opening up the remarkable possibility of using blood flow and oxygen metabolism to study brain function in humans.

Since its advent in the 1990s, the attractions of fMRI have made it a popular tool for imaging brain function, providing new insight into language, pain, learning, emotion, how memories are formed. It has also been being used to investigate conditions such as multiple sclerosis, stroke and Alzheimer's disease, helping us to better understand and manage these conditions, as well as develop new treatments.

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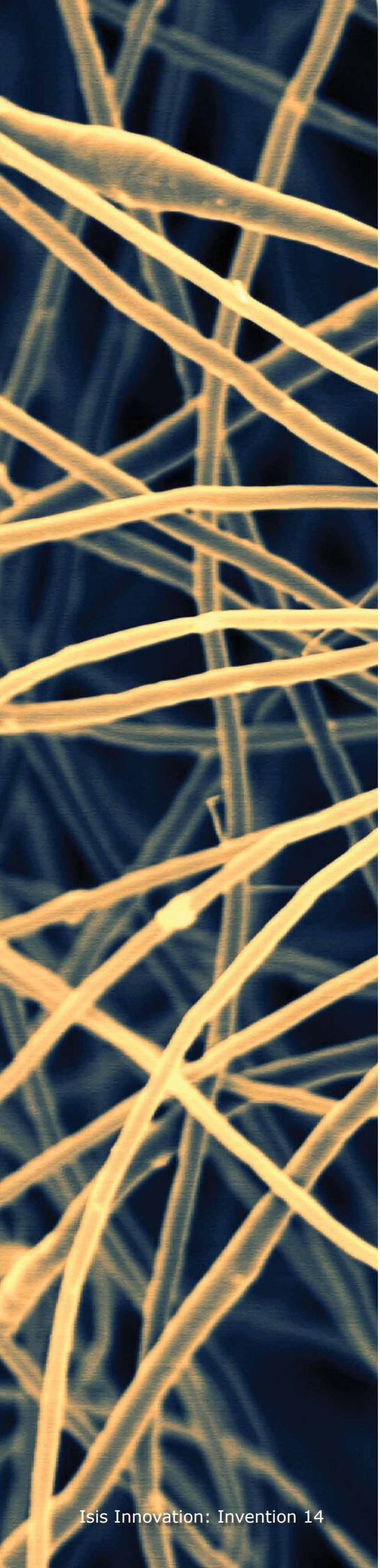
*Image: fMRI of the brain listening to sounds (blue) and seeing pictures (orange)*



# Mobile electrospinning

Electrospun materials have ideal properties for tissue engineering scaffolds and other structures. **Dr Louis Pymar** introduces two devices for improving the convenience with which the electrospinning process can be performed.

**Biomedical engineers at the University of Oxford have developed two electrospinning devices with the potential to bring about a step change in the flexibility with which electrospinning can be carried out.**

Electrospinning is the process by which extremely fine nanofibres are drawn from a polymer solution. By applying a high voltage electric charge to solution as it is dispensed from a syringe needle, a charged liquid jet is formed as electrostatic repulsion counteracts the surface tension of the liquid.

In conventional electrospinning, the charged liquid jet is directed toward an oppositely charged collector, usually a static plate or a rotating drum, typically 5 – 30 cm away and contained within a purpose built bench-top chamber. In flight – as the solvent is evaporated – the jet is deposited on the collector, forming a nanofiber membrane with a lattice-like structure.

This electrospun fibre membrane has many useful material properties, including a very high surface to volume ratio and a highly controllable and defect-free molecular structure. Such properties make electrospun material suitable for applications requiring high surface areas for physical contact, for example as tissue engineering scaffolds, filtration membranes, and as substrates for chemical reactions.

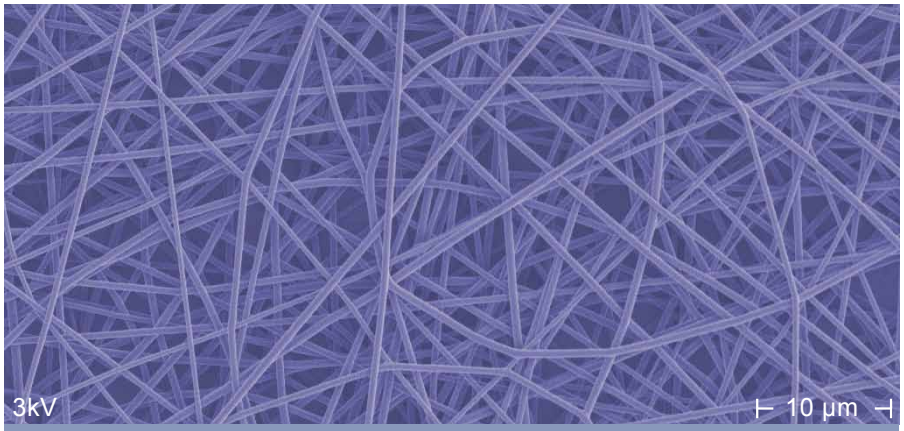
## Novel nano-material dispensing

The Oxford team has now miniaturised and made portable the conventional bulky laboratory bench-top electrospinning hardware, producing a standalone, portable apparatus.

The first distinct application made possible by this truly mobile electrospinning is the direct, *in situ* spraying of wound dressings. The properties of electrospun materials are highly suited to multifunctional wound dressings. Woven nanofibres may act as a physical barrier whilst allowing oxygen permeation and may be made both biocompatible and biodegradable as a scaffold for cellular regeneration. They may also act as a medium for drug loading, allowing for a controlled rate of drug delivery at a wound site.

The prototype device has shown equivalent performance in testing against a conventional bench-top

The applicator device may allow the properties of electrospun fibers to be taken advantage of in ways not previously thought possible




## Spinning a yarn

Electrospinning traces its roots to electrostatic spraying, first described more than 100 years ago and put to use in applications as diverse as crop spraying and dispensing of aerosolised medicines by electrostatic inhalers. In the case of electrospinning, where the charged liquid consists of a polymer in sufficiently high concentration to cause molecular chain entanglement, a fibre, rather than a droplet, is drawn from the tip of the needle.

apparatus. The device is of a modular design with separable compartments. This allows for a polymer solution cartridge — battery-powered with a high-voltage converter — to be easily accessed and features an LCD user interface for control of voltage and flow rate.

### Hand-held control

The second Oxford device adds the possibility of flexible dispensing remote from the point of charging of a conventional bench top apparatus. By means of an extendable, electrically-insulated applicator, it becomes possible to manipulate electrospun fibres in much the same way as paint may be sprayed via an extendable spray hose. A prototype applicator has been demonstrated to be safe and effective for hand-held operation at the typically-used voltage of 10kV. The extendable applicator potentially fits to the needle, or spinneret, of any bench-top or portable electrospinning system.

By enabling much more flexible dispensing of electrospun fibers, the applicator is particularly suited for uses such as the coating of 3D objects, including direct spraying onto the skin for wound repair. As such, the applicator device may allow the properties of electrospun fibers to be taken advantage of in ways not previously thought possible.

### Impact

Both the miniaturised, portable electrospinning apparatus and the applicator extension device will make new ways of applying the electrospinning method possible, potentially increasing the impact of electrospun fibers in the fields of nanotechnology and biomaterials.

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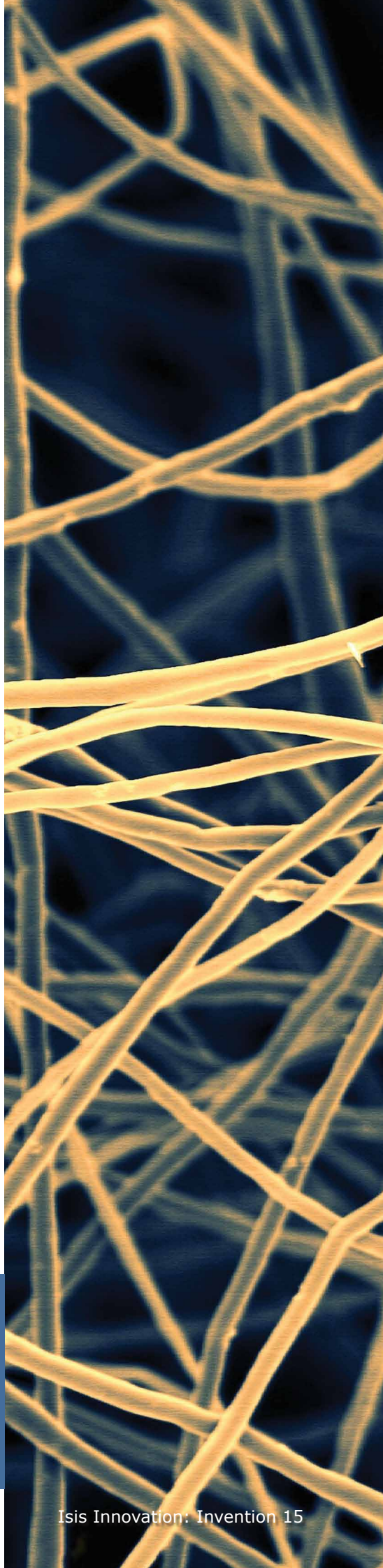

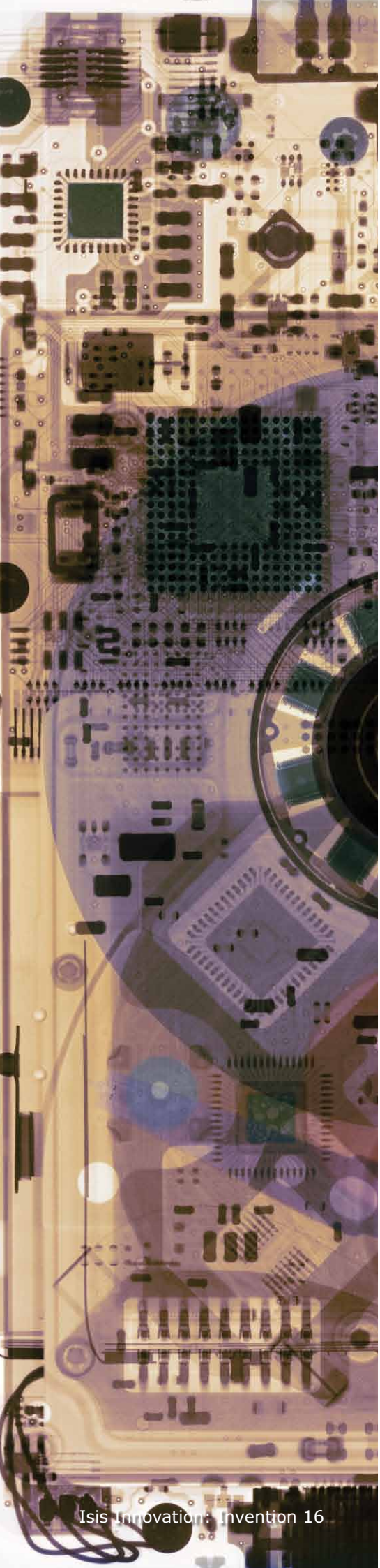

# Charging ahead

**Dr Jamie Ferguson** introduces a scalable method for constructing lithium-ion batteries with graded electrodes and tailored porosity, promising longer-lasting power for portable electronic devices and fuel-cell vehicles.

**Lithium-ion batteries (LIBs) are a mature, growing market with around three billion cells produced per annum for use in consumer, industrial and automotive applications. The relatively simple energy storage devices are produced using a manufacturing process that is both productive and scalable. Frost and Sullivan estimated the LIB market size to be US$18bn in 2013, growing at 21 percent CAGR. Despite the market size, today's bestselling tablet PC uses batteries that contain essentially the same chemistry as that invented in Oxford by Goodenough et al in 1980, along with the same manufacturing process. Not only do the current capabilities of LIBs limit the performance of portable electronic devices, their design, chemistry and capacity are yet to be optimised fully for transport applications.**

## Limitations of current LIB manufacture

Current LIB electrodes are monolithic in that the electrochemically active materials that are used in powder form in the electrodes – and the residual porosity between the powder particles – are constant through the electrode thickness. Despite their known benefits, graded electrodes are not commercially available because a scalable manufacturing technology has not been developed. Recent developments at Oxford will help to enable electrodes to be fabricated using spray deposition that will allow the porosity and other characteristics to be varied in a controlled fashion through the electrode thickness. Better performance of existing battery chemistries and the commercialisation of new battery chemistries will be facilitated by the developments.

Oxford's technology is scalable, allowing LIB manufacturers to spray electrodes from a variety of suspensions. Thin, flexible electrodes (100s nm to 10s μm) can be produced and various nanomaterials can be introduced into the electrode at any point. The spraying process allows the electrodes to be graded in different ways. Recent literature suggested that in theory, a capacity increase of up to 70 percent might be possible over conventional slurry-cast LIBs, if graded particle and porosity distributions were available. Furthermore, Oxford's technology would be compatible with the various electrode types currently used with LIBs.

## Applications in different markets

LIBs can be categorised into three distinct markets at different stages of maturity (Figure 1). Mobile electronics (phones, computers, tablets etc) is the most mature market, where the drive is for increased energy density and thinner, planar geometries, especially for tablets. Faster charging times are also desirable and future designs may also make use of flexible batteries. Electric vehicles are the next most mature market, with challenges in increasing energy density (driving range) and improving safety. Finally, the least mature market is grid scale storage, becoming a pressing need as

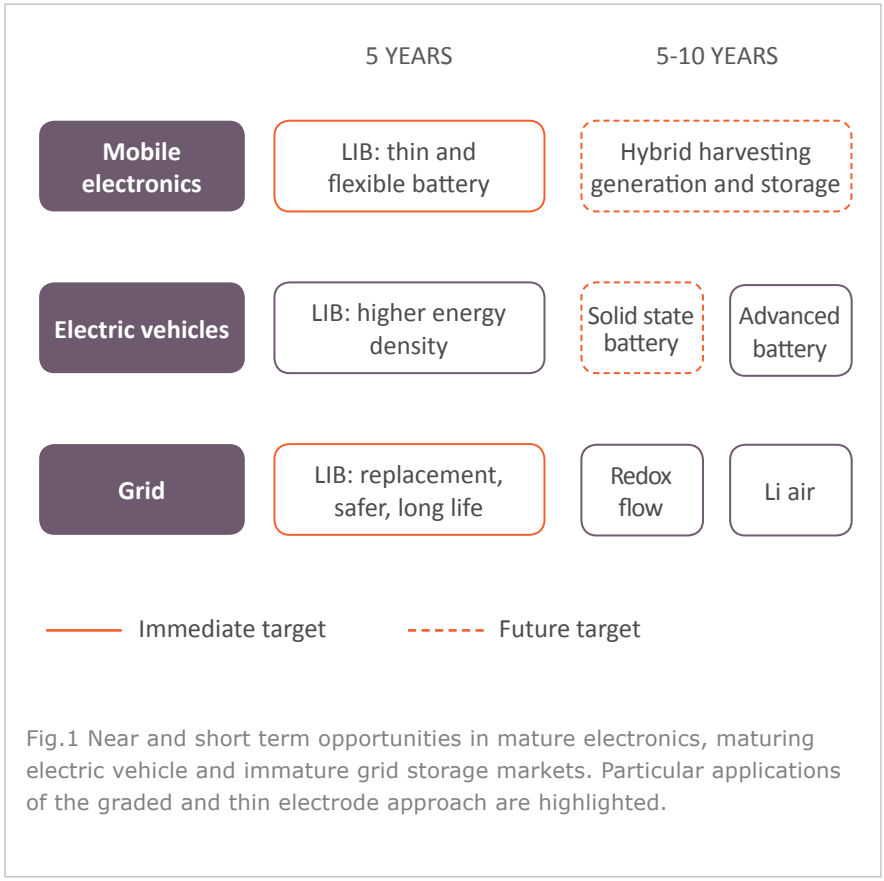


Fig.1 Near and short term opportunities in mature electronics, maturing electric vehicle and immature grid storage markets. Particular applications of the graded and thin electrode approach are highlighted.

penetration of renewables (wind, solar, wave) increases. Huge opportunities are likely to develop for grid scale electrochemical storage but inherently safer, low maintenance, low cost and very long life devices will be required.

## Patent protection and commercial opportunities

Li-ion batteries are a growing market and the advance offers the possibility of making batteries with improved performance via an industrially scaleable route. The underlying technology is the subject of a UK Patent Application. Comparative performance tests against conventionally manufactured LIBs are currently being run. Companies interested in progressing the commercial opportunities are invited to contact Isis.

Mobile electronics is the most mature market, where the drive is for increased energy density and thinner, planar geometries, especially for tablets

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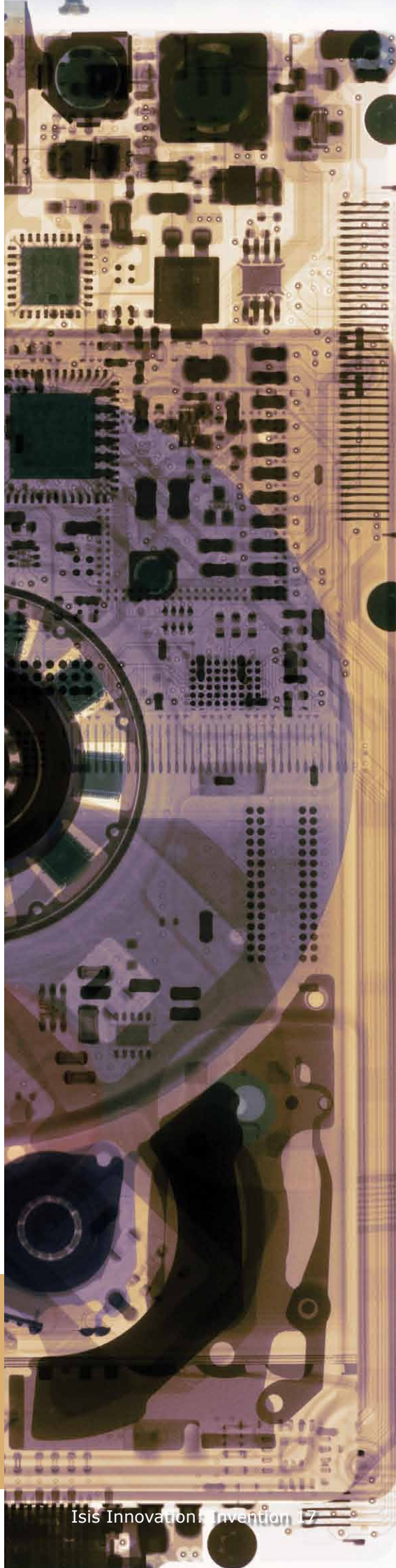

# Mercury rising

**Dr Jon Carr** introduces a software analysis and simulation package for precise temperature measurement inside car engines and other hostile environments.

## Consumer pressure

**Clear air acts across the globe are increasing the pressure to control emissions from automotive sources. In addition, consumer demands to improve fuel economy are leading some from the automotive industry to pursue a strategy of engine downsizing[1]. To increase efficiency gains there needs to be better understanding of the fundamental combustion process and how to control it. Since combustion is highly sensitive to temperature, there is a demand for ever more accurate and precise in situ thermometry. Measuring temperature accurately inside an internal combustion engine is difficult as the high temperatures reached easily melt away any invasive temperature probes. Existing laser measurement techniques are only currently accurate to within 5-10 percent.**

## The Oxford team

The Physics department has spent the past decade developing techniques to determine the thermodynamic properties of challenging environments such as combusting gases. The Nonlinear Optics and Combustion group has pioneered several laser-based techniques to determine key thermodynamic properties of gases in challenging environments such as plasmas, flames and internal combustion engines. Collaboration with the Engineering Department has resulted in a laboratory based set-up that has the capability to analyse pre-ignition temperatures in combustion engines.

The research team use Laser-Induced Gratings, created when short pulses from two laser beams cross and interfere with each other, to form a spatial fringe pattern or grating. By carefully selecting the laser wavelength to be absorbed by the gas, a spatial fringe pattern is created together with a pulse of sound. An accurate measureable signal is produced by reflecting a third laser beam off this spatial fringe pattern coupled with the sound wave moving across the grating, caused by oscillations in its intensity.

Existing laser measurement techniques are only currently accurate to within 5-10 percent

[1] http://www.wired.com/autopia/2011/09/three-is-the-new-four-as-engines-downsize/

[2] High precision in-cylinder gas thermometry using Laser Induced Gratings: B. Williams, M. Edwards, R. Stone, J. Williams and P. Ewart accepted for publication Combustion and Flame, 2013.

Software has been developed which uses a fast Fourier transform (FFT) to derive the temperature from the oscillation frequency of the signal. Additional simulation software allows the signal to be modelled for different engine conditions, temperatures, pressures and gas compositions. The precision of the technique (0.1 to 1.0 percent of the measured temperature), has allowed quantitative analysis of the effects of fuel additives on the in-cylinder gas temperatures prior to ignition, demonstrated over a temperature range of 300–650 degrees Kelvin.[2] The analysis software is, in principle, adaptable for the determination of pressure from the same experimental data.

## Further applications

As well as pre-ignition analysis there is also a requirement of understanding the 'knocking' in spark-ignition internal combustion engines, which can lead to poor performance. Within an engine the fuel-air charge is meant to be ignited by the spark plug only, and at a precise time in the piston's stroke cycle. Knock or knocking occurs when the peak of the combustion process no longer occurs at the optimum moment. The Oxford system is able to calculate continuous engine cycle measurements to allow the limits of engines to be pushed, without the occurrence of knocking.

The group is currently investigating analysis of higher temperature ranges of between 1500-2000 degrees Kelvin. This will be applicable to flame and combustible analysis, which has always been difficult to achieve accurately.

The team also plan to combine this technique with more conventional 2D laser temperature measurements in the aerospace industry to create accurate temperature maps of the entire engine cylinder. The simulation software package, which can facilitate modelling of the signal, is being further developed for different measurement vessel geometries. This will lead to other 'closed' systems such as chemical process vessels being investigated for temperature and/or pressure fluctuations.

## Copyright protection

Isis would like to discuss with interested companies the licensing of this knowhow and copyright protected software.

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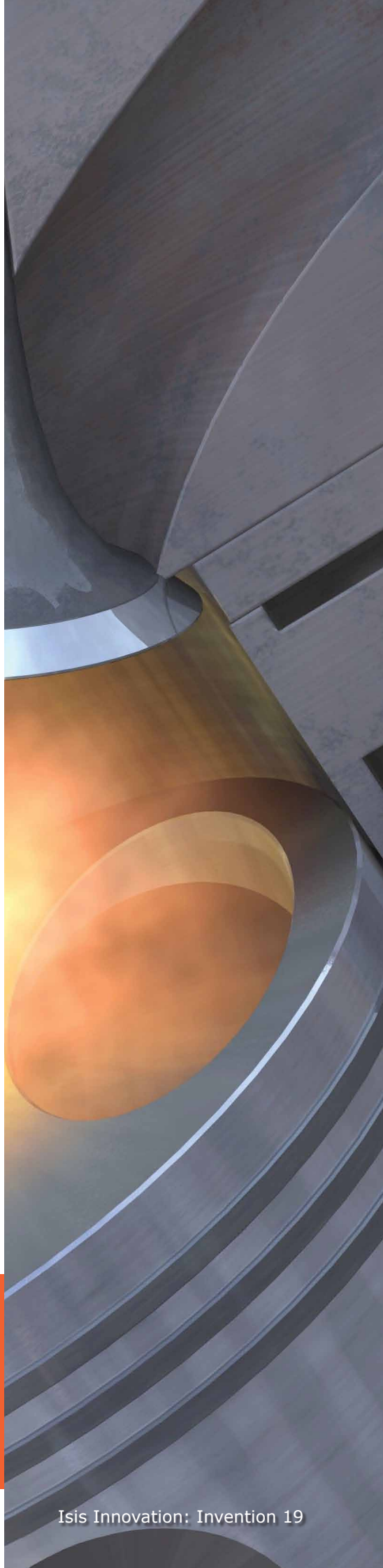

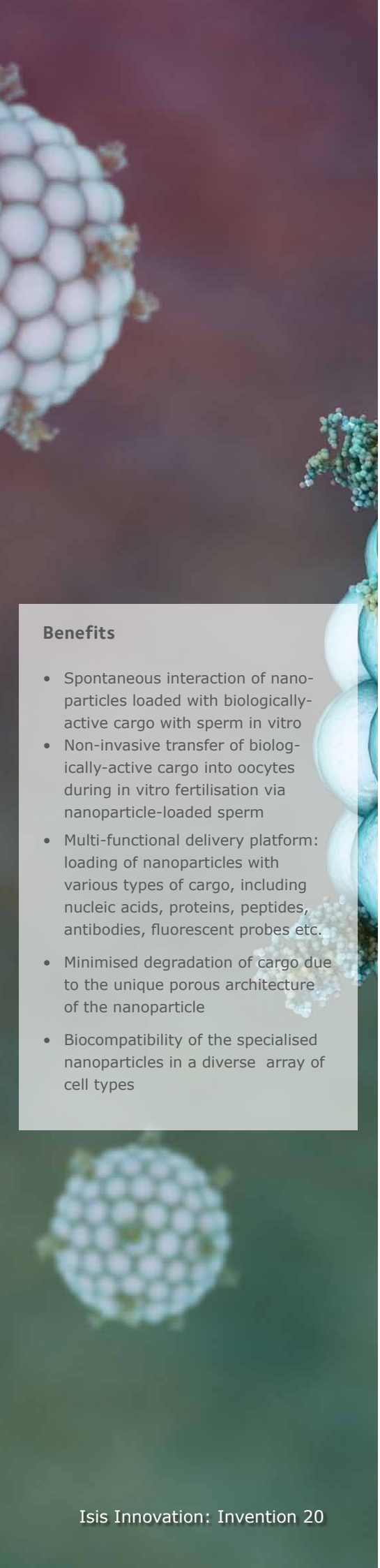

# Nanoparticle-mediated delivery

**Dr Bharti Ranavaya** describes a nanoparticle-based system which enables the non-invasive and direct in vitro delivery of molecular agents into mammalian gametes and embryos.

### Benefits

- Spontaneous interaction of nanoparticles loaded with biologically-active cargo with sperm in vitro
- Non-invasive transfer of biologically-active cargo into oocytes during in vitro fertilisation via nanoparticle-loaded sperm
- Multi-functional delivery platform: loading of nanoparticles with various types of cargo, including nucleic acids, proteins, peptides, antibodies, fluorescent probes etc.
- Minimised degradation of cargo due to the unique porous architecture of the nanoparticle
- Biocompatibility of the specialised nanoparticles in a diverse array of cell types

**Researchers at the University of Oxford have successfully developed a nanoparticle-based system for direct, fast and non-invasive in vitro delivery of biologically-active compounds into sperm, oocytes and embryos, in order to understand and manipulate underlying molecular pathways and gene expression systems, and potentially create a novel clinical delivery tool for therapeutic agents.**

## Clinical need

Research into mechanisms of infertility – a medical condition affecting 48 million couples worldwide – is increasingly showing the role of aberrant gene expression and genetic polymorphisms in various forms of previously unexplained reproductive failure. Targeted transfer of biological compounds represents both a potential powerful research tool (to study pathophysiological mechanisms underlying infertility) and a therapeutic strategy.

The specialised structure and functional role of reproductive tissues and gametes requires the use of minimally-invasive tools that do not interfere with fertility or affect the development of resulting offspring. Several studies have shown that testicular and ovarian gene transfer using viral vectors can restore production of functional gametes in mouse models of genetic gonadal failure. However, data regarding the safety of this methodology remains highly contradictory. The availability of a technique devoid of the biological risks associated with traditional gene therapy could support research into reproductive gene transfer as a possible treatment for specific forms of infertility in future.

Nanomaterial-mediated delivery represents a promising technique for reproductive biology with the potential to improve the safety and efficacy of existing methodologies, including experimental gene therapy and sperm-mediated gene transfer.

## The Oxford invention

Researchers at the University of Oxford have utilised specialised nanoparticles for the delivery of biological compounds into mammalian sperm and oocytes in vitro.

## Advantages

This novel technique offers the following advantages over current gene transfer practices:

- Safe, non-mechanical, and non-viral, gene transfer for reproductive applications
- Non-invasive, high specificity delivery
- Devoid of artificial permeabilisation of specialised gamete membranes
- No integration of viral vectors into host genome

Nanomaterial-mediated delivery represents a promising technique for reproductive biology with the potential to improve the safety and efficacy of existing methodologies, including experimental gene therapy and sperm-mediated gene transfer.

- No need for expensive micromanipulation equipment
- Improved versatility; enabling the delivery of most types of biological compounds, including small molecules, peptides, proteins and nucleic acids (DNA/siRNA)

## Applications

This approach can be used as an alternative to current methodology for the creation of transgenic animals and the experimental gene therapy of hereditary diseases. It can also be utilised for the direct in vitro supplementation of specific molecular (protein) deficiencies, associated with aberrant fertilisation and early embryo development.

Nanocarriers could also be used to facilitate the loading of sperm with alternative molecular compounds (peptides, proteins, fluorescent markers or, in the broader sense, any agents designed to inhibit, augment, or detect endogenous functional activity) for delivery into the oocyte and targeting of physiological pathways in early-stage embryos for investigative research purposes.

## Commercial opportunity

A systematic in vitro pilot study, using animal models, has successfully resulted in encouraging association rates of specialised silica nanoparticles with sperm without toxicity.

This innovative nanoparticle-based delivery system is subject to a provisional patent application in the UK and Isis welcomes the opportunity to discuss this technology with interested parties wishing to develop or licence such technology.

## Relevant markets

- A systematic in vitro pilot study, using animal models, has successfully resulted in encouraging association rates of specialised silica nanoparticles with sperm without toxicity
- This innovative nanoparticle-based delivery system is subject to a provisional patent application in the UK and Isis welcomes the opportunity to discuss this technology with interested parties wishing to develop or licence such technology

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# Cystic fibrosis screening

**Dr Jamie Ferguson** explains how electrochemistry offers a fast, point-of-care screening test for cystic fibrosis.

**CF is a common genetic disease caused by an autosomal recessive gene, the cystic fibrosis transmembrane conductance regulator (CFTR) gene. Affecting multiple organs including the lungs and the intestines, it is a life-long incurable disease with symptom alleviation the only treatment available.**

A person is diagnosed as a cystic fibrosis patient when they present high sweat chloride content and two genetic mutations of the CFTR gene. The current methods for determination of chloride levels include colorimetry, coulometry, ion selective electrodes, and manual titration. Each of these is time consuming and requires highly trained personnel.

Now, Oxford researchers have exploited electrochemical methods for the determination of chloride ions. The electrochemical oxidation of silver nanoparticles in the absence of chloride ions gives one voltammetric signal related to the oxidation of silver to silver ions. The presence of chloride ions in the solution causes the appearance of an additional signal at a lower potential, which is related to the oxidation of silver to silver chloride with the peak height correlating linearly with the concentration of chloride ions. Chloride ion levels of diluted synthetic sweat samples were measured accurately using cheap and disposable silver nanoparticle-modified screen printed electrodes.

Electrochemical methods are cost-effective, convenient and have been shown to provide a reliable quantification of chloride ion concentration. Oxford's proof-of-concept could be developed into a point-of-care system for preliminary screening of cystic fibrosis that would be fast and accurate, as well as simple to use and interpret.

The underlying technology is initially the subject of a UK patent application. Companies interested in progressing the commercial opportunities of the Oxford developments are invited to contact Isis.

*The Oxford developments are described in The Analyst (2013): "Electrochemical detection of chloride levels in sweat using silver nanoparticles: a basis for the preliminary screening for cystic fibrosis." DOI: 10.1039/C3AN00843F*

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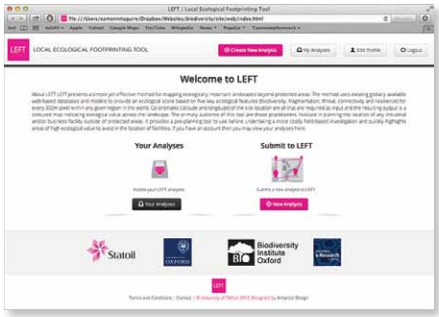
# Determining ecological value

**Dr Richard Holliday** presents an assessment tool for mapping ecologically important landscapes beyond protected areas; the tool highlights locations of high ecological value to avoid in the siting of new facilities.

**A new Local Ecological Footprinting Tool, LEFT, addresses a growing need to assess the ecological impact of industrial and business facilities outside of protected areas. The online method from Oxford integrates existing globally available databases and models to provide an ecological score based on five key features: biodiversity, vulnerability, fragmentation, connectivity and resilience. The end product is a map which indicates ecological value across the required landscape. The detail provided is sufficient to be relevant for landscape planning decisions, unlike alternative tools that provide much coarser data output.**

## Environmental impact assessment

The primary users of this tool will be those practitioners, both in industry and independent practice, who are responsible for understanding environmental impact. The method provides a pre-planning approach for use before a more costly field-based assessment is undertaken, although it could also be used to provide additional information for formal Environmental Impact Assessments.




## Using the tool

Interested end-users are able to access the LEFT tool via the online portal at **www.biodiversity.ox.ac.uk/researchthemes/biodiversity-technologies/assessing-ecological-value-of-landscapes-beyond-protected-areas-left/.**

Credits may be purchased via the online shop, which can then be redeemed against each use of the tool. Organisations interested in negotiating more comprehensive, on-going access to the tool are invited to contact Isis Innovation for a long-term subscription.

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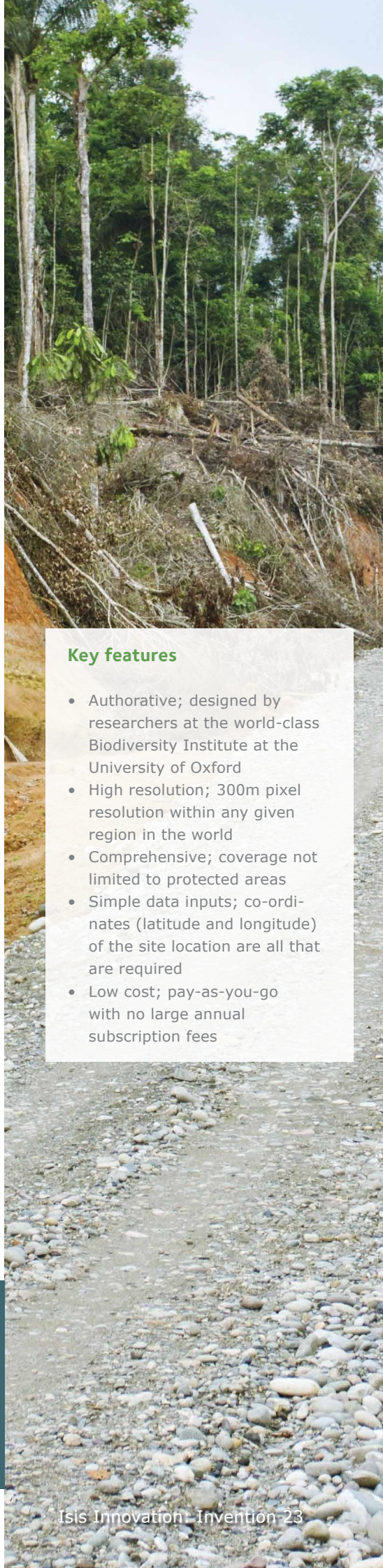
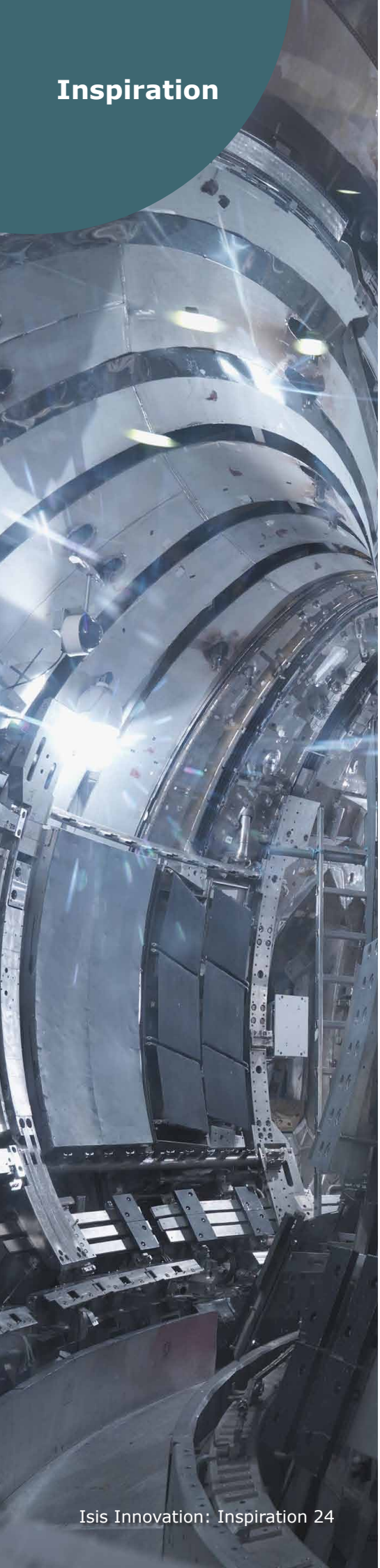


## Key features

- Authorative; designed by researchers at the world-class Biodiversity Institute at the University of Oxford
- High resolution; 300m pixel resolution within any given region in the world
- Comprehensive; coverage not limited to protected areas
- Simple data inputs; co-ordinates (latitude and longitude) of the site location are all that are required
- Low cost; pay-as-you-go with no large annual subscription fees



# Sharing Oxford's energy expertise

**Gurinder Punn** describes how consultancy represents one of the most important means through which staff at the University of Oxford can share their knowhow in energy with external organisations

**There are few topics that stir the social agenda as much as the world's current and future demands for energy.**

Concern is felt by everyone from private individuals worried about paying for their petrol, gas or electricity, to businesses and governments trying to determine their future energy policy. A sudden real or perceived threat to a sovereign state's security of energy supply can lead to geo-political global tensions resulting in increased volatility in financial and commodities markets.

Consumer trends in energy usage have become the subject of intense research amongst businesses trying to formulate future product road maps or even setting up new subsidiary companies to influence how we use energy in the future. There has been a phenomenal increase in data on how, when and why we use energy. What is it all telling us about future consumer energy behaviour?

Many organisations have sought Oxford's help in answering this and other related questions. It's plain to see why. With over 130 senior researchers in 21 departments working on energy related issues supported by postdoctoral and graduate students, the University of Oxford has a tremendous range and depth of expertise, as shown in the matrix on the facing page.

Oxford is at the forefront of many new technologies in the energy sector, in energy politics, policy and economics. University expertise is therefore vital in helping external bodies address energy issues.

Consultancy activity is one of the most important means by which the staff at the University of Oxford can work with businesses, government, public sector organisations and community groups to utilise a broad range of energy related knowledge and expertise. One particularly interesting project recently was Professor George Smith's two part consultancy advising on materials for use in a nuclear fusion reactor. OUC has also managed consultancy projects in solar, storage, energy and demand efficiency, wind farms, tidal turbines and smart metering. Energy consultancies can take a variety of forms from discrete problem solving, technical due diligence, masterclasses and scientific advisory boards, through to product testing, policy advice and strategic planning.

## Energy Specialism

| University Department | Solar | Marine | Transport | Fossil Fuels | Bioenergy | Nuclear | Storage | Demand /Efficiency | Smart Grids | Policy & Politics | Economics | Energy In Developing Countries |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemistry | ● | | | ● | ● | ● | ● | ● | | | | |
| Computing | | | | | | | | ● | | | | |
| Earth Sciences | | | | ● | | | | | | | | |
| Economics | | | | | | | | | | | ● | |
| Engineering | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | |
| Environmental Change Institute | | | | | | | | ● | ● | ● | ● | ● |
| Geography | | | | ● | | | | | | | | ● |
| International Development | | | | ● | | | | | | ● | | ● |
| Law | | | | | | | | | | ● | | |
| Materials | ● | | | | | ● | ● | ● | | | | |
| Mathematical Institute | ● | | | ● | | | ● | ● | ● | | | |
| Oxford Martin School | | | | | ● | | | ● | | | | |
| Oxford Institute Of Energy Studies | | | | ● | | | | | ● | ● | ● | |
| Oxford E-Research Centre | | | | | | | | ● | ● | | | |
| Physics | ● | | | | | ● | | ● | | | | |
| Plant Sciences | | | | | ● | | | | | | | |
| Politics | | | | ● | | | | | | ● | | ● |
| Saïd Business School | | | | | | | | | | | ● | |
| Smith School Of Enterprise & Environment | | | | | | | | ● | | ● | ● | ● |
| Transport Studies Unit | | | ● | | | | | ● | ● | ● | ● | |
| Zoology | | ● | | | ● | | | | | | | |

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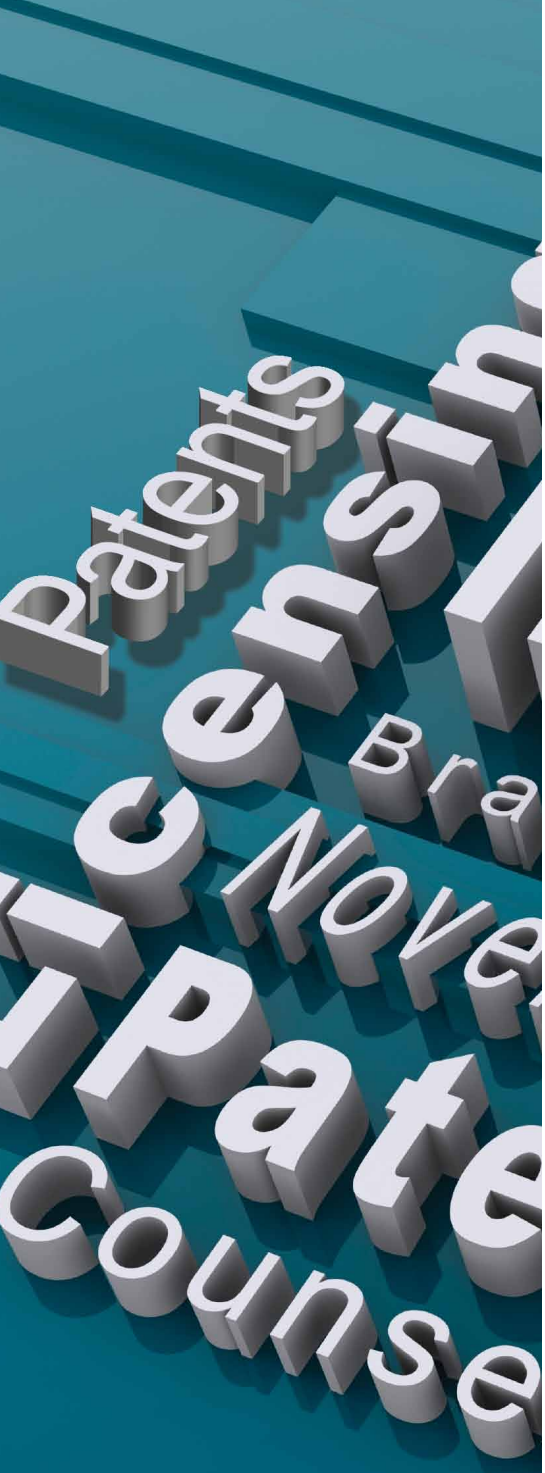
*Image: Inside a fusion reactor*




# Patent landscaping

**Gaurav Misra**, from Isis Enterprise, describes how R&D-centric organisations can benefit from Isis' experience of using patent landscaping to shape a proactive Intellectual Property (IP) strategy.

Isis Enterprise has advised organisations in over 50 countries on various aspects of strategic intellectual property management. During such engagements, our team has had the privilege of deploying patent landscaping as a tool to enable value-based judgements on technology assets across a variety of settings and technology domains.

These capabilities are offered, on a limited basis, to organisations looking to be more proactive about the way in which IP protection shapes their technology strategy.

Technology providers such as corporations, universities and institutes take justifiable pride in the size of their IP inventories and their anticipated benefits. However, as these portfolios enter the last quarter of their validity period, their renewal costs go up and their chances of monetisation decrease. This is one example situation where Isis Enterprise is often called in to assist with portfolio optimisation and budget allocation decisions. The overall challenge, though, is much broader.

## The challenge

Various innovation teams need to make value-based judgements on patents to assess comparative value and evidence a management decision. Patent landscaping can inform such strategies, enabling technology professionals to make sensible decisions and derive a sustainable competitive advantage.

An understanding of the landscape can impart a genuine benefit to the following patent landscaping service users:

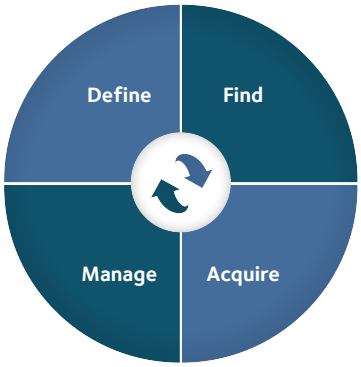
- **Out-licensing teams** that need to develop the value proposition of their assets against other assets competing for the same licensee
- **Inventors and attorneys** that are filing a new patent application and seeking to understand the breadth of claims typically encountered in the technology sub-domain
- **Owners of IP portfolios** seeking to prioritise assets and make capital budgeting decisions
- **Technology scouts** looking to build patent positions around a technology domain or business opportunity

**Get Answers To Questions Like**

- Which patent has a higher comparative value?
- Can patents be linked to a product or a business opportunity?
- Which competitors are active in this space?
- How have patent claims evolved in the past 10 years?
- Do statistical indicators support a valuation hypothesis?

## Patent landscaping may be used in many aspects of strategic Intellectual Property management

**What IP do I require?**
- Linking IP to products, services
- Developing a virtual portfolio
- Scenario planning
- Retrospective assessments
- Litigation searches




**Who has IP relevant to my needs?**
- Accessing the right networks
  - Opinion leaders
  - Industry experts
  - Spin-outs
- Assessing and prioritising opportunities
- Expertise with patent databases

**How can I maximise my IP's impact?**
- Policy development
- Portfolio optimisation
- Horizon scanning
- Technology road-mapping
- Patent budget management

**What is the best way to access the IP?**
- Relationship building
- Techno-commercial due diligence
- Transaction support
  - Consultancy
  - R&D collaborations
  - Licensing
  - Acquisition

## A structured method

Most methodologies focus on the statistical indicators and their visual outputs, with inadequate consideration given to the fundamental economic indicators. Isis Enterprise uses a case-specific approach to patent landscaping that goes beyond purely statistical or qualitative methodologies, using components of both.

The success of the process hinges on a clear understanding of the underlying technology, on maintaining a real-world strategic context, and on utilising the best available expertise available at Oxford to access subject-specific expertise. The recommendations are underpinned by Isis' experience of managing approximately 1,000 patented inventions in a cost-effective, impactful manner.

As a service, patent landscaping is designed to be adaptable to clients' needs.

**Outsourced service**
Organisations with fewer resources dedicated to patent management may outsource their landscaping requirements directly to Isis Enterprise.

**Bespoke, ad-hoc support**
For organisations with substantial internal resources, Isis can provide a second opinion on clients' internal reviews.

**Training and workshops**
Landscaping exercises may be performed as part of a training session and workshop. This enables clients to develop internal capabilities.

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# Oxford Innovation Society

Forthcoming meetings of the Oxford Innovation Society will be held on the following dates:

- Wednesday 18 September 2013
- Thursday 5 December 2013
- Thursday 20th March 2014

Meetings are held in Oxford for OIS members and invited guests, and are followed by a formal reception and dinner in an Oxford college hall.

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