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 77 Autumn 2014

FUTURE DISPLAYS

High resolution flexible technology, consuming zero static power, **p8-9**

The latest innovations, collaborations and technology transfer

UNIVERSITY OF OXFORD

ISIS INNOVATION

Issue 77
Autumn 2014

Displays and sensors focus

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NEWS

Improved patient safety and outcomes

Medical professionals naturally seek to make the best and safest clinical decisions. However, they face a difficult and time-consuming process to gather the latest scientific and clinical evidence that allow best-practice decisions to be made for each and every patient. Deontics, a new spin-out from Isis, now offers award-winning software which gathers, processes and presents scientific and clinical information, allowing a personalised treatment guide to be generated for each patient. The software also provides the same information in a lay format, improving patients' understanding and involvement in their own care. Development of the technology was funded by Cancer Research UK, University College London, University of Oxford and the Royal Free Charity.

Active investors

Spin-out companies from previous years have continued to make the headlines and attract investment. Gene therapy specialist Oxford Biomedica, formed in 1995, raised £20m to fund its portfolio of ophthalmology, CNS and cancer treatments. Oxford Nanopore Technologies, another 2005 spin-out, raised £35 million in new funding, bringing the total funds raised since its foundation to £180 million. Organox, spun-out in 2008 based on technology from Oxford's Institute of Biomedical Engineering, has closed a Series D Investment round. The capital raising was oversubscribed and supported by both existing and new investors.

Membership of the Isis Angels Network, which introduces angel investors to new spin-out opportunities from Oxford, has now grown to 200 business angels from 10 different countries, having more than doubled over the last five years. Angel investors bring not just capital to an investment, but also personal expertise and an appreciation of the way small technology businesses operate and grow.

From rocket science to the kitchen

Oxford Professor of Engineering Dr Thomas Povey applied his research into the design of high-efficiency cooling systems for next-generation jet engines to an everyday object which transfers heat: the domestic saucepan. The unique finned design channels heat from the flame across the bottom and up the sides of the pan, resulting in highly efficient, even heat distribution. This means that the pans heat up significantly more quickly and food cooks faster, saving time and using 40% less energy compared to an equivalent pan of conventional design. Isis worked with Dr Povey to protect his intellectual property and manage the licence to Lakeland, who will sell the range of pans exclusively in the UK.

Incubation partners

An additional benefit for budding entrepreneurs using the Isis Software Incubator (ISI) has been launched with the announcement of a partnership between the ISI and City University London. Students from both universities can now access entrepreneurship support, events and initiatives from either institution. ISI start-ups looking to bring their entrepreneurial ideas to London can use City's co-working space The Hangout in the heart of Tech City, whilst City's students can access the vibrant tech and event networks surrounding the UK's oldest University.

Enterprising Consultancy

News from Oxford University Consulting and Isis Enterprise

Cyprus IP Policy development

Working with the Research Promotion Foundation of Cyprus (RPF), Isis Enterprise recently supported nine Universities and Research Institutes developing draft Intellectual Property (IP) Policies.

A not-for-profit foundation, governed by a twelve-member Board of Directors appointed by the Council of Ministers, RPF's core objective is the promotion of scientific and technological research and innovation in Cyprus.

Isis Enterprise's work with the research organisations and RPF included: development of an IP Policy model document and a number of model technology transfer agreements for use by the individual organisations, delivery of a training session to representatives from the research institutes and universities on the value of an IP Policy for organisations that have research exploitation and technology transfer activities, and, finally, a series of two-day individual coaching sessions for each participating organisation, through which draft customised IP policies were developed for submission to the RPF.

Following on from this activity, Isis Enterprise is now looking forward to further collaboration with RPF supporting the delivery of technology transfer in Cyprus.

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Staff at the Research Promotion Foundation of Cyprus with Dr Alexandra Bush of Isis Enterprise

Motivating academic consultants

It is easy to see why organisations seek out advice and expertise from Oxford academics - they want cutting edge insight from an independent and authoritative source. However, it may be less obvious why Oxford academics, busy with their teaching and research commitments, not to mention a myriad other calls on their time, choose to take on external consultancy projects.

Contrary to popular belief, consultancy is not always about the money, although for some it may be a strong motivator. Oxford University Consulting's experience is that as well as financial reward, academics often look for at least some of the following before they commit to doing a consultancy project. Ideally a consultancy should be intellectually stimulating, yield some positive social or economic benefit or offer the chance to develop relationships that might lead to downstream research collaborations. Projects may also provide insights that assist the academic in their University teaching or research and, with the client's permission, provide material for a case study to demonstrate research impact. Consultancies may even broaden career horizons – it is not unheard of for academics to use their consultancy engagements as opportunities to see what a life lived beyond the University might offer.

Whatever motivates an individual academic to undertake a consultancy project, clients can be assured that a key motivator for OUC is finding them practical solutions to the challenges at hand.

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The portfolio

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

Portable Fuel Cells – PowerAq

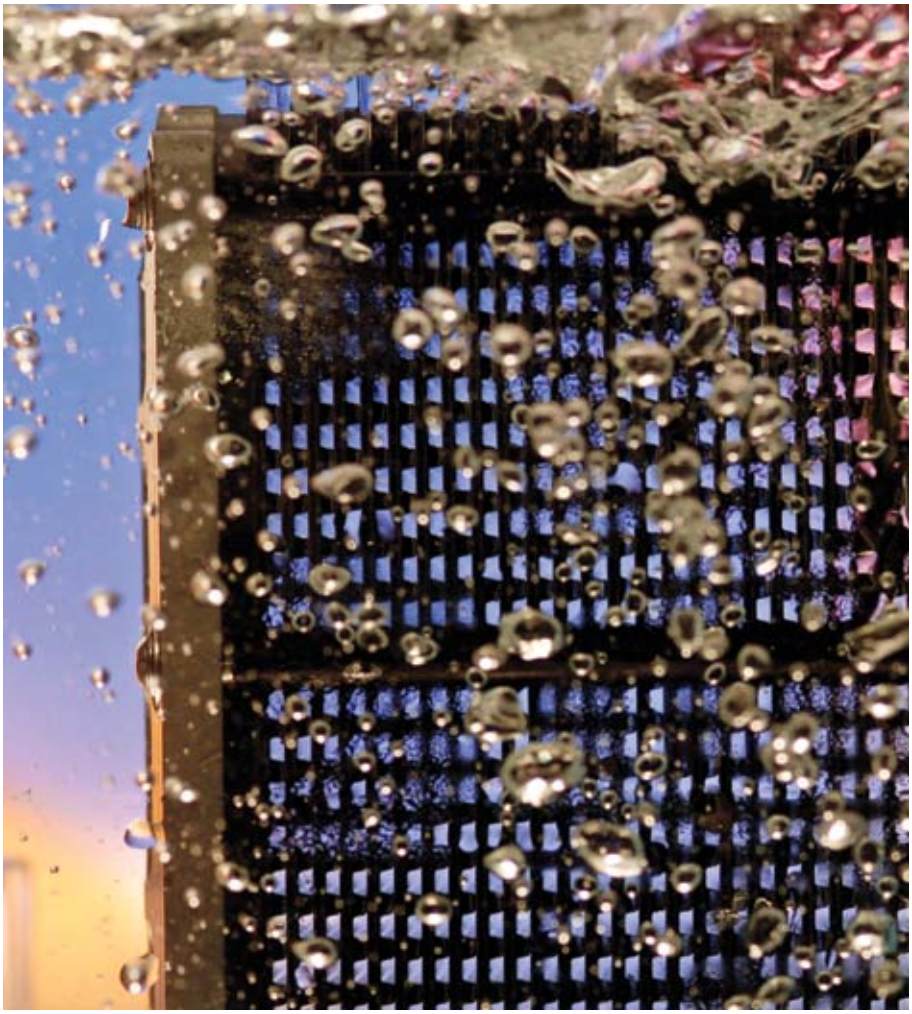
PowerAq will emerge as a leading designer and manufacturer of a new generation of portable fuel cell energy packs. The PowerAq concept is based on nanosilicon (with water as a point-of-use additive), and is more efficient, cleaner, safer and potentially cheaper than comparable products, with an energy density 10 times higher than that of conventional batteries.

Professor John Foord and a co-founder from Oxford's Chemistry Department have invented a new approach to control the release of hydrogen to power a portable fuel cell. The technology - PowerAq - uses processed silica nanoparticles that release hydrogen when water is added. The hydrogen then supplies fuel cells, generating electricity. The only waste product is sand.

The potential energy density of this technology is 10 times higher than that of Li-ion batteries, largely because a key component of PowerAq, water, need not be transported but can be sourced at point-of-use. Potential applications will be found in feeding portable fuel cells used to power devices requiring off-grid electricity in scenarios where recharging a battery is not possible. For example, the technology could provide a backup power solution for electric boats and yachts, which are particularly sensitive to noise and pollution.

After many years of gestation, the market for portable fuel cells has started to grow, and is expected to be worth $0.66bn in 2022. Primary market segments are defence applications (>50%), external battery chargers (>30%), remote monitoring (15%) and fuel cells for portable electronics (<5%). Further market analysis (via direct engagement with fuel cell manufacturers) is required to determine likely profitability in each market segment and the best point of entry for PowerAq.

"10 times higher energy density than conventional batteries"



PowerAq will partner with fuel cell integrators and product developers looking for a better source of portable hydrogen. The aim is to commercialise mobile hydrogen fuel packs for different markets, as outlined above. Together with partners, PowerAq will be able to deliver customised fuel packs tailored to each application.

A total investment of £200,000 is sought to incorporate the company.

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Centro Kappa de Conocimiento

CENTRO KAPPA DE CONOCIMIENTO, S.C.

Dr. Eduardo Ramírez González, General Director of OIS member Centro Kappa de Conocimiento, describes the breadth and international reach of innovation services offered

Centro Kappa de Conocimiento, S.C. (CKC) is a development and technology transfer centre committed to enhance and secure sustainable competitiveness based on knowledge, increasing organisations' human and structural resources. As the oldest and the largest such centre in the private sector, CKC has worked with more than a thousand Mexican companies.

CKC's efforts are focused on strengthening technological innovation, working primarily to address companies' needs for new products, processes, equipment and material. With this knowledge we contact the universities and research centres that, individually or together, can provide the required expertise. CKC works with all companies of all sizes.

CKC assists Research Centres' efforts to engage with companies based in their field of expertise, and also makes connections from companies to Research Centres, based on their requirements. Interdisciplinary skills are frequently called for, and CKC works to identify and contact the different research institutions which together could provide the required knowledge for the company.

Project management

Centro Kappa works with each of its clients to develop a project plan and obtain financial support. We follow the entire lifecycle of the project, from conception, through planning, making, approval, execution and project closure. CONACyT, Secretaría de Economía, Proméxico, are just some of the programmes which Centro Kappa works with, and through these programmes companies can obtain financial resources suitable for their processes and/or products' needs.

CKC also has important collaborations with Universities and Research Centres at national and international level (Mexico, France, Spain, England, Belgium, Chile, Ireland, and United States of America) to support their clients' projects activities and to take the project to a successful conclusion.

Consulting and training

Business training has an essential role to play in enabling companies and individuals to progress. CKC has highly efficient staff who teach courses and provide consultancy to companies in the fields of Quality, Manufacturing, Human Resources, Competitiveness and more, offering a quality service to generate positive results for all key participants in the operation of an organisation.

Studies, projects and business procedures

CKC offers high quality assessments with rigorous tools and methodologies in market analysis, new business development, organisational environment, and more. It also supports the organisation of any kind of registration at the Instituton Mexicano de la Propiedad Industial e Indautor.

Products

Recently CKC has launched the directories called “Graduate Network Linking” and “International Experts Catalogue”. Their purpose is to foster the relationships in terms of employment and/or scientific and technical advising services between Mexican institutions and companies, as well as training scientists and technologists abroad.

The “International Experts Catalogue” arose from the need for researchers to be able to offer their knowledge in specific areas and to establish contact with the business sector.

Both products are already operating and have obtained a favourable response from users.

Commitment

More than 20 years of work and more than a thousand companies support the commitment and the quality of services that Centro Kappa offers.

Technology transfer is an important activity for CKC. The company not only receives technology but also evaluates, executes, complements, improves, and transfers it. CKC manages projects, and provides communications channels to potential prospects with an interest in buying or licensing the technology.
We are fostering business opportunities with European companies and research centres. Specifically, we invite interested groups who are willing to work on joint projects for bilateral collaborations or H2020 calls to promote mutual benefits by creating international partnerships.

Offices in:

Mexico:
- Saltillo, Coahuila
- México City
- Guadalajara, Jalisco

Internationals:
- Belgium
- England
- France

Associates in:
- Spain
- France

Accreditations

Technology Transfer Office Certificated by Conacyt
Scientific Technological Institutions
Registration: 5595
Intermediate Body in Ministry of Economy:
N°00010000010868CKC080122J44
Secretaría del Trabajo y Previsión Social
Registration: CKC-080122-J44-0013

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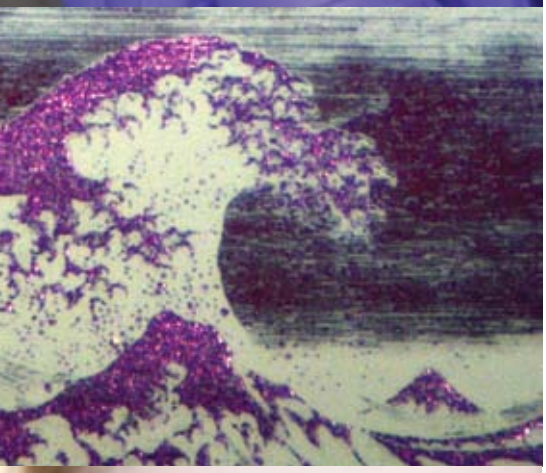

Thin, flexible ultra-high resolution displays

Dr Richard Holliday describes display technology with flexibility, high resolution and low power requirements that make it ideal for portable devices such as phones and wearables

Electronic displays are ubiquitous, and the global display market is projected to reach $165 billion by 2017. A recent Oxford discovery offers the chance to create a new class of ultra-high resolution, low-energy and flexible displays for applications such as 'smart' glasses and foldable screens. The research was recently published in Nature.

Phase change materials

A team from Oxford University's Department of Materials, which led the research, had been exploring the link between the electrical and optical properties of phase change materials, a unique class of materials that can reversibly change from an amorphous to a crystalline state. They found that by sandwiching a seven nanometre thick layer of a phase change material between two layers of a transparent conductor, a tiny current could be used to 'draw' images within the sandwich 'stack'. The phase change material used was the alloy $Ge_2Sb_2Te_5$ (Germanium-Antimony-Tellurium or GST), a material that is well-known in the electronics industry having been a key component enabling data storage on DVD and Blu-Ray discs.

Initially, still images were created using an atomic force microscope to switch the phase change material, but the team went on to demonstrate that such tiny 'stacks' can be turned into prototype pixel-like devices. These 'nano-pixels' – just 300 by 300 nanometres in size – can be electrically switched 'on and off' at will, creating the coloured dots that can form the building blocks of an extremely high-resolution display technology.

Flexible displays

A key advantage in using extremely thin films is their intrinsic mechanical flexibility. The same technology has been demonstrated to work on flexible Mylar sheets a few microns thick. This makes it potentially useful for 'smart' glasses, foldable screens, windshield displays, and even synthetic retinas that mimic the behaviour of photoreceptor cells in the human eye.

Another important feature related to display applications is that, unlike conventional LCD screens, there is no need to constantly

Example of an electrically constructed image, 70µm wide, on a phase change material optoelectronic film

refresh all pixels; you only have to refresh those pixels that actually change (static pixels remain as they were). This means that any display based on this technology would have extremely low energy consumption. In addition, flexible paper-thin displays based on the technology could have the capacity to switch between a power-saving 'colour e-reader mode', and a backlit display capable of showing video.

The advantages of this technology for projection micro-displays such as those used in the highly publicised "Google Glass" are exciting. A key requirement for this type of display is very high resolution as a small display is optically "projected" to create a viewable display. Such displays also need to be thin, light and consume very little power, especially when they are displaying static images to preserve battery life. This new technology is perfectly suited to such a market – it consumes no power when static, can be made at very high resolution and can be made ultra-thin and light.

Commercialisation

A patent application has been filed, a proof-of-concept already developed and work is now underway to upscale the number of pixels in a working display. Isis is now discussing the technology with investors and companies who are interested in developing the technology for future products.

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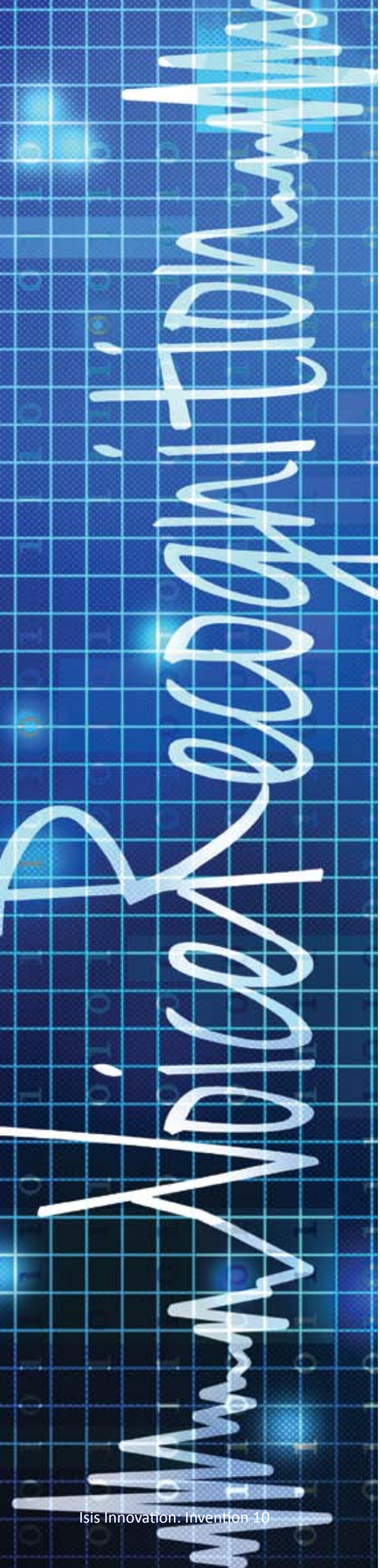

Speech recognition for the real world

Automated speech recognition (ASR) systems have been available for years. The challenge has always been to produce a robust system that copes well with variations in pronunciation. **Dr Fred Kemp** describes a new approach based on phonological principles

Say it again?

Is the 'a' in bath like bar or like bat? A small difference, but in reality every person pronounces every word differently, even when they repeat themselves. As a result, most Automated Speech Recognition (ASR) systems, which are generally based on statistical-modelling techniques, require extensive training from thousands of recorded speakers just to master the variation within one dialect. In contrast, Oxford's FlexSR system is based on phonological principles and therefore does not require training and can recognise a wide range of dialects and accents.

Heuristics or statistics?

Early attempts in the 1970's to use linguistic models for ASR were abandoned because they tried to use very specific algorithms to map signals to individual sounds and their variants, which required a comprehensive knowledge of the phonetic details of a particular language. Deviations from the specific mapping procedures led to the failure of these systems and the consequent dominance of statistical-modelling techniques in ASR for the last 40 years.

However, even for the current best-in-class ASR systems, high degrees of accuracy are only achieved with multi-layered and computationally-intensive models (such as Hidden Markov Models - HMMs). Such systems therefore require either state-of-the-art hardware, or in the case of mobile applications, a network connection to offload the analysis to a remote server. In addition, many systems also need to be trained against a particular voice to attain accurate recognition (although some might suggest that it is the speaker that is trained how to speak, not the software how to recognise!)

A more flexible approach

FlexSR is different. Rather than rely on statistical analysis alone, leading linguists at the University of Oxford have developed a "sparse" linguistic model of the human cognitive representation of words. This theory suggests that humans store a very basic acoustic representation of each word, accepting wide variation in the sounds themselves and recognising words by their general pattern. Adopting this approach has allowed the team to overcome the problems of earlier linguistically-based attempts, and allows FlexSR to identify words across a wide range of speakers and dialects by extracting approximate sounds and matching these patterns with its internal word list or lexicon.

By assuming there is only a small set of language and speaker independent features and allowing a wide range of variation, FlexSR even copes with the failure to detect features (either because they were not realised by a speaker or got lost in background noise). This has led to a much more accurate system, regardless of dialect, accent, non-ideal speech, or background noise. Consequently, FlexSR outperforms many existing ASR systems at individual word recognition, despite being computationally lightweight, requiring no system training and being easily adaptable to any spoken language. Currently it is implemented for English and German, including tonal languages, such as Mandarin Chinese. Tonal languages, where meaning is distinguished by changes in pitch – in a manner analogous to consonants and vowels – are extremely common in Africa, East Asia, and Central America, and often very challenging for HMM-based ASR systems.

By contrast, to train an HMM-based ASR system in a new language requires a large training set consisting of speech obtained from hundreds (or even thousands) of speakers, where the speech output has to be transcribed, segmented, and manually verified, to allow the mapping of the acoustic signal to the 'text'.

Looking to the future

The Oxford team's ground-breaking work was recently highlighted as one of the most innovative projects to be awarded a Proof of Concept grant by the European Research Council, an award that allows them to further refine and develop the FlexSR system, as well as prioritise additional languages to support.

Given the potential impact of this new approach and the broad range of applications, Isis would welcome discussions with potential partners who would be interested in integrating FlexSR into existing technologies or developing for mobile deployment.

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Contactless remote temperature sensor

The difficulty of temperature sensing in hostile or extreme environments is addressed by technology described by **Dr Manjari Chandran-Ramesh**

Accurate and reliable temperature measurement is a fundamental requirement when monitoring chemical, physical and biological processes. Researchers within the Dark Matter and Precision Measurements group at Oxford, collaborating with scientists from the UK's national synchrotron facility in Harwell, have developed a detector for remote, contactless temperature monitoring of systems in environments where traditional thermometric devices are unsuitable.

Although originally developed to help in the understanding of dark matter, this novel remote temperature sensor has been successfully utilised across a range of applications. Within the reaction chamber of a beamline at the synchrotron in Harwell, for example, it has been used for the real time, non-contact measurement of experimental temperature during protein crystallography studies.

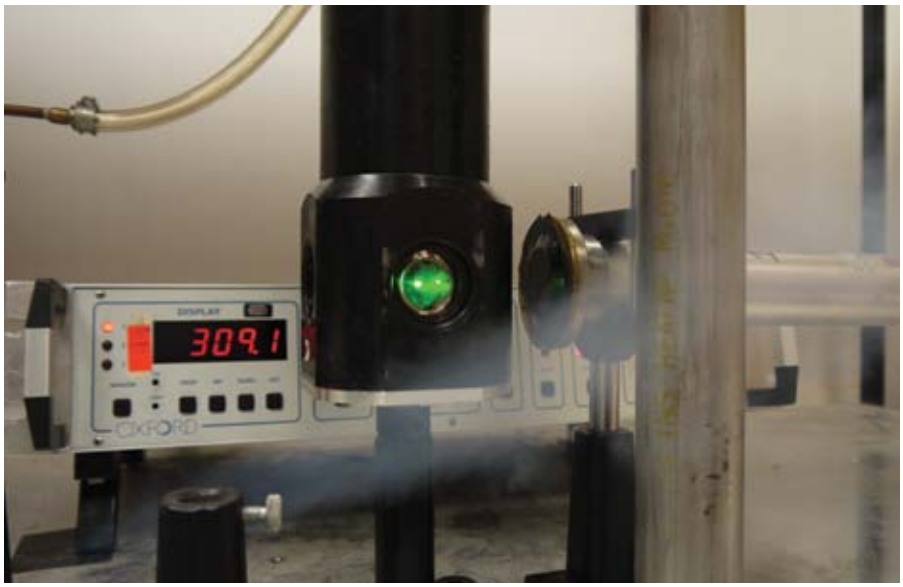
This Oxford technology addresses many of the shortcomings of current techniques for remote temperature measurements by creating a simplified and integrated optical temperature sensor without the need for external excitation sources, thus reducing cost, complexity and most critically the size of the device.

The technology determines the absolute temperature of the environment by exploiting temperature dependency of the luminescence decay time constant of certain scintillator crystals. It integrates a weak radioactive excitation source into the scintillator crystal thus removing the requirement for an external excitation source. This brings advantages of cost as well as space as no external excitation source and complex additional optical elements are required.

Advantages of this temperature sensor

A very small sensor with a contactless data acquisition system gives this technology clear advantages over existing techniques for temperature measurement. Besides the advantages of cost and space there is also no need to align the radiation source with other elements of the system, thus simplifying setup and operation of the device. Locating the detector remotely from the sensor also removes the need for electrical connections, providing further flexibility.

The Oxford Group has also identified a number of scintillator materials that exhibit good sensitivity over a broad range of temperatures. This opens up a myriad of application areas from the



Laboratory demonstration of cryogenic temperature sensing

measurement of temperatures as low as that of liquid helium to furnaces and combustion chambers.

Technology maturity and market readiness

Photons emitted from the scintillator are received by the detector system connected to a proprietary ultra-fast data acquisition module. This compact and inexpensive module provides data for analysis and determination of the scintillator temperature. The DAQ therefore replaces expensive and cumbersome electronics of traditional technologies and has a major benefit for the affordability of the measurement device.

The Oxford technology incorporates an additional optical-to-USB converter between DAQ and PC allowing for data analysis at any distance from the source experiment. This arrangement allows for off-site access to the sensor system and DAQ module. An elegant software platform provides data analysis and a simple GUI for presentation of the temperature of the experimental conditions.

Relevant markets

This technology lends itself to a range of applications which are difficult to achieve with conventional devices. Hazardous and dangerous conditions may be monitored such as chemically aggressive environments, high-voltage systems and situations that preclude human interaction due to radiation, RF and microwaves. As the sensor element occupies a highly compact form factor, the technology is perfectly suited for use in micro focusing beam lines within synchrotrons which may have congested experimental space and temperatures that can change dramatically within a short distance.

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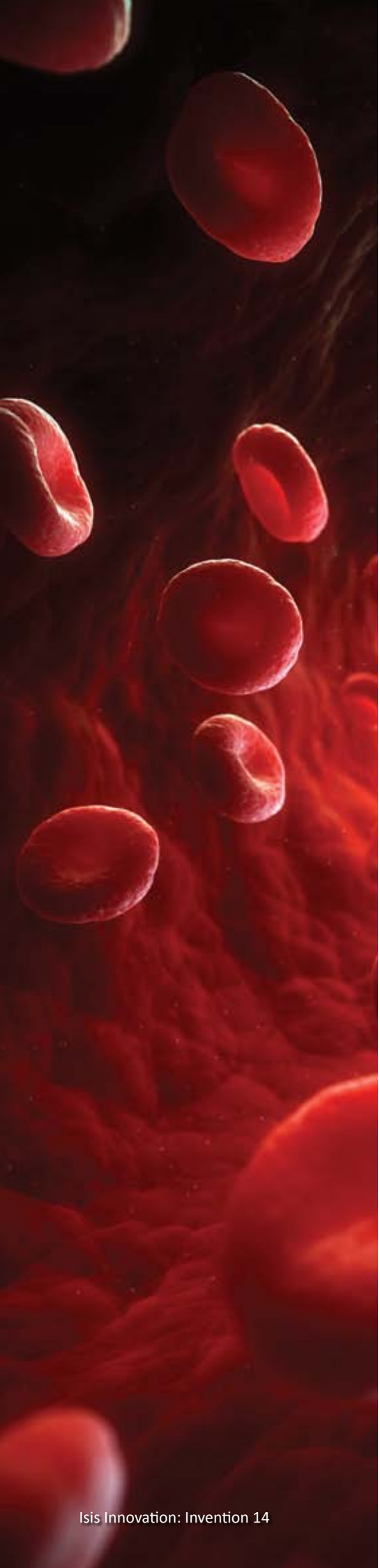


Treating blood clots without the bloodshed

Dr James Groves presents an anti-blood clotting agent, derived from the saliva of the tropical bont tick, which demonstrates high potency without increased bleeding

Blood clotting is a sophisticated physiological cascade, critical for survival by ensuring that minor traumas do not result in life-threatening blood loss. The flipside of the haemostatic coin, however, is that this protection can turn against us. The aberrant formation of a blood clot will block the flow of oxygen and essential nutrients within the vasculature and can result in a range of conditions including myocardial infarction, stroke, pulmonary embolism and deep vein thrombosis.

Narrow therapeutic window

While a number of anticoagulants have been developed, their major limitation is a narrow therapeutic window between clot-busting potency and excessive bleeding. A consequence is that dosing has to be limited, preventing anticoagulants from achieving their full efficacy. In response, significant research efforts have been focused on identifying new molecules that can deliver sufficient anticoagulation without unwanted bleeding.

Learning from the bloodthirsty

Numerous blood-feeding animals, from leeches to vampire bats, have developed an array of specialised salivary proteins that interfere directly with the clotting process, allowing them to feast on an uninterrupted flow of host blood.

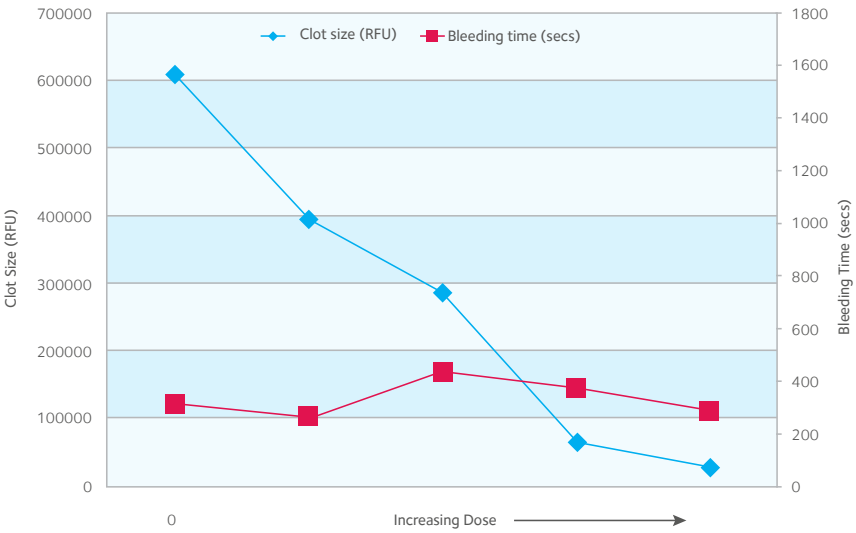
These proteins have been of great value in dissecting the blood clotting cascade, and have led to the development of an array of anticoagulant agents.

Anticoagulation without bleeding

Researchers from the University of Oxford and the National University of Singapore have identified variegin, an anticoagulant extracted from the saliva of the blood-feeding tropical bont tick *(Amblyomma variegatum)*. The team were able to synthesise the small peptide and observe a variety of ideal anticoagulant traits, including specificity, a long duration of action, dose-dependent potency and minimal bleeding *in vivo.* Variegin is a 'first-in-class' anticoagulant that breaks down blood clots by inhibiting thrombin, a key enzyme in the blood clotting cascade. Structural modifications of this protein have generated a suite of derivatives that exhibit a variety of key advantages.

Key advantages

- Unprecedented efficacy: More than 80% inhibition of clot formation
- Reduced side effects: No increase in bleeding time or blood loss
- First-in-class mechanism: Both uncleaved and cleaved peptide inhibit thrombin
- Long lasting: Retained activity of cleaved peptide permits enduring anticoagulation
- Reversible: Anticoagulation can be neutralised by protamine sulphate



Dose-dependent clot inhibition without increased bleeding in a mouse model of thrombosis

Market opportunity

An increasing prevalence of blood clotting disorders is driving investment in identifying improved oral anticoagulants, with revenues expected to be almost $12 billion by 2016 in the US alone. Furthermore, patient safety, particularly in relation to bleeding will drive market share for emerging products (Frost & Sullivan 2011, Analysis of the anticoagulant market). The superior efficacy and side effect profile of variegin, combined with its capacity for structural modification, represents an exciting opportunity to access this market. In addition, the properties of variegin will be of interest to companies engineering heamocompatible coatings for catheters, vascular stents, artificial heart valves and extracorporeal tubing.

"Surgeons want to carry out their work without worrying about their patient bleeding to death. We think we have found a safe anticoagulant, designed by nature, which could allow this happen"

Professor Pat Nuttall OBE, lead inventor, Department of Zoology, University of Oxford.

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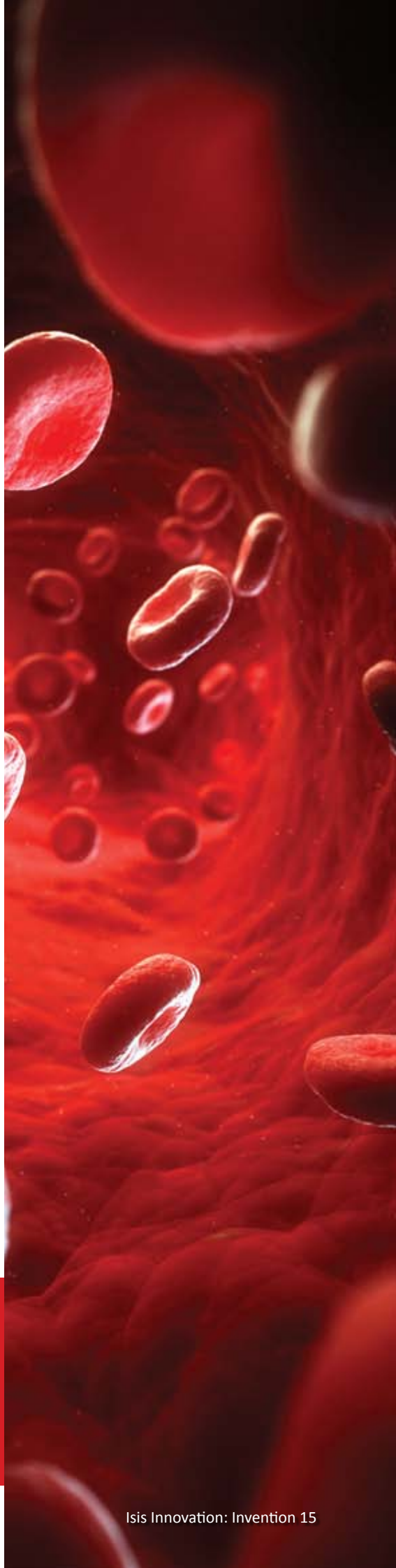


Reducing obesity

Dr Weng Sie Wong describes an Oxford discovery that could lead to new anti-obesity treatments

Healthcare challenge

Obesity is one of the major health challenges facing the developed world today. A good measure of obesity is the body mass index (BMI), which is calculated by dividing body weight in kilograms by the square of a person's height in metres. A person with a BMI between 25 - 29 is considered overweight, over 30 kg/m² they would be considered obese.

It is estimated that there are over 1.4 billion overweight adults, with over 200 million clinically obese men and almost 300 million clinically obese women. In the US alone, over 65 percent of adults are obese or overweight and approximately 10 percent of the total healthcare budget is spent on obesity related conditions such as Type 2 diabetes and coronary heart disease.

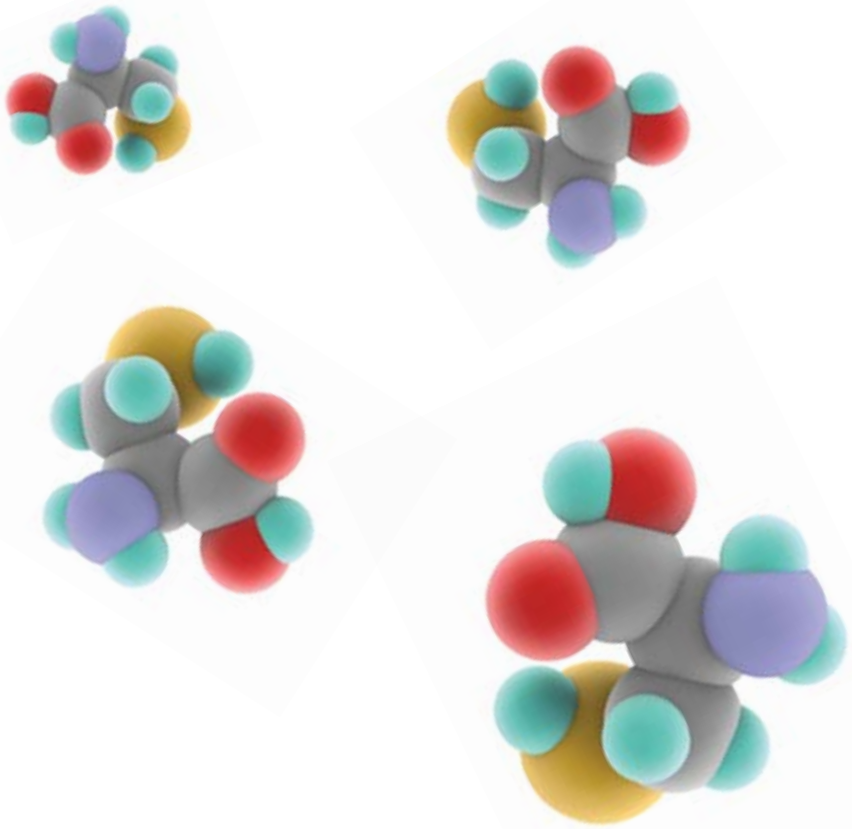
Cysteine, a non-essential amino acid

Cysteine can be biosynthesised by the body from other essential amino acids, and therefore does not need to be consumed in the diet although it is found in a large number of foods including oats, fruits and vegetables. Notably it is found in high protein foods such as dairy, meat and eggs.

In vivo and in vitro studies

The Oxford researchers were one of the first groups to report a causal link between plasma cysteine levels and body fat mass in a large population study. Subjects with high plasma cysteine levels were significantly heavier than those with low plasma cysteine levels. In one study, women in the highest cysteine quintile were 9kg heavier than those in the lowest quintile, regardless of their diet or activity levels. This weight difference was further found to be explained by changes in fat mass, not lean mass (which reflects muscle mass).

Following on from these population studies, the Oxford researchers have identified several compounds that lower plasma cysteine levels in *in vivo* and *in vitro* studies and consequently have anti-obesity effects. In one study, rodents fed a high-fat diet together with a cysteine-lowering drug had half the gain in body fat mass, and a lower activity of the fat-building enzyme stearoyl-CoA desaturase-1 (SCD1), compared with the animals not given the drug. There was minimal or no effect on lean mass. In another study, it was found that decreasing cysteine prevents maturation of fat cells and blocks their ability to accumulate fat, in conjunction with SCD1 inhibition.



Potential for healthcare

Collectively, these studies indicate that lowering cysteine levels has potential for preventing weight gain and facilitating weight loss in humans. Moreover, since lean mass reflects muscle mass, a reduction in plasma cysteine would selectively decrease fat mass, whilst protecting against muscle mass loss. This is a distinct benefit over conventional weight-loss approaches which do not preserve muscle mass. The compounds that have been identified by the researchers have the potential to be the anti-obesity treatments of the future.

"Health problems associated with being overweight or obese cost the NHS more than £5 billion every year"

– Department of Health, UK Government, March 2013

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Turbulence measurement takes the heat

Dr Andy Robertson introduces a new sensor capable of measuring turbulence and temperature fluctuations under the most extreme operating conditions

Fasten Seatbelts

Turbulence is the fluctuation in a fluid's velocity, and for most people the word conjures up the disruptive motion induced by adverse weather conditions during an air flight. In powered flight it is the velocity of the airflow past the wings which determines lift, and fluctuations in this velocity are the cause of characteristic fluctuations in lift which lead to the "Fasten Seatbelts" signs being turned on.

Wings are not only affected by turbulence, but also cause turbulence as they move through air, resulting, for example, in small aircraft being unable to land immediately after a large aircraft, as turbulent airflows need some time to dissipate. Measuring turbulence allows us to understand the conditions of the fluid flow itself, but also to infer the operating conditions of equipment "upstream" that are generating turbulent conditions and predict the impact of these conditions "downstream".

Turbochargers, planes and automobiles

Understanding turbulence in turbomachinery applications is particularly important since velocity fluctuations affect heat transfer between the fluid and, for example, the blades of a turbine. Effective heat transfer is a critical issue since blade temperatures must remain within their operating range, and turbulence affects the friction coefficient between fluid and the surface of these turbine blades. Unfortunately, measuring turbulence in these high temperature - and high pressure - conditions has proved impossible with established sensor technologies e.g. hot wire sensors cannot operate beyond 600K. As a result no instrument is available on the market to meet this requirement. The Oxford invention addresses this need directly and offers a number of benefits:

- By providing a robust solution for high temperature flows the new sensor allows manufacturers to test and validate components under real engine operating conditions enabling the development of improved combustion systems and turbomachinery.
- Test and validation processes are further enhanced by the sensor's ability to measure temperature fluctuations as well as turbulence.
- Sensor reliability and longevity are guaranteed through the use of materials which are already proven under gas turbine operating conditions e.g. the sensor can be constructed using ceramics and platinum.

- Reduced downtime through improved condition monitoring as, for the first time, turbulence and temperature fluctuation measurements can be used to infer upstream operating conditions. In principle, improved performance can be achieved through the use of the sensor's output for closed loop control e.g. by providing an additional input for an engine management system.

The Oxford invention is designed with the most demanding environments in mind e.g. exit fluid flows from the combustor of a gas turbine where temperatures can reach 2000K. However the sensor has broader application. For example, the sensor can be used for turbocharger development or in the automotive sector for engine condition monitoring in an exhaust gas flow.

Design and testing

The invention is the subject of UK patent application. Concept design work has been completed and a working sensor has been built and tested under laboratory conditions in Oxford. Funding is in place to test the sensor in an experimental combustor setup to validate the sensor in a simulated operating environment (Technology Readiness Level 5). This project will be of interest to sensor companies and others active in the aerospace, automotive and industrial gas turbine and turbocharger markets. Interested parties should contact the Isis Technology Transfer Manager.

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Auditing the auditors

For more than a decade, Oxford University Consulting (OUC) has been working with the National Audit Office (NAO) to support its Value for Money (VfM) work in a host of different ways. **Andrew Goff** and **Susan Clark** describe the role of the NAO and the contribution of OUC's consultants

The NAO, often called the Government's watchdog by the BBC, scrutinises government spending on behalf of parliament and taxpayers, making savings of millions of pounds through efficiency gains - estimated at £1.1 billion in 2013. They publish around 60 VfM reports each year, examining how Government departments are spending taxpayers' money and these are presented to the Committee of Public Accounts (PAC) in Parliament.

OUC has undertaken full VfM studies utilising staff based in the Oxford Internet Institute. We have provided training to NAO audit teams through consultants based at the Saïd Business School and the Departments of Economics and Sociology, and we have undertaken more than 200 independent academic reviews of the reports that Parliament uses to hold government to account for how it spends public money.

Value for Money

VfM audits cover a wide range of significant topics, such as the NHS and major defence projects, and increasingly focus on local services, including those delivered by local government. Each year, a programme of VfM work is proposed based on a detailed assessment of risks to value for money with input from the PAC and Parliament, however, the final decision on what will be examined lies with the independent head of the NAO, the Comptroller and Auditor General.

VfM reports aim to highlight important lessons for the bodies being audited and for government more widely. The NAO does not comment on the merits of policy, but simply aims to conclude whether value for money has been secured. It does this through an assessment of the Economy, Efficiency and Effectiveness of spending.

Economy: minimising the cost of resources used or required, i.e. spending less
Efficiency: the relationship between the output from goods or services and the resources to produce them, i.e. spending well
Effectiveness: the relationship between the intended and actual results of public spending, i.e. spending wisely

The primary aim of the NAO's VfM work is to promote enduring beneficial change across public services, through improvements to service delivery and improved governance, as well as helping to identify financial savings and efficiencies.

The financial impacts are realised when the NAO's recommendations lead to direct cash savings, improved efficiency (where more or better quality outputs are achieved for the same cost), increases in revenue or a reduction in the resources required to produce the same outputs. Some recent examples include:

- Savings arising from more cost-effective prescribing of drugs
- Reductions in government expenditure on consultants
- Improvements in departments' procurement capabilities

- Recovery of revenue by reducing the use of offshore accounts to evade tax
- Efficiency savings in local bus services
- Savings in custody costs through more effective use of electronic tagging

Oxford's academic consultants

OUC has enabled more than 50 Oxford academics to actively contribute to ensuring that the NAO's VfM audits are robustly analytical, evidence-based and evaluative, with clear conclusions and recommendations aimed at stimulating change.

The academics OUC commission to work with the NAO often relish the opportunity to carry out this type of consultancy because they see their academic expertise having real world impact.

Professor Anthony Heath, Emeritus Professor of Sociology, comments, "…we have had various beneficial effects on the NAO itself, and its methods for conducting VfM reports. Of all the government work that I have done, this is probably the work that has had the most direct positive impact."

Another experienced VfM reviewer for OUC, Professor Carolyn Hoyle, Director of the Centre for Criminology in Oxford, tells of her experience, "I have carried out external reviews of reports prepared by the National Audit Office for OUC since 2009. Anticipation of external review must influence those at the NAO and help to keep them accountable."

NAO
National Audit Office

"Of all the government work that I have done, this is probably the work that has had the most direct positive impact."

Professor Anthony Heath, Emeritus Professor of Sociology

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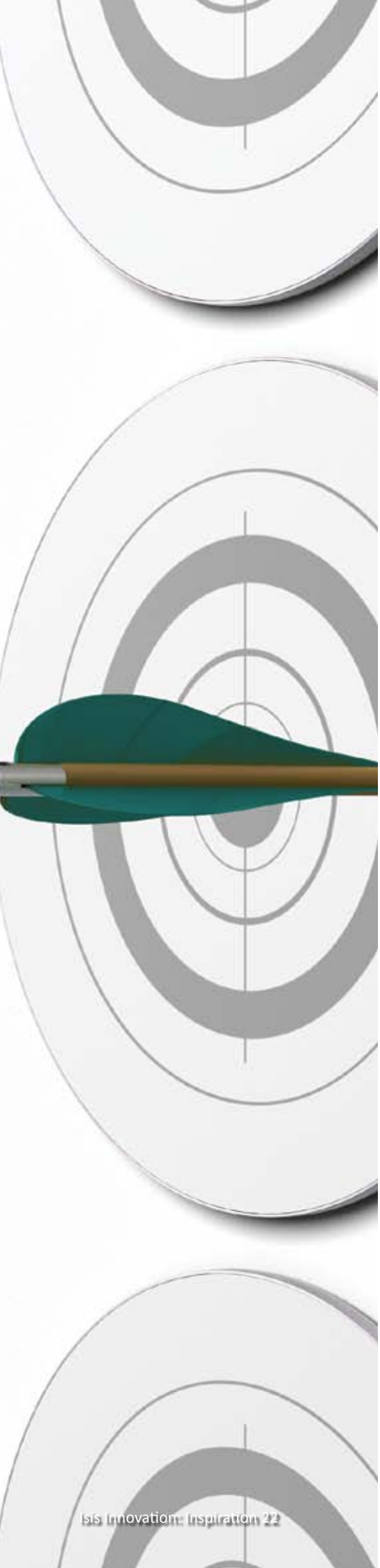


Technology scouting services

Isis Enterprise (IE) offers technology scouting services to both technology providers and seekers. Technology scouting is the process of identifying and evaluating technologies in the research base (technology providers) that can deliver value to the client organisation (technology seekers)

IE has provided scouting services for a number of companies in areas covering food technology, agriculture, pharmaceuticals, chemical engineering, electronics, computer vision and healthcare. Outcomes include new partnerships, acquisitions and licensing deals, resulting in the launch of successful products and services.

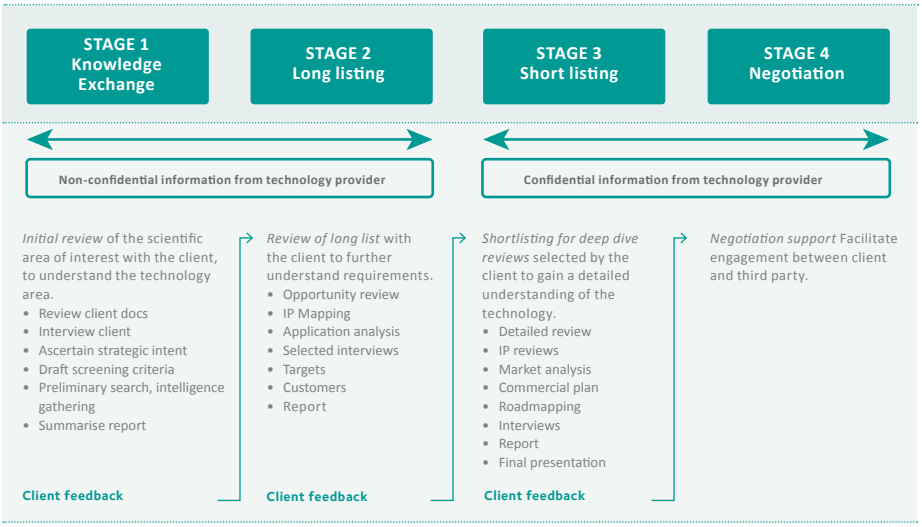
Global scouting process

The IE scouting service uses a targeted, structured approach to source relevant technologies from a global network. The general process that IE uses for its technology scouting service is presented in Figure 1. IE's success in technology scouting is built on several factors:

1. A structured and focused process that facilitates continual knowledge exchange and regular interaction with the technology seekers.
2. Skills in finding the right technologies - defined through the knowledge exchange process, with the ability to act as a third party and minimise the risk of IP contamination.
3. A balanced understanding of both academic research and commercial markets, enabling us to work effectively with labs, universities and start-ups.
4. Experience in managing multiple external relationships across different cultures.

A general view of who may be interested in technology scouting and how to engage is provided in Figure 1.

	For Technology Providers	For Technology Seekers
Who	• Universities, researchers, TTOs • SMEs • Investors	• Large companies/ multinationals • SMEs • Investors
How	• Register contact details • Meet with IE to discuss your portfolio • Submit non-confidential summaries of relevant technologies • If required, NDAs can be put in place at an early stage for confidential IP or research programmes • No charge for membership; fees for proactive scouting campaigns determined by scope of work	• Submit request for proposal to IE for technology scouting service, specifying fields of interest • Standard or bespoke technology scouting engagement is agreed • IE charge for service determined by scope of work



The stages IE implements to conduct structured and focused Technology Scouting Services

In addition to Isis Innovation's direct access to Oxford University researchers and spin-outs, it also sources technologies from a global network of technology owners which includes Oxford Innovation Society (OIS) members, universities, national technology transfer offices (TTOs), TTO associations, industry associations, development agencies and research funding bodies. Isis Innovation seeks to identify new sources and build new relationships through its network and more traditional methods such as database searching and patent landscaping.

Client benefits

Technology scouting provides researchers, universities and TTOs with new commercialisation opportunities, including assistance in developing new products, or access to investors, clients or licensors. Investors can also find value in technology scouting either as a provider of technologies from their portfolio or as a seeker of new investment opportunities.

Technology development can be accelerated by technology scouting, in particular for companies that may not have the resources or time to focus on research and development for new market areas.

The benefits of technology scouting include:

- Open Innovation for competitive advantage.
- Access to early-stage technologies and emerging markets.
- Expand the organisation's global talent pool.
- Strengthens in-house skills.

Case Study

- Isis Enterprise worked with a major pharmaceutical company to support their international science program, as part of a plan to buffer the 2016 patent loss of one of their main products.
- Having identified the company's requirements, Isis Enterprise engaged in a programme of technology scouting and relationship building across carefully selected research institutions in the UK, including a survey of the technology landscape and identification of the best UK scientists for sector-specific requirements.
- Isis Enterprise presented the client with over 100 cutting-edge research collaborations in the UK, significantly increasing shareholder value.

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Oxford Innovation Society

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

- Thursday 18 September 2014
- Thursday 4 December 2014
- Thursday 19th March 2015

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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