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Pioneering research and skills

PIONEER

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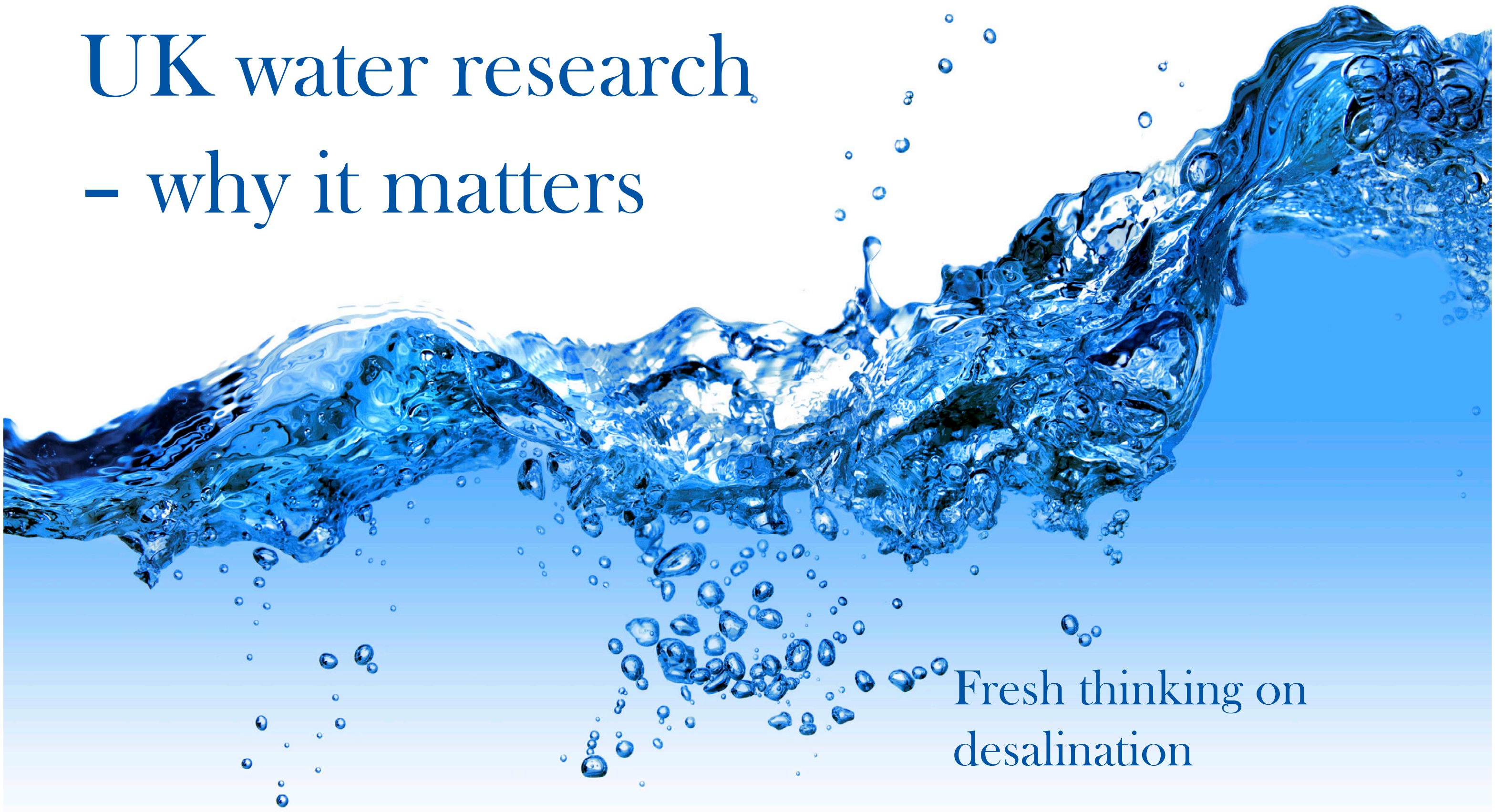
Liquid asset

UK water research – why it matters



Fresh thinking on desalination

Biofilm breakthroughs

Smarter PhD training

Research highlights

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LIQUID ASSET

Ninety-nine per cent of the water on our planet is either locked away in the oceans or frozen. Of the one per cent that's left, only a fraction is fit for human consumption. The need for research into this most precious resource has never been more important.

The water research projects sponsored by EPSRC are tackling some of the most pressing national and global challenges – new purification and filtration technologies; smarter pipeline management; stronger protection against flooding; better wastewater treatment.

The astonishing range of the research featured in this edition of *Pioneer* is also a reflection of EPSRC's diverse portfolio: mathematicians devising algorithms to predict and monitor waterpipe leakages (p8); engineers using ultrasound to create high-powered eco-friendly cleaning tools (p16-17); synthetic biologists working with chemists and social scientists on ground-breaking desalination projects (p18-19), and a host of other research activities.

Complementary to EPSRC's support for cutting-edge water research are world-leading industry-focused doctoral training programmes through which we are training the research leaders of tomorrow. A major initiative is the award-winning STREAM Industrial Doctorate Centre (p14-15), which brings together five universities and numerous industrial partners on real-world projects that help doctoral students build a platform for a career in industry or academia – or both.

If there's one overarching theme running through the enormous range of research and training we support, it is the way they join up. Scientists and engineers working with industry on mutual challenges; spin-out companies commercialising EPSRC-supported research; research groups advising government and world bodies; academics pooling their talents across universities and disciplines; research councils co-funding projects and collaborating on joint events such as the March 2012 RCUK Water Showcase.

Working together we are seeing progress in many areas and across disciplines – creating a flow of research that is greater than the sum of its parts and testament to the skills and vision of the scientists and engineers we sponsor.

Professor David Delpy
EPSRC Chief Executive

briefings

Supercomputer gets £13.9 million upgrade

The next generation of HECToR, a state-of-the-art supercomputer facility, has been launched. EPSRC has invested £13.9 million in Phase 3 of HECToR, reconfirming its status as one of the world's most powerful computers.

HECToR Phase 3, based at the University of Edinburgh's Advanced Computing Facility, will provide a world-class service for UK-based academic research, as well as opportunities for reseachers to work with colleagues in Europe and worldwide.

Industry and commerce will be encouraged to make effective use of the facility.

HECToR, which is capable of making over 800 million, million calculations a second, will help tackle today's biggest scientific and engineering challenges. Among many opportunities, HECToR will make it possible for researchers to make more accurate climate forecasts, develop smarter life-saving drugs, build safer aircraft, predict natural disasters, and understand how complex biological systems work.

Next generation solar energy harvesting

Fifteen British businesses and seven UK universities are collaborating on projects that use novel nanoscale technologies to develop the next generation of solar energy harvesting technology.

Under the RCUK Energy Programme, EPSRC and the Technology Strategy Board are investing in four industry-led collaborative research and development projects that will address challenges in building the supply chain and scaling-up technologies.

ICT Research and development boost

EPSRC and the Technology Strategy Board are investing £6 million in 10 collaborative information and communications technology (ICT) projects led by leading UK companies. ICT has a major role to play in areas such as manufacturing and construction, knowledge-sharing across supply chains and simulation and modelling.

The funding will stimulate the use of innovative ICT in areas where there are major opportunities to increase productivity and competitiveness. Including match-funding from the businesses taking part, the total value of the investment is over £12 million.

Manufacturing the future

EPSRC is investing £24 million in four new EPSRC Centres for Innovative Manufacturing. The Centres complement EPSRC's existing portfolio, and focus on future electronics; healthcare technologies; resource efficiency; complex multifunctional products; and innovative production processes.

There are 12 current EPSRC Centres for Innovative Manufacturing, co-created with industry to address the long-term research challenges of their project partners. It is intended that the centres will function as National Centres for the UK research community, provide an international presence and influence policy.

Nano healthcare investment

EPSRC and the Technology Strategy Board are investing over £6.5 million in seven business-led nano healthcare projects.

The projects will focus on developing therapeutic agents and diagnostics where nanoscale technologies are at the heart of the innovation. They will be led by Critical Pharmaceuticals Ltd, Johnson Matthey plc, Mologic Ltd, Nanomerics Ltd, OJ-Bio Ltd, Renishaw Diagnostics Ltd and Sharp Laboratories of Europe Ltd.

£20 million graphene investment

EPSRC is investing £20 million in engineering research into graphene, the strongest, thinnest material ever measured. The investment focuses on graphene-linked manufacturing processes and technologies in order to accelerate the development and generation of novel devices, applications technologies and systems.

EPSRC CEO Professor David Delpy, says: "There is an increasing awareness among the global research community of the opportunities and the need to exploit and commercialise technology based on graphene and related nanomaterials.

"With a firm foundation of graphene science, the UK is in a prime position to lead the commercialisation of this extraordinary material."

£4.5 million funding for water industry

EPSRC is jointly funding an initiative to stimulate innovation in the UK water industry by funding research and development that will address overseas and UK water security challenges.

The £4.5 million investment will include feasibility studies and collaborative research and development projects led by UK business.

The project is funded by EPSRC, DEFRA, the National Environment Research Council and the Technology Strategy Board.

Aerospace investment

EPSRC and the Technology Strategy Board are investing up to £6 million in collaborative research and development projects to encourage innovative solutions to some of the higher risk challenges facing the UK aerospace industry.

The new funding will support approaches that may not be fundable from companies' own resources.

briefings

GLASGOW RESEARCHERS TAKE FIRST STEPS TOWARDS ‘INORGANIC LIFE’

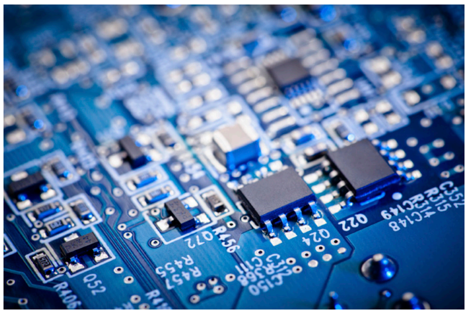
ULTRASONIC CIRCUIT BOARD CLEANING FOR GREENER MANUFACTURING

ROCKING NEW SOFTWARE COULD PREDICT CHART HITS

Green cleaning

In the electronics industry, particularly for the manufacture of printed circuit boards (PCBs), current technology employs harsh chemicals to provide surface treatment of the board, an essential first step in laying down the conducting pathways for the circuit. A green solution for this process may be at hand.

An EPSRC-sponsored team from Coventry University’s Sonochemistry Centre have devised a method involving a simple combination of water and ultrasound to treat the surface of the material used to make the printed circuit board.

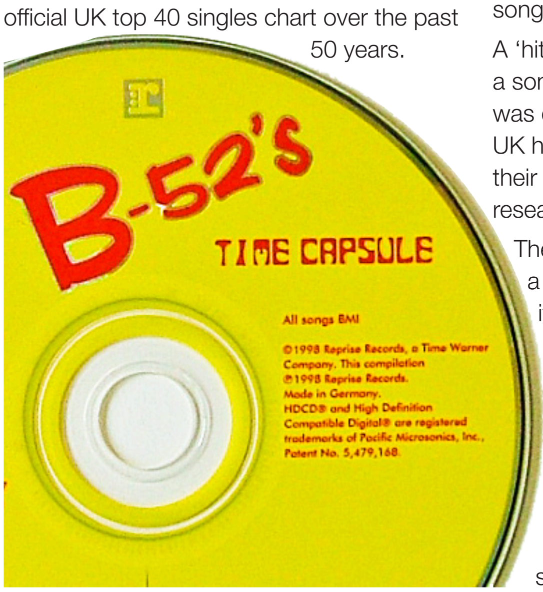


The team’s rapid progress to date suggests that ultrasonic cleaning technology could be in place in the electronics industry within three to five years.

Predict-a-hit

EPSRC-supported researchers are using state-of-the-art machine learning algorithms to determine whether a song can be predicted to be a ‘hit’.

The research team, led by Dr Til de Bje, from the University of Bristol, looked at the official UK top 40 singles chart over the past 50 years.



The researchers used musical features such as, tempo, duration and loudness. They also computed more detailed summaries of the songs such as harmonic simplicity, how simple the chord sequence is, and how ‘noisy’ the song is.

A ‘hit potential equation’ that scores a song according to its audio features was devised, which looked at all the UK hits for a certain time and measured their audio features. This enabled the researchers to compute a song’s score.

The team found they could classify a song into a hit or miss based on its score, with an accuracy rate of 60 per cent as to whether a song will make it to top five, or if it will never reach above position 30 on the UK top 40 singles chart.

For more information on the project, and to find out if it is possible to predict hits in the UK singles chart, go to scoreahit.com.

First steps towards ‘inorganic life’

EPSRC-supported scientists at the University of Glasgow say they have taken their first tentative steps towards creating ‘life’ from inorganic chemicals, potentially defining the new area of ‘inorganic biology’.

Professor Lee Cronin (pictured below), who leads the project, says: “All life on earth is based on organic biology – carbon in the form of amino acids, nucleotides and sugars etc – but the inorganic world is considered to be inanimate.

“What we are trying to do is create self-replicating, evolving inorganic cells that would essentially be alive. You could call it inorganic biology.”

The researchers say the cells, which can also store electricity, could potentially be used in all sorts of applications in medicine, as sensors or to confine chemical reactions.

Professor Cronin says: “Bacteria are essentially single-cell micro-organisms made from organic chemicals, so why can’t we make micro-organisms from inorganic chemicals and allow them to evolve?

“If successful this would give us some incredible insights into evolution and show that it’s not just a biological process. It would also mean that we would have proven that non carbon-based life could exist, and totally redefine our ideas of design.”

briefings

INTRODUCING THE THE ROBOT YOU CAN RELATE TO

SCIENTISTS HELP MET OFFICE FORECASTERS

WAVE ENERGY GOES UP RIVER

The robot you can relate to

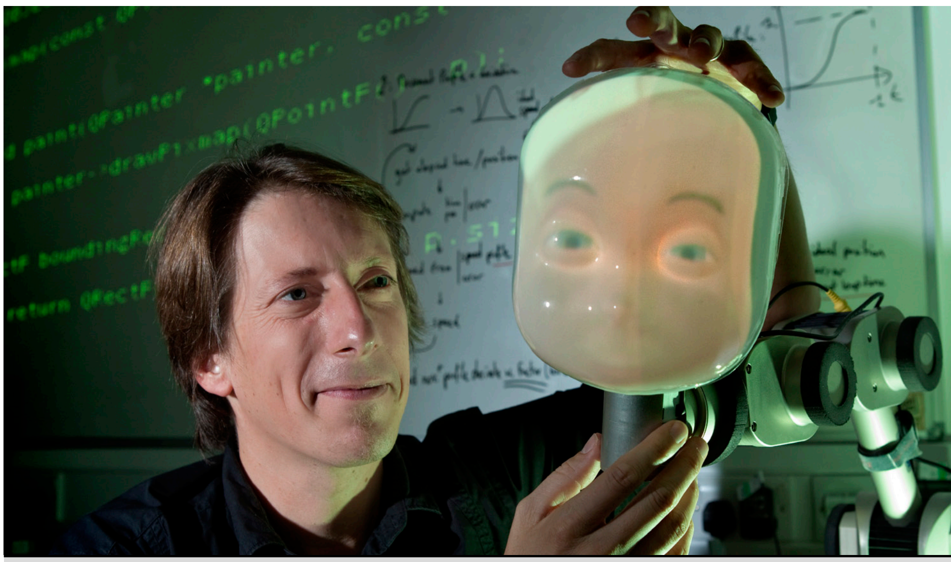
Research scientists at Plymouth University have built a robot to study how humans interact with it. The project could pave the way for a generation of more lifelike androids.

Project leader Dr Tony Belpaeme (pictured with the robot) says: “People interact with robots in a similar way to the parent-child relationship. But the inert nature of most robot faces means people do not really respond to them.”

The robot is capable of reproducing subtle and natural expressions – thanks to computer-generated responses projected onto its ‘face’. The researchers claim the robot is cheaper to make and more lifelike when compared with many other anthropomorphic robots.

The £200,000 EPSRC-funded project is proving so influential that a number of overseas institutions are now using the technology.

Novel initiatives inspired by the research include an experiment in Qatar to create the world’s first robot receptionist.



Met effect

Scientists at the University of Bath are working with the Met Office to improve its forecasting operations for extreme atmospheric events.

The project has applied research from a PhD undertaken by Emily Walsh, from the Department of Mathematical Sciences, on adaptive methods for weather forecasting.

The research has enabled a new method of adapting computational grids to increase the efficiency and reliability of Met Office operational codes for computing extreme weather events.

This has led to better forecasting of surface temperature, and improved Open Road software used to advise county councils on road gritting procedures.

The research was funded by EPSRC through a £3.4 million Knowledge Transfer Account.

Making waves

Nautricity, a University of Strathclyde company set up to commercialise EPSRC-supported research, is working with the university on a project that may soon be providing tidal electricity powered by London’s River Thames. The project, which uses Nautricity’s revolutionary tidal turbines, is in partnership with the Energy Invest Group and will involve a trial device being moored along the river. If successful, the initiative could eventually provide enough power for 35,000 homes.

In a separate development, Nautricity claims its revolutionary marine technology device will produce the world’s first domestically affordable electricity from a tidal source within the next year.

The company will shortly start pre-commercial testing of its CoRMaT machine, before it is deployed for further testing in the waters of the European Marine Energy Centre off the coast of Orkney for further testing.

briefings

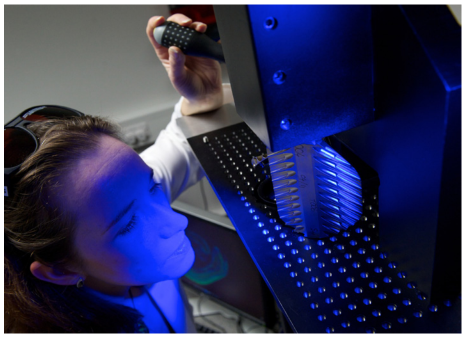
3D lens breakthrough

A new form of microscope which can produce results in seconds rather than hours – dramatically speeding up the process of drug development – is being developed by researchers at the University of Strathclyde in Glasgow.

The lens will be capable of showing three-dimensional images within cells and tissues at the same time as showing the whole organism, something which is currently not possible with any single imaging device.

The innovative Mesolens, which is the only one of its kind in the world, will be able to capture detail in organisms too big to be examined satisfactorily by existing microscopes and will offer a deeper insight into areas such as cancerous tissues and the cortex of the brain.

The research is led by Dr Brad Amos, who is seconded to the University of Strathclyde through an EPSRC Knowledge Transfer Account. The research has also received funding from the Medical Research Council.



Dr Amos says: "The confocal lens will have the capacity to produce 3D images which go far beyond the limitations of 2D representations.

"This level of detail can open up vast possibilities for discoveries which can contribute to the fight against disease worldwide."

Dr Amos's research partner, Gail McConnell (pictured above in the lab), says: "A third dimension will allow us to take the revolutionary step of presenting images with a range and versatility which no single imaging platform can currently offer."

Drug busters

Researchers at City University London are developing sensors which could replace sniffer dogs in the hunt for drugs. The sensors can find illegal substances in hard-to-reach areas such as vehicles and containers crossing borders.

Working with the Home Office and Smiths Detection, Professor Tong Sun and her team aim to create a portable prototype with real-time, multi-drug sensing capability.

The research builds on a previous EPSRC-supported project that uses fibre-based optical sensors to detect cocaine.

In 2010, the UK Border Agency made over 1,200 individual seizures of Class A drugs totalling 3,000kg.

Professor Tong says: "With the new technology, we hope to make the process of detecting illegal substances easier, more cost effective and more reliable."

The team intends to use the follow-on funding from EPSRC to develop technology to a stage that it can be licensed to an existing manufacturer for worldwide distribution.

Solar cells shine

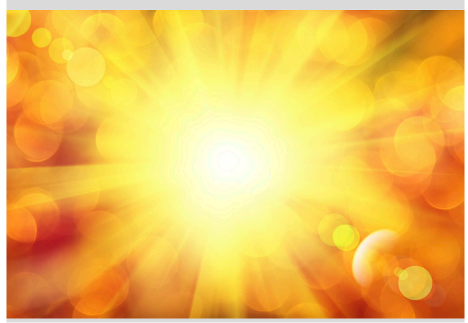
Scientists at the University of Cambridge have developed a new kind of solar cell which could capture significantly more of the energy from the sun than current cells, leading to an increase in the maximum efficiency of solar panels by over 25 per cent. The research was funded by EPSRC and forms part of the RCUK Energy Programme.

Solar panels work by absorbing energy from particles of light, called photons, which then generate electrons to create electricity. Traditional solar cells are only capable of capturing part of the light from the sun and much of the energy of the absorbed light, particularly of the blue photons, is lost as heat.

This inability to extract the full energy of all of the different colours of light at once means traditional solar cells are incapable of converting more than 34 per cent of the available sunlight into electrical power.

The team, led by Professor Neil Greenham and Professor Sir Richard Friend, have developed a hybrid cell which absorbs red light and harnesses the extra energy of blue light to boost the electrical current.

Typically, a solar cell generates a single electron for each photon captured. However, by adding pentacene, an organic semiconductor, the solar cells can generate two electrons for every photon from the blue light spectrum. This could enable the cells to capture 44 per cent of the incoming solar energy.



briefings

3D heart imaging project begins

EPSRC is funding a collaboration between researchers from the Northern General Hospital and St Thomas's Hospital London to trial state-of-the-art computer modelling systems that could provide a breakthrough in the treatment of patients with heart failure.

The multi-centre trial is using the latest 3D images of the heart to predict a patient's response to a common treatment for the condition.

Dr Paul Sheridan, who is leading the work in Sheffield, says: "The computer models allow us to predict much more accurately whether a patient would be suitable for a pacemaker or whether we would need to consider alternatives. In future, we hope to be able to use this imaging in diagnosis as well as treatment, so it is an exciting development."

Brightest light

The brightest gamma ray beam ever created – over a thousand billion times more brilliant than the sun – has been produced in EPSRC-supported research led by the University of Strathclyde.

The device, which can produce laser pulses lasting a quadrillionth of a second, is smaller and less costly than more conventional sources of gamma rays, a form of x-ray, and could have several uses, such as in medical imaging, radiotherapy and PET scanning.

Tweet predictor

EPSRC-supported academics at the University of Bristol's Intelligent Systems Laboratory are investigating whether social media could be used to track events and phenomena such as flu outbreaks and rainfall rates.

The team geo-tagged posts on the microblogging service of Twitter to investigate two case studies, into rainfall levels and flu-like illness rates.

Over several months, they gathered a database of over 50 million geo-located tweets. For the flu study, they compared their information with official data from the UK's National Health Service on flu incidence by region.

The researchers, who were supported by Nokia Research, deployed state-of-the art machine learning algorithms to create a predictive model that transformed keyword incidence in tweets into an estimate of the severity of flu in that area.

Cheque mates

An electronic cheque which eliminates the need for costly processing by banks but preserves the simplicity and ease of a traditional cheque book has been designed by a team from York, Newcastle and Northumbria universities.

The 'digital cheque book' is part of world-leading research at Newcastle University relating to ageing and health. According to Age UK, over 70 per cent of people over 65 still frequently use cheques.

The system devised by the project team, which is funded by the RCUK Digital Economy theme, led by EPSRC, uses a cheque book identical to those currently issued by banks. The only difference is that each cheque has a greyish background – which is in fact billions of tiny dots laid out in a specific pattern.

Using widely available digital pens, a camera in the pen 'tracks' the cheque as it's written. Once complete, the account holder ticks a box – the only difference from a normal cheque – and the information is transmitted directly to the payee's bank account.

Newcastle University's Dr John Vines says: "The beauty of this system is that it provides a safe and cheap electronic transaction for the banks but it's a physical paper-based transaction for the customer."

WATER WORKS

EPSRC-supported projects run the gamut of water research, from new techniques to predict pipe failures to pioneering desalination technologies. Here's a snapshot of some of them.

Pipe dreams

OXEMS, a company created to commercialise EPSRC-funded research, has developed a unique sensor device to detect underground assets such as waterpipes, sewers and cabling without the need for excavation.

The tough, low cost, low maintenance sensor identifies and detects 'tagged' piping rather like a barcode reader. The 'intelligent' part of the technology is on the surface. OXEMS believes the technology could reduce the costs to utilities or street works by at least 40 per cent.

OXEMS arose from the EPSRC-funded Mapping the Underworld project, a multidisciplinary, multi-university collaboration to develop techniques for identifying the range of services that underlie our streets. It is researching the use of vibro-acoustics, low frequency electromagnetic fields, passive magnetic field technologies, ground penetrating radar and other technologies.

Sewer researchers clean up

EPSRC-sponsored researchers at the University of Greenwich, working with industrial partners, are developing a new technique to predict underground pipe failures.

The team are designing mathematical models to predict the safe life of sewers before they are in danger of failing. For the first time ever, sewer modeling will be based on data produced on real-world test sites and in laboratory tests which simulate conditions in actual sewers.

Biofilm breakthrough

A multidisciplinary team led by the University of Glasgow is creating a bacteria-based system for treating waste in areas with poor or no sewage facilities.

The system could also be used to generate electricity.

The team are bio-engineering bacteria to break down large amounts of solid waste using anaerobic digestion (AD), a natural process occurring in soils, swamps and bogs. If applied in airtight tanks, AD can be used to treat waste. The technology is already employed by distilleries and pharmaceutical companies.

The AD process relies on several groups of bacteria working together in a cooperative manner to break down waste. Typically, one group breaks down large chemical molecules, such as fats and carbohydrates,

70%

of the earth's surface is covered with water but only 0.03% is in use

into simpler molecules. Another group continues the digestion process to yet-simpler forms of the waste, until eventually the methane-makers convert the waste to biogas.

Not only is AD cheaper than conventional technologies, the biogas it produces can be readily used for electricity generation, heat production or as a vehicle fuel. It is likely that future UK wastewater treatment infrastructure will rely on AD.

Tiny tubes, cleaner water

A multidisciplinary EPSRC-supported research team led by the University of Warwick are using microscopic carbon nanotubes to distil and purify sea water.

Early indications show that membranes of carbon nanotubes have remarkable properties in filtering salt ions and other contaminants from water. The researchers

2.4m

the number of UK homes at risk from coastal/river floods

and their industrial partners are hoping to engineer the new technologies that exploit these properties in the quest to develop new supplies of drinking water.

All in the game

EPSRC-supported engineers at the University of Exeter are using technologies normally used in computer game graphics and Artificial Intelligence to detect leaky pipes and identify flood risks.

The team have developed computer software, installed in the control room of a water company, that continuously receives and processes data sent by flow and pressure sensors installed in the water system.

The software then searches for anomalies, indicating the presence of the leak. When a potential problem is identified, an alarm is generated to notify the control room operator, who is also given suggestions of immediate actions to take to isolate it.

Underground in 3D

Researchers at the University of Nottingham are using ground-based transmitters that emulate GPS-type signals to build real-time 3D models of underground infrastructure, such as telecoms cables, electricity and gas supplies, fresh water pipes and sewers.

97%

of the water on the planet is saltwater, and much of the remaining freshwater is frozen in glaciers or the polar ice caps

The system is accurate down to a few centimetres in three dimensions. The project emerged from an EPSRC IDEAS Factory Sandpit, designed to stimulate creative thinking, and is linked to the Mapping the Underworld project, funded by EPSRC.

Bubble rap

EPSRC-supported research by Professor Will Zimmerman at the University of Sheffield has led to breakthroughs in both water treatment and low energy biofuel harvesting from algae.

The team have developed an inexpensive way of producing microbubbles that can float algae particles to the surface of the water, making harvesting easier, and saving biofuel-producing companies time and money.

Yorkshire Water's Martin Tillotson said: "Given the huge volumes, treating wastewater is very costly in electricity and carbon terms. This technology offers the potential to produce a step change in energy performance."

Professor Zimmerman is a member of the Pennine Water Group (PWG), an influential multidisciplinary collaboration dedicated to research into urban water asset management.

Pennine Water Group's internationally-leading work bridges civil, chemical and electronic engineering, computer science, environmental microbiology, instrumentation, economics, and social and behavioural science.

In just over a decade, the group, funded by EPSRC Platform Grants, the Technology Strategy Board, the EU and industry, has evolved into the largest UK urban water research group of its kind. Through partnerships with industry, PWG has had lasting impact on UK policy, industry best practice, education and training.

17bn litres
the amount of water collected, treated and supplied each day by the UK water industry, and carried across 335,000km

Block logic

Bricks made from sewage and ash could be used to build homes of the future after Encos, a company created to commercialise EPSRC-funded research at the University of Leeds, launched a collaboration with Yorkshire Water. The burned sludge combines ash with vegetable oil to create the bricks, which could provide a viable alternative to traditional house-building materials.

Encos has commissioned a £200,000 test plant at Yorkshire Water's Knostrop site in Leeds, where it is producing carbon-negative masonry from sewage which traditionally would have been sent to landfill.

On the beach

Following a significant breakthrough in understanding the behaviour of mixed sand and shingle beaches in response to waves, researchers at the University of Plymouth are developing a blueprint for coastal authorities to help them manage beaches more effectively over the next 100 years.

The team have constructed a novel temporary groyne, a kind of breakwater, that reduces longshore transport by trapping beach material.

The groyne was constructed from native beach material, then carefully measured waves, tide levels and beach positions over two-and-a-half years.

The results led to modification of the formulae currently used to estimate longshore drift and have enabled the team to produce much more accurate computational models, helping to protect coastal communities better from flood risks.

Smart sensors

Researchers have developed innovative sensors that will dramatically improve the ability to spot early warning signs of corrosion in concrete.

More resilient and much longer lasting than traditional corrosion sensors they will make monitoring the safety of structures such as bridges and vital coastal defences much more effective.

The breakthrough has been made by researchers based at City University London and Queen's University Belfast following projects funded by EPSRC.

£1.5bn
is spent annually on UK streetworks

Unlike any equivalent sensors currently available, the sensors can withstand long-term placement within concrete, and monitor temperature, humidity, chloride and pH levels – factors indicating any potentially destructive corrosion.

When the corrosion threshold is crossed, the sensors, which are connected to the internet, notify the structure's maintenance team by e-mail or text.

Rum shrub

EPSRC-supported researchers from the University of Strathclyde are ridding the Caribbean nation of Cuba of a major ecological problem while producing one of the world's most sought-after substances.

The team have found that marabú – a type of hard wood shrub that has invaded over 1.5 million hectares of land in Cuba – can be used to produce activated carbon, worth over £1,200 per tonne.

Activated carbon is most commonly used to produce batteries and can be used for gas purification and sewage treatment. It is also a highly effective water filter.

More immediately, it is being considered to replace the £5 million of activated carbon imported by Cuba for use in rum production, a crucial part of the economy.

270
the average number of cycles made each year by UK washing machines; One cycle uses 16 litres of water

Tsunami predictor

An EPSRC-supported research team have developed software to help protect vulnerable coastal communities from the destruction of a tsunami.

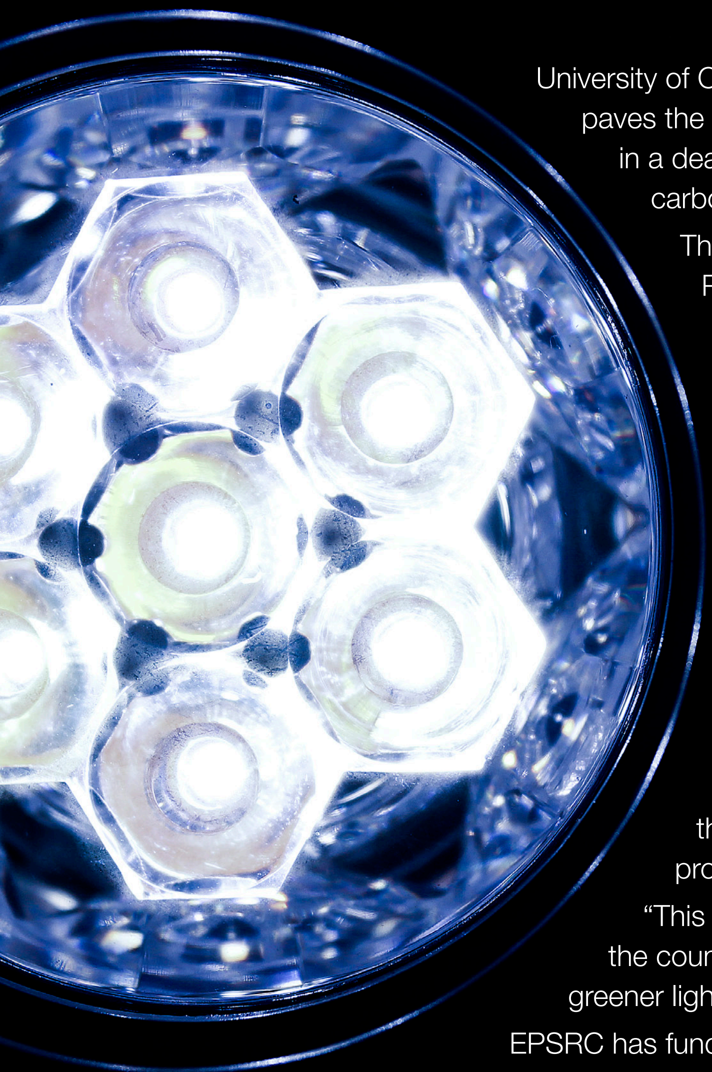
The software can be used to predict the flow induced by the tsunami as it hits land. It can predict the run-up and flooding as the tsunami hits the coast and should inform the future design and location of buildings and structures in tsunami-prone areas.

Development of the software resulted from a 2009 Knowledge Transfer Partnership between the University of Nottingham and civil engineering consultancy HR Wallingford.

The research was co-funded by the Natural Environment Research Council (NERC).

1tn
the number of tonnes of water evaporated each day by the sun

Light fantastic



University of Cambridge researchers have developed a new technique that paves the way for the UK manufacture of affordable LED light bulbs, in a deal that researchers say could have a dramatic impact on carbon emissions.

The process will be utilised by UK semiconductor manufacturer Plessey. It involves growing gallium nitride crystals on silicon and could drastically reduce the cost of making LEDs for lighting in offices and homes.

Researchers estimate that a worldwide switch to LEDs, which are far more energy-efficient than traditional tungsten filament bulbs, would enable the closure of 560 power plants and result in annual CO_2 savings equivalent to the output of all the cars on the planet.

The research is led by Professor Sir Colin Humphreys. He says: “We’ve got higher efficiency for growing gallium nitride on silicon than anyone else we know. Potentially this is a deal that puts Britain right at the forefront of LED research.”

“It’s very important to us that this research will be exploited in the UK. If we had stopped at the research stage, our work would probably have been picked up and commercialised overseas.

“This way, we can create more jobs in a low-employment part of the country and potentially turn Britain into a major centre for better, greener lighting.”

EPSRC has funded the research since its inception, over 10 years ago.

The curious case of dry water

EPSRC-supported scientists at the University of Liverpool have unlocked the enormous 'green energy' potential of a remarkable material resembling icing sugar that's 95 per cent water yet is bone dry. The other five per cent? Mostly sand.

Discovered in 1968, 'dry water' was first considered for use in the cosmetics industry. Four decades later, research into this enigmatic material was rekindled at the University of Hull. The Liverpool team has since taken the research to the next level.

Dry water is so called because it is 95 per cent water yet remains dry. Each powder particle contains a water droplet surrounded by modified silica, the stuff that makes up ordinary beach sand.

Dr Ben Carter, a member of Professor Andrew Cooper's team at the university's Centre for Materials Discovery, says: "The silica has been treated to make it intensely hydrophobic, or water-repelling – so much so that it can barely enter water.

"When mixed intensively with water, the silica coating prevents the water droplets from combining and turning back into a liquid, instead rendering them into very fine droplets – each around 50 millionths of a metre in diameter. Squeeze a handful of it, however, and water can be re-released on demand."

The key to dry water's absorbent properties is the combined surface area of its micro-particles – a thimbleful boasts a surface area on a par with a large kitchen floor.

Another feature central to the team's research is dry water's prodigious ability to swiftly absorb gases, which chemically combine with the water molecules to form what chemists call a hydrate.

Ben Carter says: "Whereas the absorption process in bulk water is very slow, because the gas is only absorbed through the surface of the water, by dividing water into tiny droplets the rate of absorption is many times faster due to the vastly increased surface area available."

Despite having demonstrated that dry water can absorb carbon dioxide three times faster than normal water, the researchers are cautious about its potential for carbon capture and storage.

Instead they have turned their attention towards other applications for the technology they've harnessed, in particular capturing and transporting 'stranded' natural gas, which makes up some 40 per cent of global gas reserves.

Ben Carter says: "Stranded gas fields are defined as too remote from market to be economically exploited using conventional transportation methods, such as gas pipelines. On-site gas storage would allow the gas to be tapped without a costly transport infrastructure.

"In the near future, dry water hydrates may offer a viable, safer, more convenient way to preserve this gas.

"While a lot of work still needs to be done with the substance to make it viable for this purpose, perhaps one day we'll see a new generation of green fuel storage devices derived from natural gas, first captured by 'dry water'."

> "Squeeze a handful of it, and water can be re-released on demand"

ICE FLOW

Icebergs in a cold dawn after a long night at sea

“We were traversing the continental shelf off south-east Greenland, measuring the temperature and salinity of the ocean water to determine the route of warm water from the Irminger Basin into Greenland’s glacial fjords.

The arrival of this warm water is increasing incidents of iceberg ‘calving’, when ice sheets break away from the glacier. Calving is commonly resulting in accelerated loss of mass from the Greenland Ice Sheet.

Understanding these ice-ocean interactions is key to sea level predictions since the ice sheet contains around seven metres of potential global sea level rise.

As part of a multidisciplinary project to investigate the future stability of the ice sheet, we made a film to document our fieldwork and the scientific process. The film was made in collaboration with project partners, 196 Productions, and supported by an EPSRC Pathways to Impact grant.”

Professor Tavi Murray, School of the Environment & Society, Swansea University

A 10-minute version of the film is available on Youtube, accessed by typing ‘Youtube Swansea Greenland’ into your search engine.

Pathways to Impact is an RCUK initiative offering funding to researchers to support activities that accelerate the impact of their research. The support enables researchers to engage with the public, address potential industry uses and work across disciplines to ensure the full potential impact of the research can be achieved.

Current account

The STREAM Industrial Doctorate Centre is an award-winning multi-university programme focused on developing the water sector's leaders of tomorrow through dynamic academic/industrial partnerships. Programme director Professor Paul Jeffrey describes the centre's progress to date.

STREAM is EPSRC's only environment-centred Industrial Doctorate Centre, so we consider ourselves to be a little bit different. We're also unusual in that the programme involves five universities spread throughout the UK – Cranfield, Imperial College London, Exeter, Sheffield and Newcastle.

The programme focuses on equipping engineers and scientists with the skills, knowledge and confidence to tackle the significant challenges facing the water sector today, such as climate change, pollution control, energy efficiency and urbanisation.

The geographical range hasn't been a problem; if anything, it's been to our advantage, as it means we can work with the gamut of regional industrial partners.

Probably the biggest challenge has been aligning five universities' contracts and finance departments so that STREAM can operate as a single programme.

Fortunately all five universities have been absolutely superb. We worked through some pretty tricky detail to get a collaboration agreement in place. The feedback from our industrial partners has been very positive.

We must be doing something right. In 2009, our first year of operation, we had 60 applicants competing for 10 places. Last year there were well over 120 applicants for 15 places. What's more, the quality of our applicants has gone up. The first intake of students comes to the end of their four-year programme next year and the plan is to fund 15 new Research Engineers (which the students are known as) this year.

Every Research Engineer spends their first three months on the programme at Cranfield. After this induction period, they go off to join their sponsor companies, so almost straight away we have a highly-distributed research community.

The students have been superb. It's particularly pleasing how they have come together as a group, despite being based in different parts of the country.

They have been self-organising in many respects. We originally set up a facility to help them stay in touch through the STREAM website, but the truth is that, using Twitter, Facebook and other social media, they have organised themselves into a self-help community much better than we could ever have attempted to.

One event where all the Research Engineers come together is the annual Challenge Week, a chance to work on a practical solution to a real life water engineering problem. Last year they spent a week as a group on the Dorset coast, and were challenged to come up with a solution to provide the public with a way to get access to the beach below an eroding cliff on Dorset's Jurassic Coast. The cliffs are among the most unstable in the UK.

Among their suggestions was a modified ski lift, which was very well received by the client, the National Trust. It was a chance for students to bring fresh thinking to an ongoing problem, develop access proposals, voice their thought processes – and strengthen friendships.

As STREAM progresses, we continue to look at ways we can more closely align the programme to meet the UK water sector's national research needs.

We're looking at two projects in particular. One is in ubiquitous computing where we are looking at ways to support smart water management. This involves more embedded monitoring and analysis of water demand and supply. The other area is working with the water utilities on remote maintenance and rehabilitation of assets such as pipes.

The motivation for this project came from experiences in the nuclear engineering field where, often in quite aggressive environments, remotely-controlled devices are used to both assess asset condition and conduct repairs. The potential for adaptation and application of these techniques in the water sector is significant.

STREAM is all about creating the engineering leaders of tomorrow. A key formal element that everyone undergoes is the Transferable Skills and Engineering Leadership programme. This comprises five modules, one at each of the five universities.

Where the students really get to earn their leadership spurs, and develop their engineering nous, is in the workplace, with their industrial sponsors. This part of the programme is coordinated through our Industrial Steering Board. We try to design bespoke leadership training for individuals. It's counterproductive to drive people through exactly the same programme.

A pivotal component of the Engineering Doctorate (EngD), a unique industry-focused alternative to the traditional PhD, is for the students to undertake a significant and challenging engineering research project within an industrial context.

Many of our Research Engineers are based with water utilities such as United Utilities, and most of these organisations have professional development programmes with leadership training components to them, but we make sure that everyone on the programme has an opportunity to develop their leadership skills.

On graduation, everyone should have the ability to design and execute industrial R&D activities, and to be able to shape and lead research teams with different disciplinary, professional and perhaps cultural backgrounds.

There's no shortage of job options. Graduates can move into R&D, asset management, operations within the water companies and the larger consultancies... It's up to the Research Engineers what they end up doing when they leave. They're highly valued within their sponsor organisations, and the message we try to give them is the future is there for shaping."

In 2011, STREAM won People Initiative of the Year at the UK Water Industry Achievement Awards.

Industrial Doctorate Centres

- Industrial Doctorate Centres (IDCs) are a subset of EPSRC's Centres for Doctoral Training (CDTs). These user-oriented centres provide the same training environment as CDTs but have a strong industrial focus, and offer an alternative to the traditional PhD for students who want a career in industry.
- Students spend about 75 per cent of their time working directly with industrial project sponsors.
- STREAM is the Industrial Doctorate Centre for the water sector, bringing together five UK academic centres of excellence in water science and engineering – Imperial College London, Cranfield, Exeter, Sheffield and Newcastle universities.

The Engineering Doctorate (EngD) degree

- The four-year Engineering Doctorate (EngD) is awarded for industrially-relevant research, where doctoral students are based in industry and supported by a programme of professional development courses.
- The central component of the degree is for each doctoral student to undertake one or more significant and challenging engineering research projects within an industrial context.
- The Industrial Doctorate Centres focus on developing students to become future engineering leaders.
- Graduates emerge with strong R&D capabilities and have the potential to shape and lead research teams with different disciplinary, professional and perhaps cultural backgrounds.

Industrial Doctorate Centres – how industrial partners benefit

- Significant leverage on research investment
- High-quality researchers dedicated to the sponsor's research
- Opportunity to guide the EngD student's training
- Added value through interaction with other EngD students and their sponsors
- Opportunities to coordinate research efforts across the sector
- Involvement in student recruitment

Best of both worlds

"The biggest benefit of the programme is being able to engage with both academia and industry. If you're a company employee you're often driven by corporate deadlines, and may not have the time to spend on speculative experiments. If you're an academic, you don't always have access to the right people to ask the questions. On the other hand you have access to the university's resources, such as its library, which employees wouldn't have. The engineering doctorate gives you the best of both worlds."

Sean Turner, second year Research Engineer, Cranfield University, sponsored by United Utilities

The long view

"The STREAM IDC allows us and our research partners to tackle research topics which are difficult to engage with within the strictures of the regulatory five-year AMP cycle but which are crucial to the long-term sustainability of water services in the UK."

Ian Walker, Innovation Director of research-based consultancy WRc

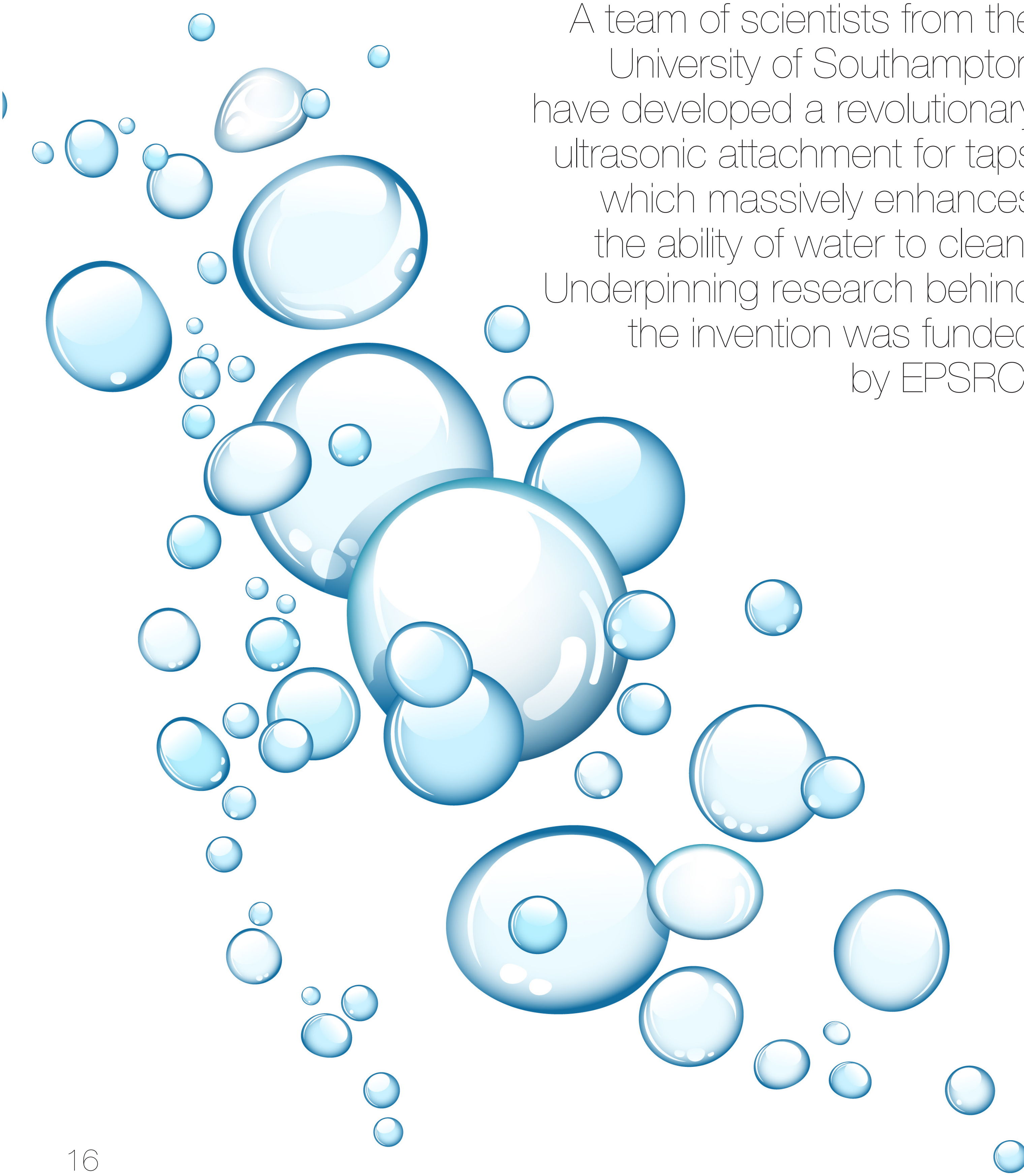
Mutual benefits

"The students become engaged in the research needs within our company, providing a dedicated resource to a specific project. As they are primarily based with us it ensures the focus of the work matches the needs of the business and complements the R&D programme and strategy."

Barrie Holden, Innovation Programme Manager, Anglian Water

GOOD VIBRAT

A team of scientists from the University of Southampton have developed a revolutionary ultrasonic attachment for taps which massively enhances the ability of water to clean. Underpinning research behind the invention was funded by EPSRC.



TIONS

In recognition of their invention, Professor Tim Leighton and Dr Peter Birkin were awarded the Royal Society Brian Mercer Award for Innovation 2011, and a cheque for £250,000 to further their research. The two scientists had previously collaborated on four EPSRC-funded projects involving ultrasonic surface effects and cavitation.

Currently, industry uses excessive water, power and additives for cleaning. For example, it can take up to 100 tonnes of water to produce one tonne of clean wool after shearing.

Many industrial processes also generate large quantities of contaminated run-off. The water from hosing down an abattoir represents a real health risk and cannot be allowed to enter the water supply. Purifying run-off is costly – for example, each cubic metre of water used for cleaning in the nuclear industry can cost around £10,000 to subsequently treat.

COLD WATER CLEANING

Professor Leighton and Dr Birkin's device works with cold water, minimal additives and only consumes as much electrical power as a light bulb. Its application will be wide – licences have already been sold to a number of industries to look at cleaning in food preparation, hospitals, manufacturing and the home.

The new technology consumes less water and power than the established competitor technologies. Using the £250,000 Royal Society award, the team will develop products based on an ultrasonic nozzle which can fit on the end of a tap or hose.

The new nozzle generates both bubbles and ultrasound. Both travel down the water stream to the dirty surface, where the bubbles act as microscopic 'smart scrubbers'. The device also features a low power setting – suitable for foodstuffs or hand washing.

Licences to enable companies to bring the technology into their product lines have been negotiated with a number of companies to explore cleaning products for hospital hygiene, dentistry, food preparation, manufacturing and the power industries.

LEAN AND GREEN

Professor Leighton and Dr Birkin's device uses less water and power than the equivalent pressure washer. It is also far less damaging, as the stream pressure is less that 1/100th that of a pressure washer.

Another advantage is that it generates far less run-off and aerosol – tiny atmospheric particles of water that can carry contaminates into the air to then settle and contaminate other surfaces.

What's more, because the device is able to use cold water, energy is also saved on heating water.

Professor Leighton (pictured below left with Dr Birkin and the ultrasonic nozzle) says: "Society runs on its ability to clean. Ineffective cleaning leads to food poisoning, failure of manufactured products such as precision watches and microchips, and poor construction – from shipbuilding to space shuttles – since dirty surfaces do not bond.

"The impact on healthcare is huge – hospital-acquired infections from instruments that aren't properly cleaned cost the National Health Service £1 billion per year."

OBVIOUS NEED

Dr Birkin says: "There's a very obvious need for technologies that improve our ability to clean while saving on our most important resources, water and energy."

Power washing generates large volumes of contaminated run-off and aerosols. These present a hazard when used, for example, in cleaning sewage systems or nuclear contamination.

One of the main pieces of equipment currently used for industrial cleaning, an ultrasonic cleaning bath, can only clean objects small enough to fit inside it. The devices to be cleaned sit in a soup of contaminated liquid.

Neither power washing (high-power pressure washing) nor ultrasonic cleaning baths can easily be scaled-up and neither can be used on delicate materials such as hands or salad.

Dr Birkin says: "For us, the new funding we have received represents a significant milestone for the development of this technology and its possible exploitation.

"As well as being timely, the award will significantly enhance the chances of this novel technology making the leap from the lab and into wider society."

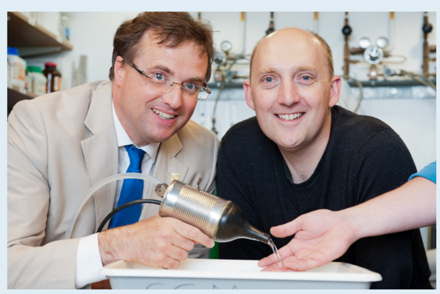
Professor Leighton adds: "Support for step-changing innovation is vital if we are to have marketable technology to address the problems that will face society on the 10-50 year timescale, rather than just responding to today's problems.

"It is pleasing that a significant 'blue skies' research effort within our team, over the last 10-15 year time period, has led to an understanding of the basic physical and chemical processes that underpin this technology.

"It's been a dream project to build on fundamental research supported by EPSRC to reach industry-funded technology transfer.

"We're at a stage now, thanks to collaborations with the Defence Science and Technology Laboratory, and through Knowledge Transfer Secondments, where industry is commissioning us to plan future products."

> "Society runs on its ability to clean"



Sun-powered superstars

A UK-wide EPSRC-sponsored research team are using sunlight-powered microorganisms to extract salt from seawater. If successful, the project could have significant impact on future desalination processes, providing a new source for biofuel, and other technologies.

The project is led by Dr Anna Amtmann, a molecular plant scientist and biophysicist at the University of Glasgow, who heads a multidisciplinary team of five UK research groups, including engineers, biologists and sociologists.

Dr Amtmann says: "Around 97 per cent of the world's water exists in the oceans as saltwater. Sodium chloride in high concentration is toxic to humans and most living organisms. It causes cells to dehydrate and can damage them by distorting the shape of their proteins, preventing them from functioning normally.

"If we can make some of this water safe for human consumption, and for the irrigation of fields, we can contribute towards alleviating problems caused by global water shortages. And the problem is global – from the Horn of Africa, where the worst drought in decades has caused malnutrition and starvation, to the south-east of England, which suffers periodic shortages of water and was declared officially in drought in February 2012.

"The basic idea of the project is simple. Marine organisms have evolved strategies to adapt and avoid toxicity. They have developed means to actively export the salt from their bodies. This is why fish don't taste salty.

"We intend to grow a large volume of marine photosynthetic microorganisms; switch-off their salt export capabilities – and then use the cells as ion exchangers to extract the salt from the surrounding sea water."

The team plan to use a type of bacteria, called cyanobacteria, that naturally occur in the sea. Just like plants, cyanobacteria use sunlight to power their growth and reproduction through photosynthesis.

Dr Amtmann and her team will then manipulate these bacteria to switch off their membrane proteins – the valves that expel salt from the bacterial cells. At the same time they will fit the cells with new membrane proteins that draw energy from sunlight to allow the bacteria to take up salt until they are packed with it.

Meanwhile, researchers at Robert Gordon University in Aberdeen, led by Professor Linda Lawton, who specialises in marine microorganisms, will investigate how best to grow these organisms to maximise the capacity of bio-desalination.

Dr Amtmann says: "In response to environmental changes, cyanobacteria produce gas vesciles (gas-filled sacs) and surface sugars that cause them to both rise to the surface and aggregate together.

"Thanks to these characteristics we will be able to easily remove the salt-packed cells from the water once the bio-desalination process is complete, leaving behind fresh water and a salty waste product."

This part of the project will be led by the team's environmental engineers, Professor Catherine Biggs, from the University of Sheffield, and Dr Michael Templeton, from Imperial College London, who will lead the development of a controlled flow-through system in seawater-filled basins, where the manipulated organisms will be grown. (Professor Biggs is profiled on page 22). These bio-desalination basins will be located inland in a closed environment.

But the project doesn't merely focus on desalination, as the bacterial biomass can be reused for further applications. For example, it could be a good source of biofuel, or it may be used in the production of biopharmaceuticals or bio-cosmetics.

Micro-organisms grown in salty environments are already in commercial use, and are key ingredients in products such as moisturising creams.

Dr Amtmann says: "This is a feasibility study, where risk assessment, exploration of different systems, scenario development and public engagement are vital.

"We'll be working with a team of researchers in environmental policy and risk assessment, led by Newcastle University's Dr Jaime Amezaga, to ensure the new bio-desalination technology meets all regulatory requirements surrounding drinking water.

"This team will also develop a programme of public engagement, including school projects and demonstrations, to build a wider public understanding of the science involved, including the emerging field of synthetic biology (see page 22).

"It's the duty of all scientists from the beginning of their research to understand and address all potential safety issues; and to determine what is publically acceptable."

Words: Cornelia Eisenbach

> "We will be able to easily remove the salt-packed cells... leaving behind fresh water and a salty waste product, which could be a good source of biofuel."

EPSRC Sandpits

Dr Amtmann's project, titled Bio-desalination: From cell to tap, was the direct product of an EPSRC 'sandpit', themed around large-scale solutions to water scarcity, in December 2010.

Sandpits are intensive multidisciplinary discussion forums where free thinking is encouraged in order to delve deep into specific issues around an important challenge and to identify solutions through radically innovative research proposals.

The sandpit concept was developed by EPSRC and has since been employed by other UK research councils and by organisations such as the US National Science Foundation.

The Water Scarcity Sandpit was an intensive residential workshop bringing together engineers, physical scientists, social scientists, economists, geographers and earth scientists. The sandpit led directly to EPSRC funding for three high-quality research projects.

The projects represent the diverse range of expertise present at the event, as well as the wider EPSRC portfolio. They are:

Biodesalination: From cell to tap: Current desalination technology is highly energy demanding and its application is therefore limited. The sandpit process led to the idea of developing an energy-efficient biological mechanism that exploits photosynthetic marine organisms' use of sun-powered transport processes to maintain low salt concentrations in their cells.

Transforming water scarcity through trading: This project is looking at ways to bring about more efficient allocation of water, develop new resources and bring about environmental improvement in areas of water scarcity. The research addresses the economics of trading water abstraction rights and aims to identify how engineered solutions can be integrated with water trading to best resolve water scarcity issues.

A global solution to protect water by transforming waste: This project focuses on providing a solution to the 'peri-urban' environment – areas outside of cities which are characterised by poor infrastructure and poor access to formal water and sanitation services.

The research focuses on the development of a low-cost, anaerobic digestion process for the safe and efficient treatment of domestic wastewater which will generate methane containing biogas, a useful fuel, and valuable products such as fertilizers (see page nine).

SWEET TASTE

The countdown is on for the European debut of a revolutionary eco-friendly chewing gum, Rev7, just one of several polymer-based products from university spin-out company Revolymer, which has already successfully launched on the US market. Its founders reveal the secret of the company's success.

The bicycle, the recipe for Coke, Sir Cliff Richard, chewing gum. All have been with us for over a century, all have stayed pretty much the same.

Unlike Sir Cliff, however, whom most would agree is impossible to improve, or destroy, the fundamental building blocks of chewing gum have been reshaped, thanks to polymer scientists at the University of Bristol led by Professor Terry Cosgrove.

It took over 10 years from that first idea for the team at Revolymer to develop the new gum, Rev7, which went on sale in America in 2010 and is scheduled for launch in Europe in May 2012. The result: an easily removable, degradable, sugar-free chewing gum that independent tests have revealed tastes as good as its competitors; its flavour lasts longer too. Unlike traditional gum, however, Rev7 is not likely to be found lining the streets of Paris or clagging up the carpets at Fortnum and Mason.

Rev7 is the first fully-fledged product to be sold by Revolymer, the company set up to develop and commercialise Professor Cosgrove's research. The polymer technology has many potential applications, including drug delivery, medical devices, paints, textiles and personal care products. Revolymer also has high hopes for its nicotine chewing gum, which is already on sale in Canada.

Rev7's unique properties are well estblished, and although it may stick to certain surfaces, such as shoe leather, it is easy to remove with mild agitation or a soapy solution. What's more, the product disintegrates in water, which conventional chewing gum does not, becoming a fine powder within six months. This is good news for UK councils which are estimated to spend around £150 million a year scraping the stuff off their municipal assets.

Ever since American flour magnate William Wrigley sold his first sticks in the 1890s, chewing gum has used a polymer base. Polymers are essentially very long molecules, characterised by their stretchability. When used in chewing gum they become pleasant to chew. Trouble is, this chewiness also makes the gum sticky. Not so with Rev7.

Terry Cosgrove, whose polymer research has benefited from EPSRC funding over the years, says: "We added a new component to the gum which is sensitive to moisture. Normal gum is softened by temperature, but Rev7 is also softened by the action of the saliva. When you take the gum out of your mouth, it mainly dries out. It becomes hard again: a hard gum won't stick. It can also reabsorb water making it both easy to clean and for disintegration to occur."

It turns out these innovations improve other characteristics of the gum, such as its retention of flavour and chewability. Feedback from US consumers shows their two favourite features are the gum's longer-lasting taste and the fact it does not get hard in the mouth.

"We're confident we have improved on the traditional product, as well as made a contribution to tackling the pollution problem."

Rev7 has been constantly refined over the years, a process that began in earnest when Terry Cosgrove and his business partner, Roger Pettman, tried the first sample prototype for themselves.

Terry Cosgrove says: "When we'd created our first realistic sample, back in the early days, we were slightly apprehensive about trying it. I recall us both looking at the sample, and I told Roger more work needed to be done to perfect it. Then Roger picked it up and started chewing. It's what he calls the acid test – trying out the prototype on consumers as early as possible."

Roger Pettman says: "If you're serious about commercialising a product, you've got to test whether consumers are going to like it – and you've got to do this as early as possible. If the gum had tasted disgusting we would have had no project, but at least we wouldn't have wasted any more lab time – or the patience and money of potential investors."

This first encounter with the product is emblematic of the successful relationship the two men have enjoyed ever since. Pettman the natural risk-taker and entrepreneur, Cosgrove the visionary developmental scientist who knows his skills lie elsewhere.

Terry Cosgrove says: "I'm not a businessman. A lot of people think they can launch a start-up company, but not everyone can. You've got to realise your limitations. You need a professional to help you."

E OF SUCCESS

Step forward Roger Pettman, who founded the company and is Chairman and CEO. After completing a PhD in organic chemistry, he eventually joined Shell where he developed a taste for business. He is now a seasoned entrepreneur, highly experienced in commercialising chemistry-based products. So he has form.

Since its early years Revolymer has received long-term backing from several key investors, particularly IP Group, which specialises in providing resources to turn innovative research ideas into commercial reality. Revolymer now has partnerships and investment from a wide range of international companies and individuals.

Roger Pettman says: "The initial attraction for the investors was that our team had successful start-up experience. I had already been through a funding process with other commercial ventures so the investors knew what they were getting into. They were confident we knew what we were doing."

Spurred on by sales in America, where Rev7 is available in over 450 retail chains and 4,000 outlets, Revolymer is growing fast and employs 38 people at a purpose-built facility in Deeside, North Wales. The polymer is made at Albany Molecular in Mostyn and the gum is made under joint agreements with various manufacturers.

Revolymer's HQ is half-factory, half-R&D lab. Virtually everyone who works on the science staff is a PhD polymer chemist. Blink and you could be back in Terry Cosgrove's lab. This is no coincidence as the founders share a common work ethic centered around building the right team.

"Having a great team is crucial," says Terry Cosgrove who knows a thing or two about building successful research groups. Over the years he has helped develop the careers of over 60 PhD students, many of whom were funded under EPSRC Industrial CASE studentships, which enable the student to spend the majority of their PhD working with industry. It transpires that over a dozen EPSRC-funded PhD holders and former CASE students work for Revolymer.

Roger Pettman says the connection with academia, and the kind of cross-disciplinary creative thinking it can inspire, gives the company a competitive edge.

Notwithstanding the success of the US and Canada ventures, it's taken much longer than anyone could have predicted to get approval to sell Rev7 in Europe – three years, 27 separate committee hearings and a raft of regulatory mechanisms to be precise. The green light was finally given in December 2011, and the company is gearing up for a European launch this May.

As for the competition, which includes some of the biggest brands on the planet, Roger Pettman remains unfazed. "Chewing gum is an extremely profitable business," he says. "This has been good for us as there has been minimal product development from the big companies for decades. A case of 'if it ain't broke, don't fix it'. In fact, before Rev7 came along there hadn't been a significant new polymer for chewing gum for 30 years.

So is serious money just around the corner for Revolymer? Terry Cosgrove puts things differently. He says: "The commercial work has given me an edge in my academic life; it's made me more focused. As for making money, for me it's secondary; it's having created a new product that's important."

Profile

Professor Catherine Biggs

EPSRC Advanced Research Fellow and Professor of Environmental Engineering, Department of Chemical and Biological Engineering at the University of Sheffield

What has influenced your career path?
Probably my undergraduate degree in environmental engineering. I was good at maths and chemistry at school and wanted to turn them into a profession, and I liked the idea of working on environmental problems. The undergraduate course was multidisciplinary from the start, with courses ranging from chemical and civil engineering, to biology, physics, social science, economics… the list goes on.

What work are you engaged in at present?
Lots of different projects, all united by their focus on techniques and tools to study and engineer biological processes in the urban water environment. One exciting project is studying how to exploit the massive potential of biofilms, which comprise various bacterial groups living very closely together in slimy communities. Biofilms are everywhere, and we're linking environmental cues with biological drivers and specific cell surface characteristics to describe their formation. Using this combined approach, our ultimate aim is to be able to control them in real world urban water environments.

What do you consider your greatest professional achievements?
That has to be my appointment as Chair in Environmental Engineering at Sheffield.

If you hadn't become an academic, what would you be doing now?
Difficult question, but I know I would not want to do anything else. Every day is different. You're able to interact with so many different people – from undergraduates and postgraduate students to peers in industry and academia.

What are the greatest challenges/ advantages of working across disciplines?
All of my research is multidisciplinary, either through the tools I use or the application. My undergraduate degree taught me that different disciplines approach problems and challenges in different ways, and while it can sometimes be frustrating, it can also be exciting and really rewarding. Having a clear understanding of your own skills and what you can bring to the collaboration is important, but that should be the beginning of the discussion rather than what defines it. Successful multidisciplinary research should be more than just the sum of the individual disciplines, and this requires enthusiasm, constant communication and a willingness to see and work beyond your own discipline.

What have been your best and worst professional decisions?
The best decision was to apply for an EPSRC Advanced Research Fellowship. It's been a fantastic springboard. The worst decision was not applying for it sooner.

You and your research associates are carrying out pioneering work in the emerging field of synthetic biology, and applying it to water research. What is feasible?
Synthetic biology aims to design and engineer biologically-based parts, novel devices and systems as well as redesigning existing, natural biological systems. Biological systems are already intimately linked to the provision of clean water and sanitation, but the exciting thing about synthetic biology is that it gives us a new toolbox, a new set of design rules, and a fresh approach to address current and emerging water challenges.
As the discipline develops, I think pretty much anything could be technically feasible. For example, we are already using synthetic biology principles to make biosensors for faster detection of water quality and to desalinate water. However, the feasibility of synthetic biology is likely to be limited less by technical advances and more by being able to apply it in the real world situation, and for it to be accepted as a viable approach for solving water challenges. The water industry does not exist within a temperature-controlled research laboratory and much has to be done to lay the foundation for the synthetic biology field before we can marry achievements in the laboratory with engineering reality.

What advances in science and technology would you like to be part of?
Perhaps it's obvious from the previous answer, but I want to be part of the synthetic biology revolution and have a leading role in addressing new and emerging challenges facing the provision of sustainable water.

Best job you've ever had?
This one!

What is the most important/ invaluable tool you use to do your work?
Diplomacy and communication skills.

What are your main interests outside science?
Travelling and seeing and experiencing new places. I am a big fan of short city breaks.

What keeps you awake at night?
Work mostly. Not very exciting, but true.

In brief
Professor Biggs' research career has developed from traditional environmental and process engineering, including wastewater treatment, to more fundamental bio-chemical engineering science. Her current research into biological processes in the water environment seeks to develop an integrated understanding of how microbial diversity and biofilm formation can be achieved and engineered. The research combines process engineering with a range of post-genomic, proteomic and synthetic biology tools. A member of the influential Pennine Water Group, her multidisciplinary research has led to published articles in both engineering and pure science journals; she has also obtained funding from industry, EPSRC and the Biotechnology and Biological Sciences Research Council (BBSRC), the EU and UK charities.

Cheap stills

EPSRC-supported scientists at the University of St Andrews have developed a new method for testing whether a whisky is genuine or not.

Using a ray of light the size of a human hair, the team are able to work out the brand, age and even which cask was used to create a single malt, from a sample no bigger than a teardrop.

The research, which has been patented and is being presented to industry, was carried out by physicists Praveen Ashok, Kishan Dholakia and Bavishna Praveen.

Mrs Praveen says: “Counterfeiting is rife in the drinks industry, which is constantly searching for new, powerful and inexpensive methods for liquor analysis.

“Using the power of light, we have adapted our technology to address a problem related to an industry which is a crucial part of Scottish culture and economy.”

The research involves placing a tiny amount of whisky on a transparent plastic chip no bigger than a credit card.

Using optical fibres the width of a human hair, the whisky sample is illuminated by light using one fibre, and collected by another. By analysing the collection of light scattered from the whisky, the researchers are able to diagnose the sample. The key lies in the fact that the laser can detect the amount of alcohol contained in the sample.

The chip used in the study was originally employed by the St Andrews team to detect bio-analytes in biomedical studies.

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