Department of Engineering Science

news

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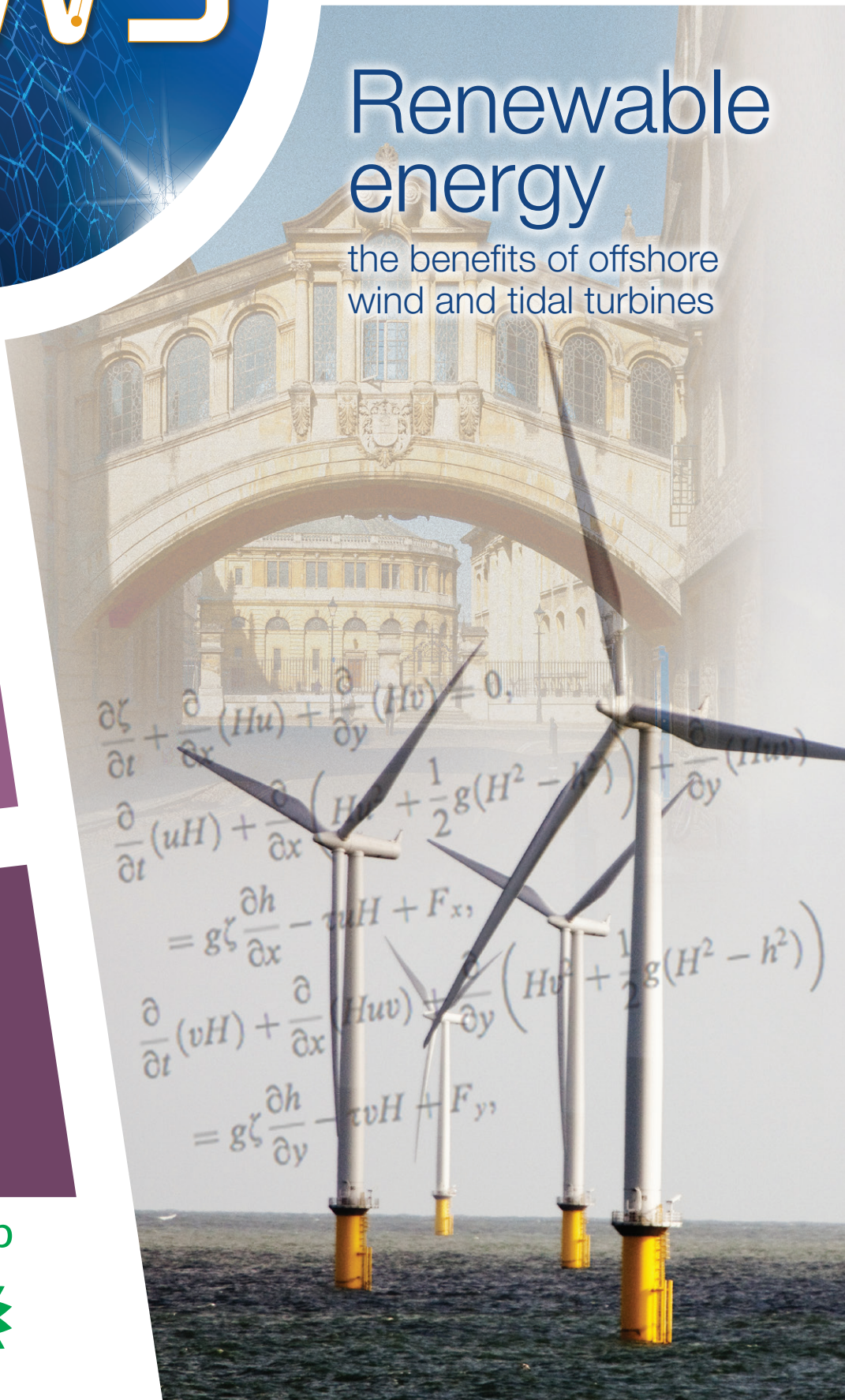
UNIVERSITY OF OXFORD

Renewable energy

the benefits of offshore wind and tidal turbines



Welcome

Welcome to the 2014-15 issue of "Department of Engineering Science News". I am delighted to announce that for the third year running this newsletter is being sponsored by BP, a British multinational oil and gas company that has operations in over 80 countries. Published once a year, the newsletter brings to life the work of the Department to a broad range of audiences covering engineering science news, research, profiles and events.

I hope that you enjoy reading it and welcome your comments on the content. Please feel free to send contributions for next year's "Department of Engineering Science News" to: newsletter@eng.ox.ac.uk

Eva Williams
Editor

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Reflections on the past 5 years

Professor Guy Houlsby, FREng, who has just completed his 5-year term as Head of Department, reflects on what has been achieved in that time…

The Department's most important assets are our staff (both academic and support), and the rather more transient population of students. In the past five years we have made significant progress with our long-term strategy of growth: in 2014 we shall have 94 permanent academic staff, compared to 77 (including 10 on short term appointments) in 2009. This growth has been research-led (our sustained year on year growth rate of research income is around 11%), including appointments across our whole range of activities, but particularly focussed around some very strong areas such as turbomachinery, biomedical engineering, information engineering and materials. As a civil engineer it has been a pleasure to encourage and support all this activity, as I believe passionately in our ethos as a wide-ranging Department with no divisions between the branches of our subject.

Recent appointees (and some less recent too), have achieved remarkable success in a whole range of projects during the past year, and this newsletter gives some idea of the range of the Department's activities, which address important issues across the whole spectrum of engineering endeavour.

All this activity means that the Department is in excellent financial shape, contributing a modest annual surplus to the University's finances. This is important, as it means that the University is extremely supportive of our future plans, with the confidence that we manage our resources efficiently.

It has been an exciting five years, both for myself and for the Department, and I am proud to have had the opportunity to represent the Department as its Head. I hand over to my friend and colleague Lionel Tarassenko, confident in the knowledge that the Department is currently in good shape, and confident too that he will lead it to an even more dynamic future.

Returning to research

Personally, I am looking forward to returning to a more active role in research. My main interests are focussed around the opportunities afforded by marine renewables, and on *page 5* you can read more about the work that I am doing with my colleagues in civil engineering.

Professor Guy Houlsby

New Head of Department

In September 2014 Professor Lionel Tarassenko CBE FREng FMedSci, started his new role as the Head of the Department of Engineering Science.

Professor Tarassenko is an alumnus of the Department (Keble, 1975-8). He was a College Lecturer at Magdalen (1986-8), a University Lecturer and Tutorial Fellow at St Hugh's (1988 -1997), before taking up the Chair of Electrical Engineering (and Professorial Fellowship at St John's) in 1997. He was the Director of the Institute of Biomedical Engineering from 2008 to 2013.

Professor Tarassenko has held a number of positions in academia and industry, and won multiple awards for his work in the area of signal processing, especially in the context of medical problems. He is also founder of a number of spin-out companies.

He is a world-leading expert in the application of signal processing to medical systems, with a strong track record in translation to clinical medicine. His work has had a major impact on the monitoring of patients in acute care. He has been a pioneer in developing early warning systems for identifying physiological deterioration. *Read more about his research on pages 6 and 7.*

Speaking at the World Economic Forum in Davos, Switzerland:

"I was invited to present two sessions at the 2014 World Economic Forum. The theme was 'The Reshaping of the World: Consequences for Society, Politics and Business'. The overall aim was to develop insights, initiatives and actions necessary to respond to current and emerging challenges.

In my first presentation I discussed how engineering, chemistry and biology can combine to create digital health. I explained how the digital health platforms, which we are developing, can transform the management of chronic diseases in the next decade.

For what can only be described as a packed IdeasLab the next morning, I was joined by fellow Oxford academics to discuss 'Data, Machines and the Human Factor'. I spoke about building self-monitoring healthcare technology into everyday lives. I explained that machine intelligence is required to help patients understand their readings in the context of their disease and its current trends. Digital health platforms have to be made user-friendly so that they can be fully integrated into people's lives. This includes making the data collection as easy as possible. I introduced non-contact vital-sign monitoring, which was a new concept to most of the audience.

These talks on digital health generated a lot of stimulating discussions. There is no doubt that digital health, the application of machine intelligence to health and well-being, is now firmly on the agenda in both Europe and the US, especially now that Obamacare is starting to make a difference on the ground".

Professor Lionel Tarassenko

Engineers are creators

Dr Kinam Kim, President of Samsung's Semiconductor Memory Business, delivered the Department's 40th Maurice Lubbock Memorial Lecture, which was titled: "Technology innovations revolutionising society". Dr Kim said: "Stakeholders in industry try to push the limits of technology within their capabilities. But they always have to rely on academia for the big breakthroughs that could revolutionise society. Engineers are creators. What they imagine today will be the future of human society".

The presentation provided fascinating insights into global advances in technology. Dr Kim highlighted how technological innovations of devices such as televisions, computers and smartphones impact every aspect of our lives from our environment, our education, our leisure time, the way we work and our health. He demonstrated how in future 'resource scarcity, climate change and accelerating urbanisation' will need to be addressed. Dr Kim's vision of society in the future is that it will be 'smarter, healthier and greener as ICT technology continues to be developed'.

Dr Kim said: *"Technology is a key driving force for socio-economic change. Silicon device technologies continue to evolve. In the future, CMOS (complementary metal–oxide–semiconductor) technology innovation will enable exa-scale (10E18) computing, which is potentially up to human-scale and real-time processing. Silicon scaling technology, which is expected to reach sub-10nm, will enable cost effective ultra-high density memories to satisfy future data storage requirements. Mobile network will open an era of the internet of things where everything could potentially have a digital identity and be connected to the internet and to each other".*

He added: *"All these connected objects and devices will generate an exorbitant amount of data (traditional IT data as well as medical/ health, bio informatics, environment and so forth), which need to be analysed in order to produce meaningful data. Therefore, Big Data analytics will also be an important technology in the future. Display technology in the future will be more realistic and immersive as well as more intelligent as it has started to become interactive".*

Over 250 representatives from industry, academia, the University's alumni community, government, and schools from Oxfordshire attended Dr Kim's lecture.

Our special thanks to the Trustees of the Maurice Lubbock Memorial Trust for their continued support.

The Engineering Science Research Exhibition
The Department's research exhibition showcased the following areas of work: 'Robotics - Science for Self-Drive Cars'; 'Robotics - The Big Picture'; 'Engineering Visual Data'; 'Immediate Search of Big Data'; 'Communications and Electromagnetics'; 'Optical Wireless Communications'; 'Biomedical Image Analysis'.

4th Year Exhibition

The Hon. Lyulph Lubbock, who represented the Lubbock Trustees at this year's Maurice Lubbock Memorial Lecture, presented eleven prizes to the following 4th Year Engineering Science students:

- **ARM Ltd: 'The ARM Prize for Digital Technology'**
  Student: Mark Pullin (Hertford College)
  Project title: *"Optimal Control of a 2014 Formula One Car".*
- **Atkins: 'The Atkins Prize for the Best Energy-related Exhibit'**
  Student: Sam Poulson (Worcester College)
  Project title: *"Wave Energy and Climate Variability".*
- **BP: 'The BP Award for the best Chemical Engineering or Energy related Exhibit'**
  Student: Andi Tao (St Edmund Hall)
  Project title: *"Comparative study of heavy metal removal in single and binary systems by metalworking fluid acclimated bacterial biofilms".*
- **GlaxoSmithKline: 'The GSK Excellence in Communication of Engineering Innovation Award'**
  Student: Joon Son Chung (St Catherine's College)
  Project title: *"Computer Vision and the History of Printing".*
- **Ibex Industrial Brushes: 'The Ibex Industrial Brushes Mechanical Engineering Award'**
  Student: Matthew Winters (Pembroke College)
  Project title: *"Impact Experiments using the Virtual Fields Method".*
- **Laing O'Rourke: 'The Laing O'Rourke Best Civil and Construction Engineering Award'**
  Student: Ben Brooks (Balliol College)
  Project title: *"Tunnel-induced settlement damage to buildings".*
- **Mirada Medical: 'Mirada Medical Best Image Processing and Computer Vision Award'**
  Student: Rose Michael (St Edmund Hall)
  Project title: *"Can Cancer Catch a Cold".*
- **Osborne: 'OSBORNE prize for the project with the greatest practical application to civil engineering or structure'**
  Student: Mark Shepherd (Lady Margaret Hall)
  Project title: *"Practical Aspects of the Installation of Screw Piles".*
- **Rolls-Royce: 'The Rolls-Royce Award for Innovation in Thermofluids'**
  Student: Chris Kennell (University College)
  Project title: *"Design of high Mach number turbomachinery blading for unusual application".*
- **Sharp Laboratories of Europe: 'SHARP Prize for best Electronics Engineering Exhibit'**
  Student: Uchechukwn Ukachi (St John's College)
  Project title: *"Magneto-inductive mobile phone charger".*
- **Sony BPRL: 'Sony Image Processing Prize'**
  Student: Jai Juneja (Balliol College)
  Project title: *"Beyond The Naked Eye: Localisation and Mapping of Textured Scenes".*

Our thanks to the judges of the Project Exhibition, all of whom were alumni of the Department of Engineering Science and are now working in industry. They were: Tom Vining, (Jaguar Land Rover); Dr Richard Pearson (Ricardo); Judith Packer (Parsons Brinckerhoff), and Zeena Farook (Arup).

Investing in ‘great technologies’

“This capital investment will help scientists make new discoveries and take their research through to commercial success”. **David Willetts, Minister for Universities and Science (from May 2010 to July 2014)**

Department of Engineering Science research on ‘robotics and autonomous systems’, ‘advanced materials’ and ‘grid-scale energy storage’ received a multi-million pound boost thanks to a national investment in ‘eight great technologies’ to drive UK growth.

Mobile robotics

Research on mobile robotics, led by Professor Paul Newman and Professor Ingmar Posner in the Department, includes the development of self-driving cars. Ground-based mobile robotics research also has applications beyond personal transport, and the work the grant will support has potential impact in space exploration, construction, logistics, security and defence, inspection, warehouse and factory automation, and agriculture. The grant will provide the vehicles and tools needed to drive Oxford’s robotics agenda forward into new arenas.

Metallic alloys

Also benefitting from the Government’s investment is the development of metallic alloys that can withstand extreme environments – for use in aerospace, energy generation, transport, defence and a range of other fields. Many engineering materials must be multi-functional and able to withstand combinations of harsh conditions – such as in energy generation, where corrosive conditions can co-exist with high temperatures for extended periods of time, or in defence applications, where materials must be both lightweight and blast-resistant.

The research, run jointly by Professors Roger Reed, Patrick Grant, Chris Grovenor and Alan Cocks in the Departments of Materials and Engineering Science, will benefit from new research infrastructure that will speed up the lengthy process from the discovery of a new metallic alloy to the point where it can be used in industry. New modelling, manufacturing and testing laboratories will be established on Oxford University’s Begbroke Science Park, supported by University technicians and engineers.

Storing energy

The third area of departmental research receiving support is in collaboration with Imperial College London and other institutions, and aims to tackle the challenge of storing energy on a large scale, at the level of the national grid. Energy storage is essential for the greater use of low-carbon energy from renewable sources: sources like wind power and solar power have peaks and troughs, so unless the energy generated during high winds or strong sun can be captured and stored for later use, they cannot be relied upon for a predictable supply of electricity.

The grant will allow the purchase of specialised equipment for a possible solution to the challenge, with the Oxford contribution led by Professors Peter Bruce and Patrick Grant in the Department of Materials and Professor David Howey in Engineering Science.

David Willetts, former Minister for Universities and Science, said: *“For Britain to get ahead in the global race we have to back emerging technologies and ensure our universities have the latest equipment. This capital investment will help scientists make new discoveries and take their research through to commercial success. It will drive growth and support the Government’s industrial strategy”.*

‘Great British Technologies’ Fellowship

To maintain the UK’s research leadership in three areas identified as ‘Great British Technologies’; Advanced Materials, Robotic and Autonomous Systems, and Synthetic Biology, the Engineering and Physical Sciences Research Council (EPSRC) Fellowship grant was awarded to Antonis Papachristodoulou, Associate Professor at the Department of Engineering Science.

Professor Antonis Papachristodoulou, has been awarded an Engineering Fellowship for Growth on “Designing Feedback Control in Biology for Robustness and Scalability”. He will build a research team and work in partnership with researchers at the California Institute of Technology, ETH Zurich, KAIST, Massachusetts Institute of Technology and Microsoft Research Ltd to undertake research in “Synthetic Biology”.

Professor Papachristodoulou said: *“Synthetic Biology is the “Engineering of Biology”: it aspires to use the Engineering design cycle to produce bio-circuits that behave predictably and reliably, usually with specific applications in mind. Synthetic Biology has the potential to create new industries and technologies, from agriculture to the environment, and from energy to healthcare. Some of these applications require Synthetic Biology designs to be scalable, so that small circuits can be composed to form larger systems. However, even small bio-circuits seldom function as expected because of the high level of uncertainty in the cellular environment, the way poorly-characterised parts are assembled together and the lack of a systematic framework for integrating parts to form systems. This is a major challenge that needs to be overcome in order for the potential of Synthetic Biology to be fulfilled and for industry and society to reap the rewards”.*

Professor Papachristodoulou also received major Government funding for an EPSRC and Biotechnology and Biological Sciences Research Council (BBSRC) Centre for Doctoral Training in Synthetic Biology.

Begbroke Science Park

Marine renewable energy - wind farms and tidal turbines

A new study reveals that tidal turbines stretched across Pentland Firth, which separates the Orkney Islands from mainland Scotland, could generate up to 1.9 gigawatts (GW) of power averaged over the year - equivalent to almost half of Scotland's electricity needs.

The study, led by Professor Adcock and Professor Houlsby at the University of Oxford's Department of Engineering Science, working with the University of Edinburgh and the University of Western Australia, provides the first reliable estimate of the maximum energy that could be generated from Pentland Firth. The 1.9GW figure is considerably lower than some early estimates, as it takes into account factors such as how many tidal turbines it would be feasible to build, how a series of turbines would interact with each other, and averages out variations caused by the fortnightly cycles of the tides.

The researchers found that, averaged over the entire tidal cycle, the maximum power a Pentland Firth scheme could generate would be 1.9GW, or 16TWh per year. Figures from the Scottish government state that in 2011 Scotland's consumption of electricity was 37TWh per year.

Associate Professor from Oxford's Department of Engineering Science and lead author of the paper, Thomas Adcock, said: *"Our study provides the first robust data about how much energy it would be feasible to extract. It also suggests that to be efficient any scheme would have to be "joined up" so that, for example, individual tidal turbines do not interfere with each other. Provision needs to be made to cope with the much greater power produced by spring tides compared to neap tides".*

When looking at the feasibility of a scheme for Pentland Firth, the researchers assumed that, to be economically viable, the power generated by each tidal turbine would have to be comparable to that of offshore wind turbines of similar size. They also used mathematical models to investigate how different rows of turbines would interact, working out how to arrange them so as not to 'steal' each other's tidal energy, and calculating how power generation for the overall scheme might be maximised.

The Pentland Firth is a prime candidate to house marine power projects because of its tidal currents, which are among the fastest around the British Isles. To exploit the Firth's full potential, turbines would need to be located across the entire width of the channel. In order to minimise the impacts on sea life and shipping trade, a number of individual sites have been identified for development by the UK Crown Estate, which will lease these sites to tidal energy firms.

Researchers have pinpointed locations where turbines would need to be positioned for the Firth to meet its full energy production potential.

The work was commissioned and supported by the Energy Technologies Institute. A paper reporting the research, entitled 'The available power from tidal stream turbines in the Pentland Firth', is published in "Proceedings of the Royal Society A".

PISA - reducing the cost of energy

Research aimed at reducing the cost of energy from offshore wind turbines is being conducted by academics in the Department, in collaboration with Imperial College London and University College Dublin. The project explores, along with the Carbon Trust, DONG Energy and a number of offshore wind developers, how offshore wind turbine foundations can be designed more effectively.

The research focuses on monopile foundations; large diameter steel tubes driven into the ground on which the turbine is located. Bent Christensen, Senior Vice President in DONG Energy, said: *"The cost of energy from offshore wind turbines must be reduced. We expect to find significant savings by trimming monopile sizes and finding new ways of installing the foundations, amongst others. Consequently, we believe a significant contribution can come from this area towards our efforts of reducing the price of offshore wind power by 35-40 per cent by 2020".*

© DONG Energy A/S

Professor Byron Byrne, who leads the Oxford research, said: *"The Pile Soil Analysis (PISA) project represents the first significant joint industry investment by the offshore wind industry into targeted civil and geotechnical engineering academic research".*

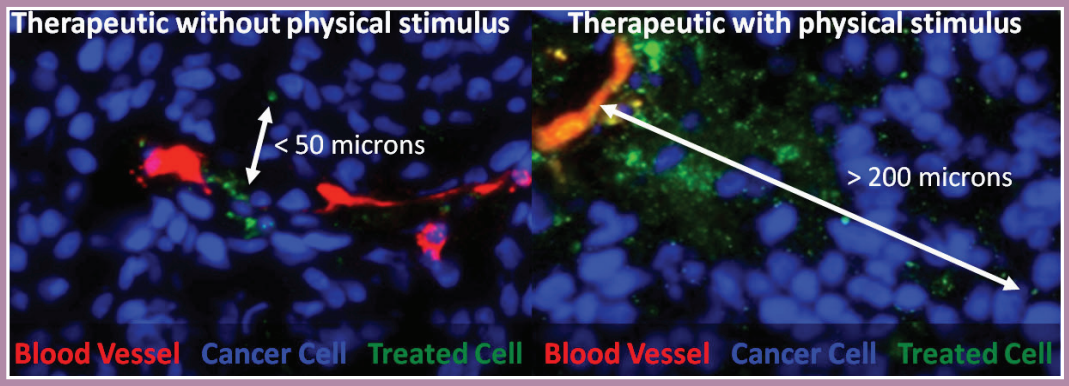
A typical steel monopile foundation weighs approximately 600 tonnes or more. For a wind farm of 100 or more turbines this represents a substantial fabrication and installation cost. Each pile is fabricated from steel about 100mm thick. If this thickness can be reduced, even by a fraction, without compromising the engineering response of the foundation, there could be significant savings.

The project provides funding for a range of academic activities including two full time post-doctoral research assistants and, in the longer term, will result in three doctoral projects.

Boost for health-

New Drug Delivery Centre – OxCD3

Cancer therapy drugs tend to achieve limited accumulation and poor penetration in tumours, reducing their effectiveness. For many years, the only methods used to improve drug uptake by tumours have been pharmacological, and these have had limited success.



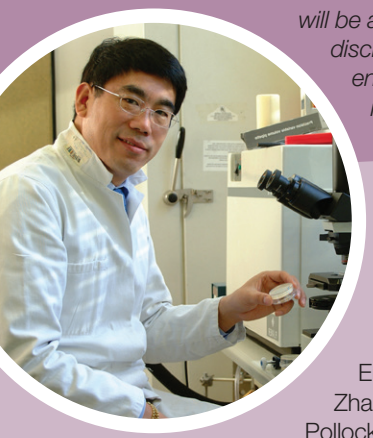
Research at Oxford University has shown that physical mechanisms triggered by ultrasound, magnetic fields or shock waves can dramatically improve the delivery and penetration of existing and experimental drugs into tumours.

Now a new research centre, The Oxford Centre for Drug Delivery Devices (OxCD3), will look to exploit engineering approaches, involving a combination of stimulus-responsive nanocarriers and medical devices already in clinical use, to improve the therapeutic outcomes of drug-based cancer treatments. The new centre will be based at the University of Oxford.

Led by Professors Coussios, Stride, Carlisle and Cleveland, OxCD3 represents a partnership between the Department of Engineering Science, the Department of Oncology, the MRC Weatherall Institute of Molecular Medicine, the Nuffield Department of Surgical Science and the Clinical Biomanufacturing Facility.

Professor Constantin Coussios said: *"OxCD3 will be a sustainable, world-unique multi-disciplinary environment for combinational engineering of biology, chemistry and medical devices to improve drug delivery under a single roof. It is also expected to create a much-needed training environment for the next generation of young scientists working on combination therapies and biomedical nanotechnology, by providing direct exposure to regulatory and manufacturing issues encountered when translating laboratory research into production and clinical practice".*

The centre will initially focus on improving the delivery of several classes of cancer drugs, ranging from conventional chemotherapy and radiopharmaceuticals to next-generation antibodies, viruses and siRNA, from proof-of-concept laboratory studies to manufacture in preparation for clinical trials. The ultimate aim is to establish a centre of excellence for challenging drug delivery applications across a broad range of biological barriers and disease indications beyond cancer.



Leading the field in tissue engineering

A five year programme of sponsored research titled, "Enabling Technologies for Stem Cell Therapy and Tissue Engineering," will be led by Professor Zhanfeng Cui, the Department's Donald Pollock Professor of Chemical Engineering, Director of the Oxford Centre for Tissue Engineering and Bioprocessing, and Fellow of Hertford College. Professor Cui was recently elected as a Fellow of the Royal Academy of Engineering (RAE) in recognition of his contributions to engineering.

This programme of research, sponsored by China Bio-Med Regeneration Technology Limited (CBMRT), will be conducted in the Oxford Centre for Tissue Engineering and Bioprocessing at the Department's Institute of Biomedical Engineering.

The Oxford Centre for Tissue Engineering and Bioprocessing is a world leader in the development of bioreactor technologies for the growth of bone, cartilage, tendon and neuron cells, and the longer term aim is bulky tissue growth from stem cell cultures.

Professor Cui also has research interests in technologies that will monitor and regulate tissue growth, including micro membrane probes and micro sensors, and in cryo-preservation techniques. A further related area of research is into membrane filtration processes.

Professor Cui's first degree and doctorate were gained in China, and he has been very active in promoting engineering and scientific collaborations between the UK and China. He has a wide range of collaborative activities in the People's Republic of China (PRC) with Chinese Universities and Chinese Academy of Sciences. He was a Chang Jiang Scholar of the Ministry of Education of the PRC and has acted as an adviser to several governmental organisations, including the Overseas Chinese Affair Office of the State Council.

CBMRT's mission and aim is "to strive for improving and promoting the quality of life and health of human beings and continuous commitment to support and cultivate academic pursuit and leading-edge scientific development in the tissue engineering field".

new technology

Pioneering patient monitoring system

Handwritten medical observation charts could become a thing of the past in hospitals as a result of the development of a pioneering patient monitoring system.

A team of researchers in the Department's Institute of Biomedical Engineering (IBME) and clinical staff from the Oxford University Hospitals NHS Trust has developed latest computer tablet technology both to record and to evaluate patients' vital signs. This is one of the projects funded by the 'Safer Hospitals, Safer Wards' £260 million NHS Technology Fund to improve patient safety.

Leading the research team is Professor Lionel Tarassenko, from the Department, who said: *"Just as now, nurses will regularly take readings of a patient's vital signs such as heart rate and blood pressure. But instead of writing the information on an observation chart, they will input it into an iPad or computer tablet. An Early Warning Score will then be calculated automatically and displayed instantly. The traditional chart-based method of recording vital-sign data is susceptible to errors and limits the availability of the data to the bedside, making its sharing across the hospital difficult".*

He added: *"The new electronic system automatically calculates the hospital's Early Warning Score, a scoring system which we have developed from extensive statistical studies of patient data. The system enables all vital-sign data and scores to be accessed instantly by all relevant healthcare staff, wherever in the hospital they may be".*

Courtesy of the Oxford Mail: Jon Lewis

At present, six vital signs are measured to calculate the Early Warning Score: heart rate, respiratory rate, blood pressure, arterial oxygen saturation, temperature and level of consciousness. Details of oxygen therapy and clinical concerns can also be recorded on the iPad at the same time. The system has been designed with the future in mind so that it can easily be extended to include other data.

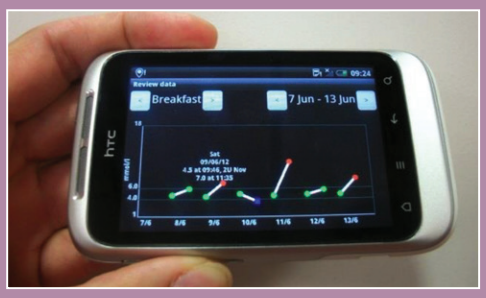
The new system is seen as a major step towards the 'digital hospital' in which all sources of patient information will be interlinked and all healthcare staff will be interconnected.

The Research Council UK's Digital Economy Programme, which is led by the Engineering and Physical Sciences Research Council, funded the research underpinning this unique 'track-and-trigger' system; its translation onto the ward was supported by the Oxford Biomedical Research Centre, which brings together university academics with clinicians at the Oxford University Hospitals NHS Trust.

Helping mothers with Gestational Diabetes

"Being diagnosed with Gestational Diabetes at 28 weeks pregnant … was extremely worrying. The remote monitoring system provided me with the real-time reassurance and guidance I needed to get my blood sugar levels under control through mainly my diet. I genuinely believe that without the real-time advice from the diabetes midwife that this trial provided I wouldn't have stayed as in control and therefore the amount of medication (metformin) and insulin required would have been greatly increased.

The diabetes midwife was able to discuss my readings with a consultant and communicate medication and insulin changes with me through text messages in between clinic appointments. Without the monitoring more hospital appointments would have been required (the clinics are already extremely busy). In addition to the enhanced communication from the midwife, the data visualisations in the app allowed us to spot (and understand) problem trends easily instead of just trying to pick them out on a handwritten form. With the constant help and feedback I remained healthy throughout the remainder of my pregnancy…."
Hannah Scott, a patient under the care of the John Radcliffe Hospital Maternity Diabetes Service.



It is estimated that gestational diabetes mellitus (GDM) affects 5% - 16% of all pregnancies in the UK.

The newly developed Oxford GDm-health management system, by Professor Lionel Tarassenko from the Department and Dr Lucy Mackillop from the John Radcliffe Hospital in Oxford, has been designed with extensive input from both patients and clinicians. It comprises a smartphone app, with a Bluetooth-enabled blood glucose meter, for the patient; and a secure website, with optimised data presentation and alerting algorithms for healthcare professionals. The app automatically transmits the blood glucose measurements to the website, along with annotations entered by the patient. The app provides visual feedback on blood glucose control to the patient. The system has a built-in capability for communication between healthcare professionals and patients.

The new system allows communication between healthcare professionals – ideal for team-based care. Electronic capture of data also allows detailed auditing of care and outcomes.

Engaging alumni…

If you are an Oxford Engineering alumnus or alumna, or a past member of teaching or research staff of the Department, then the Society of Oxford University Engineers (SOUE) is for you. There is now no membership subscription. If the Department has your contact details, you are already a member. Otherwise, you can apply to join via the SOUE website: **www.soue.org.uk**

In the Department we strive to offer the best possible experience to our students. So we are always delighted when SOUE members offer their talents and time in helping us achieve this aim, for example, helping students find vacation internship places, giving talks to students, providing careers advice etc. Could you help? Or could the Department help you? If you are a former student or staff member we want to hear your ideas: please get in touch at: **alumni@eng.ox.ac.uk**

My story: Lynsey Thomas

Alumna, Balliol College (1995-1999)

During my time at Balliol I was fortunate enough to receive a sponsorship from Cable & Wireless Marine and due to this involvement I started to develop an interest in fibre optic telecommunications. After I went down I sought out a career in international submarine systems engineering. My work involved all aspects of "EPIC" projects - engineering, procurement, installation and commissioning. Spending time both at sea and on land I worked all over the world, testing cables between Australia and New Zealand, installing the first fibre optic cable between Hawaii and Fiji (during a military coup), and leading the commercial team to negotiate a new system between the UK and India.

More recently I transferred into operations & maintenance of cable systems, looking after the transatlantic cable system Apollo. As Operations Director I had to make sure the cable system was continually up and running, servicing our customers as per their requirements.

My position also afforded time for research and it has been a pleasure to write and present white papers at various international conferences. I have always enjoyed writing and as a side-line produced a regular column in the Work supplement for The Guardian. This in turn led to other opportunities such as speaking on Radio 4 Woman's Hour. I am currently a trustee for the Westmill Sustainable Energy Trust, an organisation that promotes the deployment and education of sustainable energy. I have three little budding engineers at home and am still involved with the University's engineering alumni via the Society of Oxford University Engineers (SOUE).

The SOUE runs a LinkedIn group open to members and alumni, and is a great way to get in contact with other engineers. Visit: **www.linkedin.com**.

Weather and Climate Prediction

The 2013 Jenkin Lecture

Dr Andy Brown, Director of Science at the Meterological Office, presented the 2013 Jenkin Lecture. He described weather prediction as computational numerical modelling on a truly global scale. The whole Earth's atmosphere is meshed as 55 million cells, with local mesh refinement for the UK. Input data comes from many sources: from manually read ground-based instruments to satellites. A 3-day forecast now is as accurate as a 1-day forecast was 20 years ago.

Dr Brown highlighted that climate forecasting is a similar exercise, but complicated by the need to include the oceans and polar ice in the model. Timescales are much longer and the mesh used in simulations is coarser. The UK is a leading player, benefiting from the Met Office also being a major weather forecaster. Long-range weather forecasting for months ahead is an intermediate case, and greatly in demand commercially. It is especially difficult for the UK, but remarkable progress is being made, on the basis of extensive study of behaviour of the Gulf Stream.

Named after the first Oxford Professor of Engineering Science (1908-1929) Charles Frewen Jenkin FRS, the annual Jenkin Lecture was established by the Society of Oxford University Engineers (SOUE).

To read a full account of Dr Andy Brown's Jenkin Lecture visit:
http://www.soue.org.uk/souenews/2014/jenkinlect2013.html

Passing of a Pioneer

Dr Gerry McCrum: 1927 - 2013

We regret to report the passing of one of the Department's longest-serving lecturers, who will be remembered by alumni especially for his passionate lectures on engineering materials. Gerry McCrum arrived here in 1963 and became a Fellow of Hertford College. His research was best-known internationally for pioneering work on the viscoelasticity of polymers.

Gerry enjoyed challenging convention. In the later years of his career and after retirement in 1994 he became a prominent campaigner for reducing gender bias in universities. He lived life to the full and will be missed by many.

To read more on Dr Gerry McCrum visit:
http://www.soue.org.uk/souenews/2014/mccrum.html

"Objects of Invention" educational aspiration

Students from the Department of Engineering Science participated in "Objects of Invention", a new initiative at Oxford University's Museum of the History of Science. This project was one of three finalists in the STEM category of the National Coordinating Centre for Public Engagement's "Engage 2014" competition. "Engage 2014" brought alive the transformative power of engagement: from dissemination of research to inspiring the next generation of researchers.

"Objects of Invention," funded by the Royal Academy of Engineering under their Ingenious programme for public engagement, was the brainchild of Chris Parkin, Lead Education Officer at the Museum. Chris said: *"I wanted to find a way of capitalising on the Museum's remarkable collection of inventive artefacts whilst enabling young engineers to gain experience in public engagement bringing their knowledge and enthusiasm to the Museum's diverse audiences".*

After a series of training sessions in methods of public engagement and museum object handling, which were supported by the Joint Museums' Volunteers Service, the Department's students devised activities for families and school groups. Activities ranged from experimenting with gyroscopes and Stirling engines, to steam pumps and mobile medical devices.

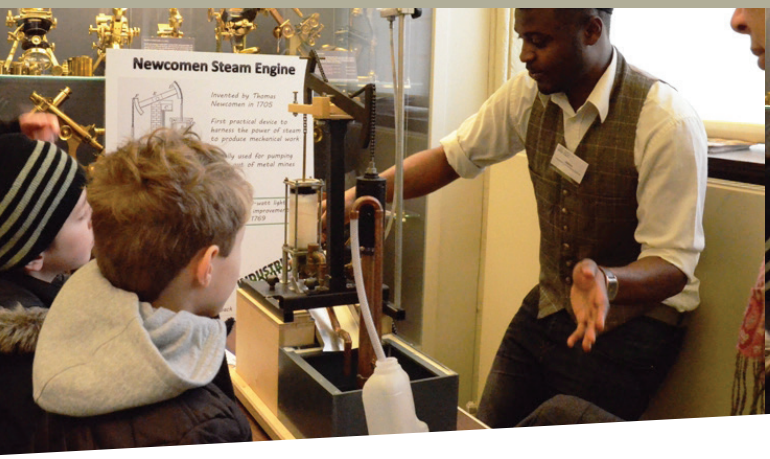
Teachers accompanying the school groups were very enthusiastic and one commented on the positive effect on their students: *"It was good to have people working in the field to share their knowledge with students from our school, which encouraged their view on engineering".*

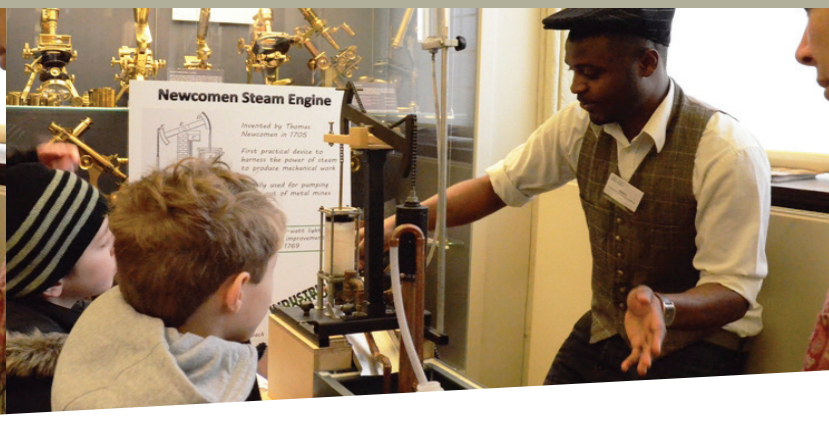
national co-ordinating centre for public engagement

Although the emphasis was on current engineering applications, the students were able to relate their ideas about engineering to historical ancestors in the collection, which include the earliest radio devices invented by Marconi and pieces of Charles Babbage's extraordinary mechanical computer from the Victorian era.

The Department's students reported that they all benefited from the training and opportunities to gain experience in public engagement. One Engineering Science student said: *"I have gained a lot of public speaking experience and talked to a wide range of audiences about something that relates to my work. Educating children also made me feel confident in what I do".*

This initiative reached the national finals in the 2014 Engage Competition, thanks to the efforts of 18 engineers and the training in public engagement provided by the Oxford University Museums and Collections Joint Museums Education Service.





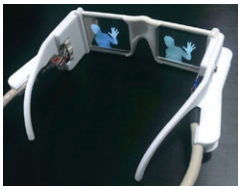
Winners of the Google Impact Challenge

Projects involving teams from the Department of Engineering Science won two of the four prizes in the 2014 Google Impact Challenge, each receiving £500,000. The Google Impact Challenge is a UK competition, which aims to support non-profit organisations 'using technology to tackle problems and transform lives around the world'.

The Smart Glasses project

The prize for the Smart Glasses project, which was also awarded the 'People's Choice' receiving more public votes than any other of the 10 finalists, will be used towards developing technology to help the sight of millions of people with sight defects using computer vision and augmented reality. The prototype has already enabled users to identify faces and obstacles more clearly than they have seen for years.

The glasses work by capturing images of the world with a 3D camera. This information is used to separate out nearby shapes and objects and highlight them clearly on the inside of small transparent displays. The displays form part of the lenses of the glasses, allowing people to use their own vision as much as possible.

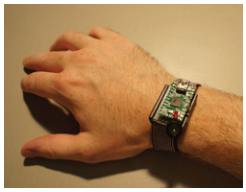


Professor Phil Torr, from this Department, is working in partnership with the Royal National Institute of Blind People and the Nuffield Department of Clinical Neurosciences at Oxford University.

The Wearable Sensors project

In the Wearable Sensors project the Department's researchers, led by Professor Stephen Roberts, in partnership with Kew Gardens, the Malaria Atlas Project at Oxford University and the Eijkman Oxford Clinical Research Unit in Indonesia, are working to create a smartphone app and a range of wearable acoustic detectors to detect the sound of mosquitoes. The team will then equip villagers in rural Indonesia with the novel technology and the data thereby captured will be invaluable in modelling the movement and lifecycle of deadly malaria-bearing mosquitoes.

More than half the world's population live in areas where they are routinely exposed to disease-carrying mosquitoes. Governments, international agencies and charities spend billions of pounds on global efforts to control mosquito populations, protect people and livestock, and treat those infected. These programmes need reliable data on which species of mosquito occur in a given location, and what attracts them there in the first place. This project aims get to the heart of understanding these different factors.



For more information on both projects please visit: www.rnib.org.uk/smart-glasses and www.kew.org

Out of the jet engine and into the 'Flare Pan'

Research leads to cooking with 30% less energy

The Department's research into high-efficiency cooling systems for next-generation jet-engines has led to a new design of cooking pan that uses 30% less energy.

The new 'Flare pan', based on research by Thomas Povey, Professor of Engineering Science, has been launched by the UK's leading kitchenware firm Lakeland.

Professor Povey worked with Isis Innovation, the University's technology commercialisation company, to license the new technology - the pan's finned design ensures a more even heat distribution, speeds up cooking, and so lowers energy consumption.

The 'Flare pan' has won an award from The Worshipful Company of Engineers and a Design Council award. The Worshipful Company of Engineers awarded Professor Povey their prestigious '2014 Hawley Award' for *"the most outstanding Engineering Innovation that delivers demonstrable benefit to the environment".*

Formed from cast aluminium, Flare pans are most effective on gas hobs, estimated to be used by over two thirds of the UK. The unique, patented, finned design channels heat from the flame across the bottom and up the sides of the pan, resulting in highly efficient, even heat distribution. An equivalent pan of conventional design was shown to need 40% more energy to heat up than a 'Flare pan'.

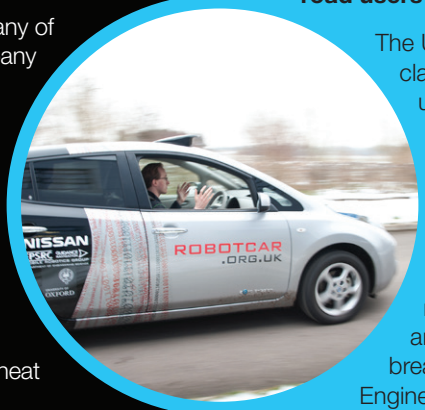
Professor Povey and Isis Innovation went through the Design Council's Design Leadership Programme, a mixture of workshops and direct support part-subsidised by the Department for Business, Innovation & Skills. It is designed to help turn scientific and technological ideas into innovative, profitable products and services.

Matthew Canwell, Lakeland's Buying Director said: *"Innovative thinking has been cemented into all that Lakeland has done for 50 years, and we're always looking for new innovations that will save our customers both time and money. Flare pan does just that, and we're extremely excited to be able to bring this incredible new technology to our customers".*

Professor Thomas Povey is based at the Department's Osney Thermofluids Research Laboratory, one of the leading laboratories in the world for turbo-machinery and heat transfer research. The Department's history of work in fluid mechanics and thermodynamics dates back to its foundation in 1908.

World-class training for doctoral students

In the next decade our society will be revolutionised by Autonomous, Intelligent Machines and Systems (AIMS), which can learn, adapt and act independently of human control. There is an exciting opportunity to develop these technologies for sectors as diverse as energy, transport, environment, manufacturing and aerospace. In transport, for example, we will eventually have cars that can drive themselves, interacting safely with other road users and using roads efficiently.



The University of Oxford has a world-class reputation in research in the underpinning technologies of AIMS. Graduates have gone on to become entrepreneurs, taking leading roles in industry and commerce or continued their careers in academia. Recognising the strength of our research and teaching in this area and the potential for future breakthroughs, the departments of Engineering Science and Computer Science were awarded an Engineering and Physical Sciences Research Council (EPSRC) Centre for Doctoral Training (CDT). This focuses on the development of new methods, technologies and applications. Fundamental research will be combined with graduate training enabling students to undertake a wide array of exciting projects, including many proposed by our industrial partners.

An impressive team of global multi-nationals and large corporations are supporting the 4-year CDT programme. These include: BAE Systems; BP; Microsoft; Schlumberger; QinetiQ; YouGov; Google; Honeywell; Ascending Technologies; ABB and Infosys.

The CDT will prepare future leaders to make a contribution to solving some of the most significant challenges faced by society - from intelligent machines and systems that can help people with assisted living to building sensor systems and citizen science platforms to monitor the environment, pollutants and biodiversity.

Industrial and commercial partners will be involved throughout in the shaping of the CDT programme, identifying research problems with students, encouraging active participation via internships in their labs, and playing a key role on the CDT External Steering Group.

For more information please visit: www.robots.ox.ac.uk/aims-cdt

More than a storm in a tea-cup:

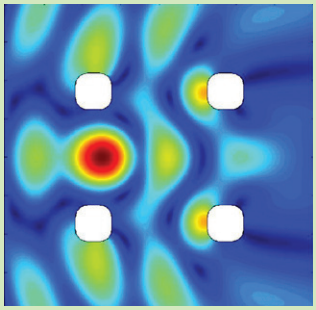
Violent water projection to high levels beneath the deck of floating offshore platforms

Offshore structures are exposed to the vagaries of the open ocean, with severe winter storms in the North Sea and hurricanes in the Gulf of Mexico providing some of the most extreme environmental conditions. Semi-submersible platforms are used extensively, for drilling and then for oil and gas production. These structures have multiple large diameter surface piercing columns supporting the platform topsides and connected by submerged pontoons *[Figure 1]*.

For such structures there are many accounts of minor damage to equipment and secondary steelwork caused by 'green' water reaching much higher levels than anticipated. Some of these incidents date back to the early days of exploration drilling for gas in the southern North Sea when flooding of the laundry room was a frequent complaint! – the laundry room being located at cellar deck level between a pair of legs of the platform, a common place for violent wave interaction and water jetting upwards.

◀ *Figure 1: BP's Thunder Horse platform in the Gulf of Mexico*

▼ *Figure 2: Peak response between the front two legs of a platform, waves from the left.*



Such minor damage can occur even on the largest and most modern structures in relatively modest storms – where it is more an inconvenience than a threat to the platform survival. But even minor damage means lost oil and gas production until it is repaired.

Wave impact

Recent work in Oxford as part of James Grice's DPhil thesis, supervised by Professors Paul Taylor and Rodney Eatock Taylor and in cooperation with the oceanography group in BP Sunbury, has provided an explanation for such damage. In extreme design conditions – the types of event that occur perhaps once every one thousand, or ten thousand years – the damage could be much more significant: there is the possibility that wave impacts could threaten a platform's ability to survive.

Ocean waves produce run-up on the surface of any surface-piercing column and wave energy is scattered outwards. With columns in close proximity, it is possible to 'bounce' waves between them, resulting in the excitation of local standing wave patterns below the deck of the structure - 'near trapping'. *Figure 2* shows one such a predicted response, made using Oxford's DIFFRACT code, showing how water at high level can occur between the front two legs of a structure. Different wave conditions move these interference patterns around.

Linear and non-linear wave interactions

Significant near trapping can occur below the deck of a realistic 4-leg platform in random waves, with water predicted to reach >2x the level on the open sea away from the platform. Both linear and non-linear wave interactions are important for very large structures exposed to large waves, both high and steep, when a range of near-trapped modes can be excited. Whether the platform is restrained vertically (a tension leg platform) or freely floating with a soft mooring (a semi-sub), so it can ride the waves, also has a dramatic effect on the risk of water reaching the main deck level.

Professor Taylor, from the Department, comments: *"Oxford has very smart students. BP has vast experience in offshore engineering, and is able to identify practically important problems as well as having lots of oceanographic data, so working together means that both gain from fundamental research into marine hydrodynamics. Such safety related work benefits not only BP but also the whole offshore industry worldwide".*

Dr Richard Gibson from BP Sunbury, said: *"Wave-structure interaction in extreme waves is a complex non-linear problem that has important practical implications for the integrity of offshore platforms. The collaboration with Oxford has enabled us to utilise their expertise in this area in order to understand the physical processes and hence improve our design methods".*

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Networks

The University of Oxford's Alumni Office provides a range of opportunities for alumni of the University to come together. Throughout the year there is an exciting mix of social and professional networking events, presentations by leading academic speakers, as well as the chance to get involved in student recruitment and outreach activities.
To find out more please visit:
http://www.alumni.ox.ac.uk or
e-mail: enquiries@alumni.ox.ac.uk

The Oxford University Engineering Society (OUEngSoc) - this is one of the largest undergraduate societies in the University. It promotes the engineering profession within the University and provides students with a wider overview of the profession that are otherwise outside the scope of the degree course. Talks, debates and trips as well as socials and networking opportunities are offered to undergraduates.
To find out more please visit:
http://www.ouengsoc.org

The University of Oxford Careers Service – is for life, the Alumni Careers Adviser, Dr Mike Moss, is the key Careers Service contact with the Department of Engineering Science. He offers 30 minute Skype appointments for alumni all over the world, these can be booked on-line on the Career Connect portal. Alumni can also post job vacancies, offer internships and volunteer to be mentors.
To find out more please visit:
http://www.careers.ox.ac.uk/
or e-mail: alumni@careers.ox.ac.uk

Thank you for your support

We would like to acknowledge the important role played by our individual and corporate supporters, and we thank them for the invaluable contribution they have made to the Department.

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Student Achievements

Winners of the BP Ultimate Field Trip 2014

The Department's three second-year students from Keble College, Christopher Clay, Talbot Kingsbury and Jan Paszkiewicz* (team name: 'I Challenge You to a Joule'), won the BP Ultimate Field Trip 2014. The students were presented with their prize, which includes an internship with BP's Alaskan operations, by BBC broadcaster, Clare Balding, at the Royal Institution in London.

Pictured from left to right are: Clare Balding with Engineering Science students: Talbot Kingsbury, Jan Paszkiewicz and Christopher Clay.

BP's nationwide competition promotes science, technology, engineering and maths (STEM) skills. The challenge to STEM students was: *'The environment is facing more problems today than ever before. Greenhouse gases are building up at an alarming rate, pollution is one of the major problems facing us today and a change in the way we use energy is needed. Can you identify an innovative solution to significantly reduce energy consumption within the energy industry that could be implemented by 2025 and would be scalable across the industry?'*

The 'I Challenge You to a Joule' team solution focused on a system that would see energy from gas flares at oil and gas wells used for aluminium electrolysis. The concept uses a modular and mobile system that could be deployed in areas of the world where both oil and gas and aluminium production currently occurs, such as Texas and Russia.

***Jan Paszkiewicz** was one of nine engineers to receive the Sir William Siemens Medal Award 2014. He has been recognised by both Oxford University and Siemens for engineering excellence and achievement during a student's first year at university. All nine engineers received the Sir William Siemens Medal, specially designed and struck by The Royal Mint, and a paid internship with Siemens.

Jan said: *"For the Award, I was asked to write an essay on the greatest engineering challenge the world faces and how it should be solved".*

Award for best undergraduate project

Peter Forsyth (Trinity College), an undergraduate with the Department, was awarded the Heat Transfer Society (HTS) 'Best Undergraduate Project on Heat Transfer'. Peter Forsyth received his award from Martin Gough, Hon. Chairman of The Heat Transfer Society (HTS), which is the UK's leading society for those involved in heat transfer industries.

Peter's project titled: *'Understanding Development of Cooling Features in Gas Turbine Engines'*, has been recognised as the *'best heat transfer project report with potential benefits for industry, from a UK university undergraduate in the current academic year'*. Peter's project was supported by his supervisors, Professors David Gillespie and Matthew McGilvray.

Best student poster award at Singapore International Water Week

Mr Darryl Day, co-Chair of the SIWW, presented Huijuan Wu with her award.

Department of Engineering Science DPhil student Huijuan Wu (St. Edmund Hall) has won the best student poster award at the 2014 Singapore International Water Week (SIWW).

Huijuan's poster, titled: *'Sustainability Assessment for the Yellow River: Engaging Stakeholders in IRWM'* looked at how water from one of China's most heavily utilised rivers could be managed to maximise economic and social welfare in an equitable manner without compromising sustainability. The poster was chosen from around 200 displayed at the prestigious annual convention, which aims to share and co-create innovative water solutions.

Best student paper award at the American Control Conference

DPhil student Richard Mason (Lincoln College) was awarded the Student Best Paper Award at the American Control Conference. Richard's paper titled: *'Chordal Sparsity, Decomposing SDPs and the Lyapunov Equation'*, was based on research carried out in the Department with Professor Antonis Papachristodoulou.

Richard's achievement is especially impressive given the fierce competition for this award; it was chosen out of 900 papers presented. The paper develops a new computational approach for understanding the properties of large system models such as the ones arising in Biology.

Pictured left to right: Tariq Samad, Chair of the American Automatic Control Council; Richard Mason; Mehran Mesbahi, Student Programmes Chair.

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