UNIVERSITY OF OXFORD

Department of Engineering Science news

Issue 3
2013-14

A world first - life-saving engineering at its best... (page 3)

Welcome

Welcome to the 2013-14 issue of "Department of Engineering Science News". I am delighted to announce that for the second 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

IN THIS ISSUE:

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Head of Department's news this year ...

It has been an exciting year here in the Department, and the principal focus from my point of view has been the recruitment of new academics.

Dr Tom Adcock
(St Peter's College)

Dr Alfonso Castrejon-Pita
(Wadham College)

Dr Manolis Chatzis
(Hertford College)

Dr Bhaskar Choubey
(Somerville College)

Dr David Clifton

Dr Justin Coon
(Oriel College)

Dr Martin Davy
(Exeter College)

Dr Felix Hofmann

On this page are pictures of new academics recruited since I last reported in the newsletter a year ago. As these are balanced by just two departures (Dr Will Moore retiring from Jesus College, and Professor Yiannis Ventikos who has moved to a new post as Head of the Department of Mechanical Engineering at UCL) you will realise that the Department is expanding rapidly.

The new appointments, involving Professors, University Lecturers and Senior Research Fellows, will strengthen the whole Department. In some areas this will be transformative – for instance four posts are in electrical engineering, radically changing our capabilities in this area. Fourteen of the appointees pictured here are from outside Oxford, so we start the coming year with an influx of new ideas and skills from around the world – including four appointees coming from posts in the US.

Our relationship with Colleges is very important, and I am delighted that two of the new appointees will have Fellowships at Colleges which are new to Engineering. Professor Ron Roy (pictured and featured on page 9) will be a Fellow of Harris Manchester College, and Dr Aidong Yang, who joins in January 2014, will be a Fellow of Green Templeton College.

The rest of this newsletter should give some feel for our research and achievements over the past year, and I am confident that the new faces shown here will lead to even more exciting reports in the future.

Professor Guy Houlsby
Head of the Department of Engineering Science

Dr Chris MacMinn
(University College)

Dr Matt McGilvray

Dr Stephen Morris
(Jesus College)

Prof. Roger Reed
(St Anne's College)

Prof. Katya Shamonina
(Wadham College)

Prof. Phil Torr
(St Catherine's College)

Dr Frank Wood
(Kellogg College)

Dr Aidong Yang
(Green Templeton College)

Pictured above: Mr George Robinson (centre) with 2013 Sloane Robinson scholars, Qian Cheng (left) and Marisol Martinez Alanis (right).

"There is good econometric evidence that the demand for graduate engineers exceeds supply and that the demand is pervasive across all sectors of the economy."

Royal Academy of Engineering Report, September 2012

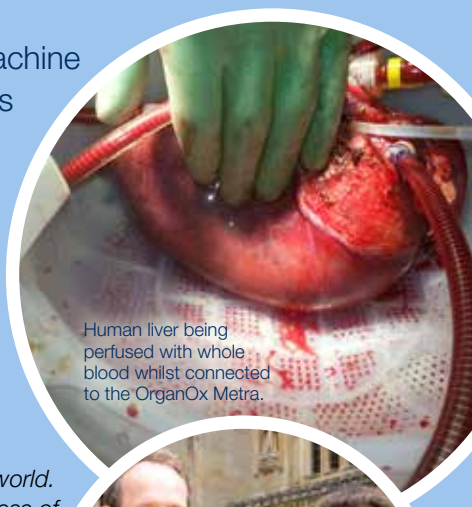
Society benefits from scholarships

Since 2006, the Sloane Robinson Foundation has supported 13 students who have demonstrated exceptional talent and promise in the field of biomedical engineering and who have been offered a place on the taught MSc in Biomedical Engineering.

Talented graduate students form the backbone of Oxford's research in Engineering. During this time of concentrated study, many graduate students make breakthroughs that can have profound impacts and benefits for society. It is also a base from which they can launch their careers in industry, business and academia, and our graduate students enter a huge variety of occupations – in design and manufacturing, research and development. Applications studied are as diverse as aerospace, pharmaceuticals, electronics, energy and advanced healthcare. The rising costs of graduate study can deter top students from continuing their education at Oxford and we are very grateful to Mr George Robinson and Mr Hugh Sloane for their support.

Life-saving engineering at its best

In a world first, a human liver has been 'kept alive' and functioning on a machine outside the patient's body prior to transplantation. So far the procedure has been performed on eight patients on the liver transplant waiting list and all have made excellent recoveries.



Human liver being perfused with whole blood whilst connected to the OrganOx Metra.

Professors Peter Friend and Constantin Coussios.

The technology has been jointly developed by Constantin Coussios, Professor of Biomedical Engineering in the Department, and Professor Peter Friend of Oxford University's Nuffield Department of Surgical Sciences and Director of the Oxford Transplant Centre. Constantin and Peter are also the academic founders and Technical and Medical Directors of OrganOx, Oxford University's spin-out created in 2008 to bring the device from bench to bedside.

The OrganOx CEO, Dr Les Russell, said: *"In Europe and the US, around 13,000 liver transplants are undertaken each year. However, there is a combined waiting list of around 30,000 patients and up to 25 per cent of these patients die whilst awaiting transplantation. Meanwhile, over 2,000 livers are discarded annually because they are either damaged by oxygen deprivation or do not survive cold preservation due to elevated intracellular fat"*.

The revolutionary OrganOx technology is being trialled at King's College Hospital in London as part of a controlled clinical investigation. A donated human liver is connected to the device and irrigated with oxygenated red blood cells at normal body temperature, enabling the organ to function normally and produce bile outside the body for up to 24 hours.

Professor Coussios commented: *"We have had to create an artificial environment that mimics most of the key functions performed by the human body, such as pumping of blood by the heart, ventilation by the lungs, and provision of nutrition to the organ, yet is readily transportable. Most importantly, advanced automated control algorithms had to be developed to make the machine easy to use by transplant teams around the world. The device operates at the press of a single button, and automatically creates physiological pressures around the liver whilst enabling the organ to choose its own blood supply on the basis of its own vascular resistance"*.

Professor Friend pointed out: *"This new technique allows us to assess how well an organ is working before having to decide whether to commit a patient to the operation. This technology promises to quality-assure organs which would otherwise be discarded"*.

Mr Wayel Jassem, Consultant Liver Transplant Surgeon at King's College Hospital, who has performed all transplant operations to date, said: *"There is always huge pressure to get a donated liver to the right person within a very short space of time. For the first time, we now have a device that is designed specifically to give us extra time to test the liver, to help maximise the chances of the recipient having a successful outcome. This technology has the potential to be hugely significant, and could make more livers available for transplant, and in turn save lives"*.

The OrganOx Metra machine.

Ian Christie, 62, the first person to receive a transplanted liver kept alive on the OrganOx device, said: *"In May 2012, I was told I had cirrhosis of the liver and without a transplant I had an estimated 12-18 months to live. I was placed on the waiting list but I was told there was about 12-18 months to wait for a liver of my type. The waiting is horrible. You're waiting for the phone to ring, wondering are they ever going to call me? Are they ever going to call me? Today, I feel better than I've felt for 10-15 years, even allowing for the pain and wound that's got to heal…I just feel so alive!"*

Ian Christie **before** transplant

Ian Christie **after** transplant

Mr Stefano Domenicali, Scuderia Ferrari Team Principal, visited the Department in May 2013 to deliver the annual Maurice Lubbock Memorial Lecture. During this lecture he announced the evolving research partnership between the University and Ferrari (the oldest Formula One team), centred on their base at Oxford University's Begbroke Science Park in Oxfordshire.

The Ferrari F1 Connection

DPhil Engineering Science students Chris Lim, Giacomo Perantoni and Ingrid Salisbury are working with Ferrari on novel ways to improve Formula One performance.

Chris Lim said: *"I'm very excited that I'll be the first student working with Ferrari in the Department's Southwell Laboratory, under the supervision of Professor Peter Ireland, the Department's Professor of Turbomachinery. It's a privilege to work with a prestigious manufacturer such as Ferrari in an industry like Formula One where the application of thermo-fluids has such a large impact".*

Chris has a first class MEng in Engineering Science from Oxford University and did his 4th Year Project under the supervision of Dr Budimir Rosic who was also his tutor at St Anne's College.

Mr Domenicali said: *"Ferrari combines determination, curiosity, generosity, decisiveness, courtesy, Italian spirit and international professionalism. A breeding ground for bright ideas and solutions, be they graduates from the Ferrari Graduate Programme or experienced professionals. People with talent can show it".*

Pictured from left to right are: Chris Lim (postgraduate), Ingrid Salisbury (postgraduate), Mr Stefano Domenicali, Giacomo Perantoni (postgraduate) and Professor David Limebeer (supervisor to Giacomo Perantoni and Ingrid Salisbury).

The Department is working with a number of partners in the automotive industry, which include Lotus F1 Team; Williams F1; Jaguar Land Rover and BMW.

Photograph courtesy of Lotus F1 Team.

Sixth Formers (pictured above), on the Department's Headstart programme, visited the Lotus F1 Team headquarters in Enstone, Oxfordshire. Headstart is a national initiative that encourages young people into technology-based careers.

Robot car moves on

The Department's Mobile Robotics Group, led by Professor Paul Newman and Dr Ingmar Posner, has developed a new navigation system that enables a car to 'drive itself' for stretches of a route – taking the strain off drivers during a busy commute or school run. In July 2013, the Government announced that driverless cars can be tested on public roads for the first time.

This robotic technology, tested on a Nissan Leaf electric car, is controlled from an iPad on the dashboard that flashes up a prompt offering the driver the option of the car taking over for a portion of a familiar route – touching the screen then switches to 'auto drive' where the robotic system takes over. At any time a tap on the brake pedal returns control to the human driver.

Professor Newman said: *"We are working on a low-cost 'auto drive' navigation system, that doesn't depend on GPS, done with discreet sensors that are getting cheaper all the time. Advances in 3D laser mapping enable an affordable car-based robotic system to rapidly build up a detailed picture of its surroundings".*

Our thanks to the Engineering and Physical Sciences Research Council (EPSRC) for funding this research, and to Nissan for providing support and the cars for the research.

The 2013 Oxford London Lecture

The prestigious Oxford London Lecture, hosted by the Vice-Chancellor of Oxford University annually, was delivered by Professor Paul Newman, and supported by the Romanes Fund and The Guardian newspaper.

Over 200 pupils from London schools, alumni, corporate partners and representatives from government and academia attended the lecture in London.

Professor Newman said: *"Humans are the ultimate toolmakers and in many ways robots are the ultimate tool; operating on the frontier where the physical world we see meets the invisible world of data and computation. But if robots are such powerful tools how should we use them? What are their strengths and limitations? What sort of difference can we expect them to make to our daily lives?"*

Drawing on decades of robotics research, the Lecture examined how close we are to being able to answer these and other questions.

The Sterling Group

The Sterling Group (https://www.sterlinggroup.org.uk/) was established in 1998 by a group of research-led engineering Universities. It has the principal aim of promoting awareness of the high quality engineering research and teaching in UK Universities to selected countries overseas. There are currently 17 member Universities, and the Group is supported by the Royal Academy of Engineering, the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Structural Engineers' Educational Trust.

Each year the Group usually organises two lecture tours abroad, and in recent years these have targeted Vietnam and India, both of which are seen as future countries for collaboration and for recruitment of students.

The Department of Engineering Science is committed to promoting awareness of its research excellence abroad, and plans to continue working with the other Universities in the Sterling Group to build new links with overseas Universities.

Professor Houlsby in Vietnam
For each of the past three years Professor Guy Houlsby (Head of Department) has taken part in the tour to Vietnam. During that time he has delivered 25 lectures in 12 different Universities, including a number of repeat visits to key centres such as the Vietnam National University, Hanoi, and the University of Technology in Ho Chi Minh City.

Professor Guy Houlsby (second left), pictured with three of his past graduate students (Lam Nguyen-Sy, Luan Ngo Tran and Jan Mangal), visiting a construction site in Ho Chi Minh City.

In 2012 the Group formed the core of a special conference at Danang University of Technology, a very dynamic establishment in central Vietnam. The lectures are mainly attended by final year undergraduate students, to give them some idea of the possibilities offered by research in UK Universities.

Each tour usually involves a group of anything up to nine different lecturers, each with a programme of University visits and lectures. There are networking events with local businesses and with alumni of the Universities, as well as interviews with the media. The whole exercise is co-ordinated by local staff, from the British Council, who do an amazing job to get all the lecturers to the right place at the right time. The visiting team soon become aware that they are representing not just their own University, but the Sterling Group as a whole, and even more widely, UK engineering.

Professor Noble in India
In 2012 Professor Alison Noble OBE, Director of the Department's Institute of Biomedical Engineering, joined the tour to India, which included visiting the Indian Institute of Technology (IIT) Roorkee in northern India, and Anna University and associated colleges in the Chennai area.

A two-day mini-conference on Advanced Materials and Technologies was held at Anna University with approximately 200 participants at which Professor Noble talked about her research on soft tissue imaging and analysis. Sterling Group trip members were also invited to the 2012 Olympic Opening Ceremony event party in the beautiful surroundings of the UK Deputy High Commission in Chennai.

Professor Noble said: *"The Institute of Biomedical Engineering is working hard to develop research and educational links with India in affordable healthcare technologies. As part of this initiative we are developing links with the Indian Institute of Science in Bangalore, and its collaborators in both urban and rural India. The Sterling Tour provided me with the opportunity to gain insight into the research and educational systems in India. It was also wonderful to meet the bright young students and hear their aspirations to become the next generation of innovators who will develop healthcare solutions to meet the needs of this fascinating country".*

Professor Alison Noble (pictured third from right) in India.

Careers in Engineering

The UK is host to some of the top global engineering firms and most engineering areas are thriving, particularly given the crucial link they play in supporting a new low carbon economy.

In the commercial field these range from multinational corporations with offices and projects all over the globe, to small engineering firms working in niche markets supplying smaller components or expertise to larger companies. A rise in opportunities in the BRIC nations (Brazil, Russia, India and China), particularly for energy and natural resource companies, has made graduate applicants with relevant languages and/or a willingness to travel particularly sought after.

In the public sector, opportunities range from the Civil Service through to supporting regional engineering projects in local government and working for government agencies (e.g. reducing national flood risks).

For more information on careers in engineering visit: http://www.careers.ox.ac.uk

The engineering sector makes up nearly a quarter of the UK economy (23.9% of GDP), making it almost three times the size of the financial sector, and it employs over 5.4 million people.

Engineering UK 2013: The State of Engineering

Women in Engineering Science

Across academia, women are underrepresented in senior positions. In 2009, less than 10% of departmental heads at Oxford were female, and in 2010, only a quarter of committee members overseeing strategy and resourcing at the University were women. At reader and professorial levels, the numbers are often smaller still, particularly in science, technology, engineering, maths and medicine (STEMM) departments. The reasons for the disparity between men and women in top scientific posts are complex, but it is no longer sufficient to accept the status quo.

The Athena SWAN Charter, supported by the Equality Challenge Unit and Research Councils UK, was established in 2005 to address the underrepresentation of women in academic science by recognising good employment practices in STEMM departments.

Its award scheme aims to promote cultural change at all levels within academic departments to help remove barriers to progression for women. However, it's not just about increasing the number of women working in a department. To receive an Athena SWAN award, departments must demonstrate that practices are in place to support the work–life balance and promote equal opportunities for career progression. The awards celebrate recruitment and working practices that will benefit both men and women.

In 2013, Engineering Science was one of seven departments at Oxford University that was presented with an Athena SWAN bronze award in recognition of its efforts to help promote and advance the careers of women in academia. Accepting the Award on behalf of the Department from Professor Dame Julia Higgins (pictured left), Patron of Athena SWAN, was Professor Alison Noble OBE, Director of the Institute of Biomedical Engineering (IBME) and Technikos Professor of Biomedical Engineering (pictured right).

*This article first appeared in the July 2013 issue of Blueprint (the Oxford University staff magazine).

Professor Alison Noble OBE FREng

In 2013 Professor Noble, Fellow of St Hilda's College, was appointed OBE for services to science and engineering. Her research area is biomedical image analysis, with a particular recent interest being application of machine learning to medical imaging, with application to cardiology, obstetrics and perinatal care, and microscopy.

Professor Noble is a graduate of the Department and has worked in both academia and industry in the UK and USA respectively. At Oxford she has been influential in setting up biomedical engineering educational programmes at the undergraduate, MSc and doctoral research training levels, and was the Director of the Research Council UK Centre for Doctoral Training in Healthcare Innovation prior to becoming Director of the IBME.

Professor Noble is a Fellow of the Institution of Engineering and Technology (IET), the Medical Image Computing and Computer-assisted Interventions (MICCAI) Society (the international society in her field) and the Royal Academy of Engineering, and has served or currently serves in different capacities for each of these professional organisations. She was elected President of the MICCAI Society in 2013.

The first female engineering graduate

In 1939, Anne Burns (née Pellew) graduated from St Hugh's College with a first in Engineering Science. She was Oxford's first female engineering graduate and was awarded the Edgell Sheppee scholarship to stay on for research.

In 2014, the University will be celebrating the 40th anniversary of the first Colleges to admit both men and women, which includes an event on 6th November at the Royal Society in London titled: "Women in Science".

The Vice-Chancellor's Diversity Fund

In 2013 the Vice-Chancellor, Professor Andrew Hamilton, announced the creation of a new £1m fund for the advancement of diversity among academic and research staff at Oxford.

The Vice-Chancellor said: *"This new fund signifies the priority the University attaches to this work. It is only by having a fully diverse workforce, where people are appointed and promoted solely according to their merits, that the University can achieve the very best in teaching and research. Furthering diversity and equality is a matter that deserves our highest priority".*

From Art to Biomedical Engineering

Originally with her heart set on becoming an industrial designer, Dr Eleanor Stride's love of engineering was actually inspired by her 'A' level Art teacher: "It is the combination of creativity with scientific rigour that makes engineering unique and exciting". **Dr Eleanor Stride**

Today, Dr Eleanor Stride is a University Lecturer at the Department's Institute of Biomedical Engineering and Fellow of St Catherine's College. Dr Stride and her team are investigating the technology of microscopic bubbles *in vivo* to diagnose, treat and prevent illnesses such as stroke and cancer. Many more potential uses are in the pipeline, including for Alzheimer's, Parkinson's and depression.

Identifying a range of diseases

The team's research focuses on bubbles of a few 1000ths of a millimetre that are injected into the bloodstream to increase the strength of the echoes from blood vessels. Clinicians use these bubbles to map the flow of blood in a particular region, using ultrasound imaging, in order to identify a range of diseases.

The bubbles are coated with biocompatible shells that can also be loaded with drugs. By focusing the ultrasound, the bubble can be popped open to unload the drug in the area it is needed. This means fewer side-effects because the drug is focused to a specific target. Although doctors have used so-called micro-bubbles for some time to produce clearer images in body scans, only now is their full potential being realised.

Dr Stride and her team are working on new methods for manufacturing micro-bubbles to control the amount of drug that can be loaded into them and how they respond to ultrasound. Dr Eleanor Stride said: *"Micro-bubbles have the potential to target delivery of drugs and minimise their side effects, for example in cancer chemotherapy".*

Prestigious Award

In 2013, Dr Stride received the R. Bruce Lindsay Award of the Acoustical Society of America. This Award is given annually by the Acoustical Society of America (ASA) to a single researcher under the age of 35 across all fields of acoustics, who has made a significant research contribution to the field.

Dr Stride received this prestigious Award for 'contributions to biomedical applications of acoustic bubbles', with particular reference to the development of ultrasound-responsive micro-bubbles that can be guided and trapped under the effect of an externally applied magnetic field.

Dr Stride is the fifth woman out of 53 total recipients of the Award since 1942, and the third recipient of this Award in the Department: the 2000 R. Bruce Lindsay Award was presented to Professor Robin Cleveland, who joined the Department in October 2011 as a Professor of Engineering Science, whilst the 2012 Award was given to Professor Constantin Coussios who is Professor of Biomedical Engineering. This represents the greatest number of R. Bruce Lindsay awardees working for a single University, Department or Institute anywhere in the world.

Communication of Science

Dr Stride's extensive contributions to the communication of the science of acoustics to the public were also acknowledged, through her participation to BBC Radio 4 science programmes, television documentaries on BBC2 and BBC4, two YouTube videos which have been viewed about 13,000 times, and recent televised appearances to announce the Queen Elizabeth II Prize in Engineering on the BBC.

Dr Eleanor Stride with The Prince Philip, HRH the Duke of Edinburgh at the Royal Academy of Engineering headquarters, which in 2012 was named Prince Philip House. Prince Philip is Senior Fellow of the Royal Academy of Engineering.

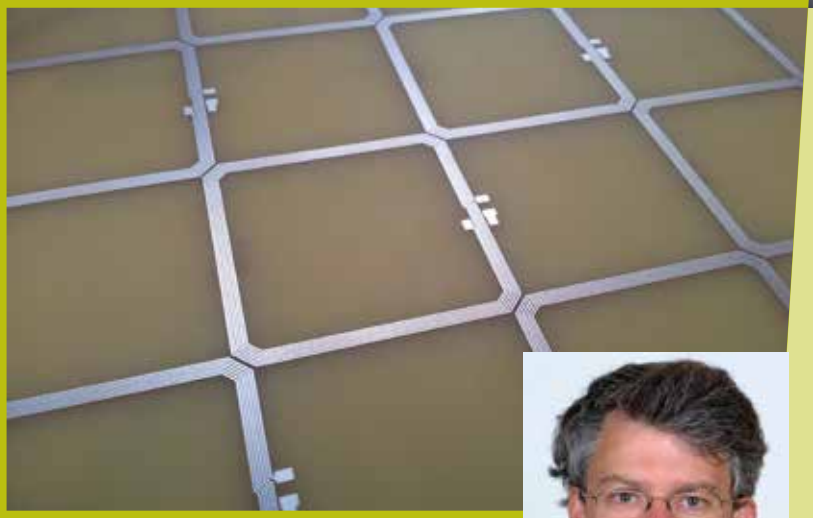
First 'Distinguished Lecturer'

In May 2013, the first Oxford IBME Distinguished Lecturer Seminar was delivered by Professor Mathias Fink, Professor of Physics, École Supérieure de Physique et de Chimie Industrielles (ESPCI) de la ville de Paris & Collège de France and Member of French Academy of Sciences. He is also the Founder and Director of the Laboratory Ondes et Acoustique at ESPCI that in 2009 became the Langevin Institute.

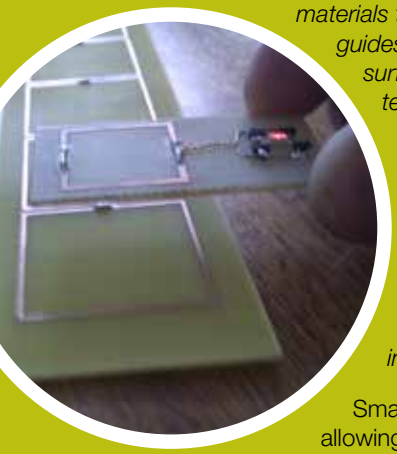
Professor Fink's lecture titled: *"Biomedical applications of ultrasonic time-reversal: from cancer detection to functional imaging,"* provided a fascinating insight into how his research on ultrasonic time-reversal methods applied to medicine and highlighted his commitment to making an impact in the real world of healthcare.

A cable-free lifestyle

Dr Chris Stevens and his research team from the Department have developed a new technology that allows devices such as mobile phones and cameras to both charge and transmit data without cables. Current applications target smaller, low power devices. However, employed on a larger scale, this technology might eliminate the need for power and data cables altogether. Isis Innovation Ltd, the University of Oxford's research commercialisation company, is working with Dr Chris Stevens to bring the technology to market.



Dr Stevens said: "*You could have a truly active, cable-free, battery-less desktop that can power and link your laptop or PC, monitor, keyboard, mouse, phone and camera. For example, by incorporating the technology behind the screen of a computer monitor, digital files, photos and music could be transferred effortlessly to and from a USB stick simply by tapping the flash drive against an on-screen icon".*



"This work comes from research into metamaterials - materials that act as magneto-inductive wave guides and magneto-inductive power surfaces. You can find simple inductive technology in the charging unit of an electric toothbrush, but in this case we can transfer data as well, and over a distance".

"The real beauty is that since the technology is in a patterned conductive layer, we can start adding that layer to any surface or indeed into a fabric".

Smart clothing will be a possibility, allowing for efficient body area networking, such as linking up headphones, mobiles, cameras and music devices through clothing. The team has already incorporated the cable-free technology into carpet to power a lamp. The living room of the future could have the stereo, TV, DVD and satellite box powered and linked through the carpet and wallpaper.

Devices can be completely encapsulated, making them waterproof and robust. This makes metamaterials attractive for service in the aerospace, military, automotive and medical sectors.

Technical Innovation Award

The Department's researchers and technicians in the Energy and Power Group and their partners at the Oxford Martin School won the Technical Innovation Award ahead of nearly 200 others in the 2013 Shell Eco-Marathon Europe competition. The innovations included an android app that maps the efficiency of the motor in real time for the driver, a reconfigurable photovoltaic array that allows optimisation of the solar energy use, and a clutch mechanism that allows regenerative braking and free-wheeling.

With batteries still struggling to pack the same power as petrol, one of the great challenges for electric vehicles is extending their range. The researchers have been pushing the boundaries of what such machines can do with their prototype electric vehicle PEGGIE.

The Oxford team was in the top ten of the main prototype electric vehicle endurance race, delivering a performance of 564 km/kWh, a 50% improvement on last year.

Pete Armstrong, Team Technical Manager, said: *"The Shell Eco-Marathon was a fantastic, if at times traumatic, experience. It was an honour to be awarded the technical innovation prize. We were very impressed by other vehicles that had developed a range of exciting ideas and techniques in areas such as real-time throttle control and 3D printed components that could be swapped out quickly".*

The Shell Eco-Marathon Europe competition is a showcase for ultra-energy-efficient vehicles built by student teams.

“I am an acoustician”

Engineering Science News Editor, Eva Williams (EW) interviews Professor Ron Roy (RR), the Department’s newly appointed Professor of Mechanical Engineering and Fellow of Harris Manchester College. Professor Roy joins the Department of Engineering Science (DES) from Boston University where he was Professor and Head of the Department of Mechanical Engineering …

EW: I understand that your year in Oxford as the 65th George Eastman Distinguished Visiting Professor ‘proved to be the most fulfilling and interesting of your career’ – please can you say why?

RR: At Balliol College, I was thrust into an environment where men and women from several disciplines interacted frequently, exchanging opinions and ideas on a variety of topics, most of which had nothing to do with engineering. It was a revelation for me, and I felt greatly enriched by the experience. The fact that the DES is a general engineering department devoid of disciplinary boundaries added to the multi-disciplinary atmosphere that pervaded the University.

EW: What excites you about working for the DES in Oxford?

RR: I am excited about the possibility of building a premiere research programme in physical acoustics fuelled by the efforts of some of the best students in the world. Students are the University’s greatest asset.

EW: Can you give examples of how your cross-disciplinary research experience will benefit the DES?

RR: I am an acoustician. Acoustics is inherently multi-disciplinary and engages both fundamental and applied work in areas ranging from the oceans to the human body to art and architecture. For example, my work in biomedical ultrasound resides at the intersection of physics, fluid mechanics, and biomedical engineering. An important aspect of this work is getting people from diverse backgrounds in the same room to address complex problems, share perspectives, and map out strategies.

Students who engage in cross-disciplinary activities are invariably trained to think outside the box. They learn to distinguish the forest from the trees and see potential where others see risk. By pursuing cross-disciplinary research and inviting open collaboration, I hope I can help students to see the technology challenges of tomorrow.

EW: What will be your strategy for the DES Mechanical Engineering discipline?

RR: : Before I can formulate a strategy, I need to identify the relevant faculty and learn about their current research activities as well as their interests and aspirations. It’s a question of educating students on the depth and breadth of modern mechanical engineering and getting the relevant faculty to buy into the notion of a mechanical engineering community within the Department.

EW: I believe that your research at the DES will focus on developing new energy technology – please can you elaborate and give examples?

RR: My research will initially focus on two areas: cavity implosion physics and biomedical ultrasonics. The implosion physics work relates to a very high-profile problem in energy generation technology – the use of nuclear fusion to generate usable power. One current technology employs symmetrically imploding cavities, driven by high-powered lasers, to create the densities and temperatures required to ignite a fusion reaction. Working with the spin-out company Oxyntix, we are exploring alternative ways of using cavity collapse to concentrate energy in space and time.

My work in biomedical ultrasound is largely rooted in my background in physical acoustics and acoustic cavitation, that is, the physics of how bubbles and cavities behave in acoustic fields. I have long standing collaborations with DES Professors Constantin Coussios and Robin Cleveland on the use of the physical effects of acoustic cavitation for promoting both biomedical imaging and therapy, and hope to take advantage of the excellent clinical access afforded by the Institute of Biomedical Engineering (IBME) to explore new ideas and approaches.

EW: How important do you think it is for academics to possess business acumen in today’s competitive global higher education environment?

RR: Creating a learning environment that incorporates elements of product development and manufacturing as well as some exposure to management techniques and entrepreneurship will help generate engineers better prepared to seamlessly enter the professional workforce.

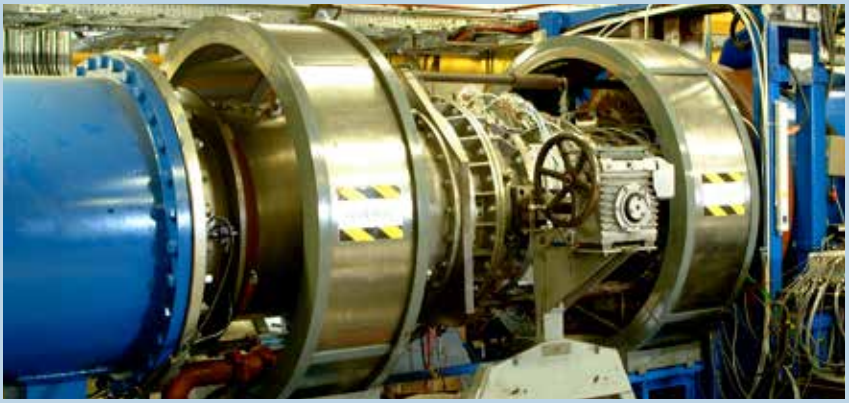
Academics who understand and appreciate the business aspects of the profession are more likely to generate students who follow suit. Moreover, many great ideas never make it out of the laboratory because they lack a champion that understands both the science and how to translate novel ideas into realisable products. The academic who understands business is often the best person to do this, and can be an enormous asset to a university looking to impact society in ways that go beyond educating students.

However, I am wary of a growing emphasis among many universities on research that is deemed applied or translational. Many of the most influential discoveries of the 20th century were the results of scholarship driven by curiosity. I seriously doubt if Einstein, Bohr, and others had lasers and transistors in mind when they laid the foundations for modern physics and quantum mechanics.

EW: What aspects of Oxford University’s undergraduate and postgraduate teaching programmes do you admire?

RR: I very much like the fact that the Oxford system makes a student accountable for his or her own learning. Oxford instructors appear to paint with a broad brush and leave it to the student to fill in the details. This results in a person who understands the virtues of self-education. It can impact how a person approaches all phases of life.

Helping to make the world's most efficient civil turbofan



Rolls-Royce jet engines are being used on the Airbus A350, which had its first flight in June 2013 in Toulouse. Rolls-Royce collaborated with the Department's Osney Thermo-Fluids Laboratory in the development of technology used in the Trent XWB engine. The results of research performed both in the University Technology Centre (UTC) in Heat Transfer in Aerodynamics and Heat Transfer and in the UTC in Solid Mechanics have helped make the Trent XWB the world's most efficient civil turbofan.

The Department's Osney Thermo-Fluids Laboratory houses some of the most sophisticated turbine and high speed flow facilities in the UK, and the research group includes internationally recognised experts in Computational Fluid Dynamics (CFD), flow and heat transfer experiments and instrumentation.

According to The Sunday Times, 'ministers have long seen the Rolls-Royce model as a template for harnessing world-class talent in British universities to boost growth'.

In 2013, Mr Colin Smith, Director of Engineering and Technology at Rolls-Royce plc, received an honorary degree at Encaenia, Oxford University's annual honorary degree ceremony. He was made Doctor of Science.

Mr Colin Smith, CBE, BSc, has served on the board of Rolls-Royce as Director of Engineering and Technology since 2005. During his career, he has held the lead engineering roles for three of Rolls-Royce's most important engine projects and has been responsible for the design of engines which now power thousands of aircraft.

In the role of Chief Design Engineer for the Trent 500 engine, Mr Smith led the design, development and certification of the engine which powers the Airbus A340-500/600 wide-bodied jet. He was also the Chief Engineer for the Trent 700 engine which powers the Airbus A330 and Chief Engineer for Rolls-Royce's latest helicopter engine, the RTM322.

As Director of Engineering and Technology, he oversees all of Rolls-Royce's engineering activities and has led the company into a diverse range of new markets – including Tidal Power, Nuclear Power and Marine Engineering.

He is a Fellow of the Royal Academy of Engineering, the Royal Aeronautical Society, and the Institution of Mechanical Engineers. In 2002, he won the prestigious Royal Academy of Engineering Silver Medal for his outstanding contribution to British engineering.

The annual Jenkin Lecture

The Airbus being tested on a flooded runway.

Named after the first Oxford Professor of Engineering Science, Charles Frewen Jenkin FRS (1908 – 1929), the Department's annual Jenkin Lecture was established as a result of the foundation of the Society of Oxford University Engineers (SOUE) in 1988.

The first Jenkin Lecture was given by Dr Alastair Howatson who joined the Department in 1963 and became one of Oxford's first group of tutorial fellows in engineering when he was elected by Balliol College in 1965.

The Jenkin Lecture, given by Frank Chapman (Experimental Test Pilot of Airbus) in 2012, on *"Flight-testing the A380 - from first flight to certification",* gave a superb insight into the work of the test pilot as well as the extent of the tests that modern airliners have to go through to achieve certification.

Frank Chapman highlighted: *"To date the A380 is the largest Airbus built. It can carry up to 850 passengers, and takes off at weights of up to 565 tonnes. The first flight, in 2005, had a fairly modest programme, but in practice had to be even more modest, when a warning light came on at 10,000 ft, indicating that an undercarriage door hadn't shut properly. But that was easily corrected, and hundreds more flights were made before the aircraft was certified as fit for airline use. Many of them had to be done in exotic locations to get the specified nasty conditions, e.g. in Iceland for high cross-winds for take-off and landing, the Canadian Arctic for very low temperatures and Abu Dhabi for very high ones".*

He said: *"One of the more spectacular tests was to bring the aircraft safely to rest after an aborted take-off, with no help from reversed engine thrust. Most of the kinetic energy has to be absorbed by the brakes and tyres of the landing gear, which get so hot that they catch fire. This is accepted, but the rest of the aircraft mustn't catch fire too. It didn't!"*

SOUE was formed to enable past members of the Department of Engineering Science to keep in touch both with engineering at Oxford, and with one another.

Physics of combustion

At present over 90% of the world's energy is derived from the combustion of chemical fuels, in engines for transport or in power stations for generating electricity. While this is, at present, a relatively inexpensive way of meeting our energy needs, the burning of fossil fuels by current methods comes at a cost to the environment and human health due to the emissions of greenhouse gases, noxious compounds such as nitrogen oxides and soot particles.

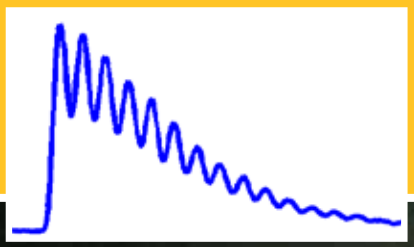
It is increasingly important to understand more about the complex physics and chemistry of combustion and to improve the efficiency of the process in order to maximise energy output whilst minimising emissions of harmful by-products. Owing to the global extent of combustion as a source of energy, an improvement in efficiency of only a few percent will have a major impact on our transport systems and environment.

Crucial factor of temperature

A crucial factor in combustion, affecting the efficiency of and emissions from engines, is the temperature of the fuel-air mixtures both before ignition and of the products afterwards. It has been found notoriously difficult to measure such temperatures since it must be done without affecting the engine operation. Optical methods are preferred since they are inherently non-invasive. Unfortunately the best current methods, that involve measuring the intensity of a light signal, usually have insufficient precision and accuracy since they are adversely affected by noise and fluctuations in background intensities.

The key to success

Research collaboration between Professor Richard Stone in Engineering Science and Professor Paul Ewart in Physics is overcoming the main difficulties using a new method derived from fundamental research in non-linear optics and laser spectroscopy. The key to the method's success is that it measures a frequency, rather than intensity, and so is much less affected by intensity noise.



A typical signal, lasting 0.2 microseconds, showing the oscillation in the intensity at the frequency determined by the sound speed and temperature.

A view into the engine through another window showing the fluorescence of the fuel from the pulsed laser beams.

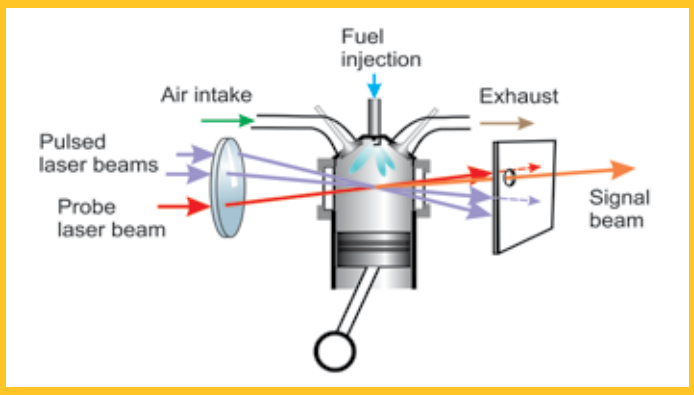


Diagram showing the two pulsed laser beams crossing inside the engine cylinder at the focus of a lens and the third laser beam that reflects off the generated 'grating' to produce the signal beam.

The technique uses the interference pattern created by pulses from two crossed laser beams. Absorption of light by gas molecules inside the engine leads to the sudden creation of a tiny hologram or grating. Simultaneously a sound wave is created that travels across the grating. A third laser beam is reflected off the hologram and the frequency of oscillations in the reflected beam's intensity, caused by the sound waves crossing the grating, is measured precisely. The measured frequency is used to find the speed of sound from which the temperature can be derived.

Fuel blends quantified for the first time

The precision achieved is more than ten times better than the previous best method. Using this technique, with the support of BP, the effect of "evaporative cooling" in direct injection spark ignition engines has been measured allowing subtle, but important, changes arising from different fuel blends to be quantified for the first time.

Dr John Williams, BP Research and Technology, said: *"Aggressive CO_2 targets are driving automotive manufacturers to develop ever more efficient engines. The concept of gasoline engine downsizing, where a large engine is replaced by a smaller one of equivalent performance, offers great potential improvements in efficiency and CO_2 output when tested over the legislative test-cycle. However, this will increase the propensity for abnormal combustion to occur when the engine operates at higher load conditions. Our collaboration with Oxford University will help us better understand the temperature conditions within the combustion chamber so that we can design fuels and lubricants to allow our customers (i.e. manufacturers and drivers) to take full advantage of these efficient new engines".*

The perfect knowledge platform

Omar Islam MEng Oxon AMIMechE (Pembroke College, 2011)
Chassis Graduate Engineer, Jaguar Land Rover

My fascination in the way things work is what led me to study engineering; the art of science. It was never enough for me just to accept a process without knowing its ins and outs.

My Oxford degree offered me the perfect knowledge platform for initiating my career with Jaguar Land Rover. Although the course offered starts off as a general one, I later opted to specialise in civil and mechanical engineering subjects. My 3rd year design project of a mechanical KERS (Kinetic Energy Recovery System) for Formula 1 is what grew my interest in cars.

Working in the automotive sector, I have found that real life problems require an understanding of all engineering disciplines; one day I may be analysing component stresses and load paths, and the next day I may be wiring up instrumentation on a prototype vehicle prior to testing. Everyday can offer a new challenge. The Engineering Science course taught me the latest technologies and industry techniques. It is this theory and skill which I put in to practice every day as a product development engineer.

What I believe is alive in every engineer is the thirst to see our logic materialise into a creation that improves our existence. With Jaguar Land Rover I am able to exercise this in whatever role I undertake.

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.

bp

Student Achievements

NCE Award

Andrew Mather (Keble College), who graduated with a first class honours degree from the Department of Engineering Science, was one of the finalists for the New Civil Engineer (NCE) Graduate of the Year.

Andrew Mather receiving his award from Antony Oliver, Editor of the NCE (pictured left) and Chris Hollins, BBC television presenter (right).

The NCE magazine's Awards recognise the best and brightest graduates that demonstrate strong academic and practical achievements in their career combined with putting into practice what they learned at University.

Andrew was one of six finalists selected from a record 115 worldwide entries. Each finalist faced gruelling interviews from a panel of 17 senior directors from the Awards' sponsoring companies and gave a 30 minute presentation on their academic and engineering capabilities to the judging panel.

Andrew said: *"Engineering has always been a passion of mine and studying all the numerous disciplines and seeing the interconnection whilst at Oxford was fantastic"*.

RAE Award

Undergraduate, Neil Alliston (Worcester College), received one of this year's Royal Academy of Engineering (RAE) "Engineering Leadership Advanced Awards".

Neil Alliston

RAE "Engineering Leadership Advanced Awards" provide support and motivation to some of the most exceptional engineering undergraduates in UK universities. They are highly prestigious and the Academy awards no more than 40 in any one year. These Awards 'help those who want to become leadership role models for the next generation of engineers to undertake an accelerated personal development programme'.

Salter's Institute Award

David Adler (Oriel College) won the Salters' Graduate Prize in Chemical Engineering.

David Adler (centre) is seen here with Professor Sir John Holman, Master of the Salters' Company and on the right is HRH Princess Sumaya bint El Hassan, President of the Royal Scientific Society of Jordan.

The Salters' Institute offers up to ten prizes to final-year undergraduates studying at UK universities. Candidates are expected to obtain a First Class Honours Degree in either Chemistry or Chemical Engineering.

David said: *"I chose the Chemical Engineering route during my undergraduate studies as I always enjoyed Chemistry at school and its application"*.

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

The Society of Oxford University Engineers (SOUE) invites past members of the Department of Engineering Science to keep in touch both with engineering at Oxford, and with one another. Membership is open to all graduates of the Department (including those with postgraduate degrees); undergraduates can join as associate members, becoming life members on graduation. The Society has one main meeting per year, generally in September, which combines the Annual General Meeting with the Jenkin Lecture, usually given by a member of the Society. To find out more please visit: http://www.soue.org.uk

The Oxford University Engineering Society (OUEngSoc) 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

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