Newsletter

Issue 7 | Winter 2008

UNIVERSITY OF CAMBRIDGE
Department of Engineering

Executive Introduction

The Department is an integral part of the University's 800th anniversary campaign, striving to retain the brightest academics and students in pursuit of intellectual excellence. You can read about some of our successes on page 21.

In spite of these successes and the world-ranking of the University, we are conscious that we cannot continue to maintain this position without a substantial increase in funding.

Keeping in line with the Department's mission to address the world's most pressing challenges with science and technology, we are forging ahead with an exciting fundraising campaign. We recognise that it is harder to give in these difficult economic times but it is at such times that we depend even more on philanthropy and that the gifts we receive have an even greater impact. There are three main thrusts:

Engineering Foundations to create teaching and research facilities worthy of one of the best engineering departments in the world. The main project is to create a vibrant central hub where the courtyard currently stands on the Trumpington Street site. Students, staff and industrial visitors will be able to work and socialise together in dramatic new space and extra research and teaching areas will be added. The design will meet high standards of energy efficiency with a combined heat and power centre at its heart. We are actively seeking major gifts to further this transformational project.

Engineering Frontiers to create new posts that secure the Department's prospects and push the boundaries of engineering. For example, we are offering a naming opportunity for our top priority, the Professorship of Engineering for Sustainable Development. The demand for academic work in this area from students, industry and government is high.

Engineering Futures to nurture the next generation of engineering leaders from school to the start of their careers. We will create a general fund to support a wide variety of projects from outreach to primary schools through to fast-track funding for securing the world's best PhD students. The fund will gather together many donations from our alumni and other supporters around the world. Every contribution, no matter how small, will greatly help young engineers.

If you are interested in getting involved, then please contact either Philip Guildford, pg28@eng.cam.ac.uk or Ms Liffy Gorton, eag26@foundation.cam.ac.uk

Thanks to the support of many of our engineering alumni, Arnaud Bizard has been awarded the first Ashby Scholarship. He has started his PhD in the mechanics of powder processing, with direct application to sugar refining. The idea is to develop a theoretical model for the operation of a continuous conical centrifuge: wet paste enters the machine and moves up its perforated walls, thereby separating the liquid from the powder. By understanding the underlying principles, it is hoped that this class of machine will find widespread application beyond the sugar industry.

The Ashby Scholarship is vital to our work in the Mechanics and Materials Division at the Department of Engineering. We are very grateful to everyone who has given us financial support.

In this issue

An integrated engineering department founded on core strengths spanning all engineering disciplines and also cross-connected by three strategic themes:
- Cognitive Systems Engineering
- Engineering for Life Sciences
- Sustainable Development.

www.eng.cam.ac.uk

Alumni event: Cities of the future

On a beautiful sunny Sunday morning in September it was fabulous to see over 100 alumni turn up to our showcase of research on the theme of "Cities of the Future".

Age was certainly no barrier to enthusiasm, as many of our older alumni crowded round the poster displays, engaged in lively conversation with our PhD students and staff alike, always with an opinion or two!

Professor Roberto Cipolla and Dr Bjorn Stenger drew a constant crowd to see their experimental TV where the visitors were able to interact with the display system simply by gesturing with their hand while others were intrigued by Cambridge University Eco Racing (CUER) team's amazing solar powered car parked in the courtyard. From Tsunami resistant housing to aero-engine combustion research there was something to educate and interest everyone and to make sure everyone behaved themselves, a rather cheeky Dalek, courtesy of Adam Strawson, was on patrol. This year's Sunday showcase turned out to be the most popular yet.

Many thanks to Jane Hunter for organising the event and to all those who participated.

Jane Hunter event organiser (left)

Professor Austyn Mair, CBE: 1917 – 2008

Professor Austyn Mair, CBE, the former Head of the Department of Engineering, University of Cambridge who carried out pioneering work on supersonic aircraft designs, has died aged 90.

Professor Mair was Professor of Aeronautical Engineering at Cambridge and headed the Department for a full decade, overseeing the introduction of new professorships, changes to undergraduate teaching and the modernisation of facilities. Earlier in his career he had contributed to the design of the RAF's first jet aircraft.

William Austyn Mair was born in 1917 and educated at Highgate School, London, and Clare College, Cambridge, where he took a first with distinction in the mechanical sciences tripos.

He took a job at the aero-engine department of Rolls-Royce in Derby but when World War II broke out and he was commissioned by the RAF and sent to the Royal Aircraft Establishment (RAE) at Farnborough. He spent the rest of the war designing and commissioning wind tunnels and testing and investigating the performance of fighter planes.

Professor Mair was particularly interested in the problems of aerodynamics at speeds approaching the speed of sound. At the time the behaviour of aircraft flying near and above that speed was not well understood. His work in this field contributed to an improved design for the Gloster Meteor – the RAF's first operational jet aircraft.

At the end of the war he was sent to Germany to discover what developments had been made there in aircraft and rocket technology. A year later he was decommissioned and continued his experimental work in the academic sphere. He became director of the new Fluid Motion Laboratory at the University of Manchester, researching aspects of supersonic flow, before returning to Cambridge in 1952 as Professor of Aeronautical Engineering, aged just 35.

At the time Cambridge's aeronautics laboratory comprised three small, low-speed wind tunnels in a small wooden hut. Professor Mair designed and built a supersonic wind tunnel and a larger, low-speed wind tunnel, which was up and running by 1960. In 1961 he moved into research for Hovercraft Development Limited, examining problems caused by wind forces on both hovercraft and trains.

He became Head of Department in 1973 during the economic recession. Such was his success in guiding the Department through this difficult period that a second five-year tenure followed in 1978. This allowed Professor Mair to oversee numerous improvements to laboratory facilities, the appointment of a number of new professors of engineering and the introduction of a new four-year course for the Production Engineering Tripos, later known as the Manufacturing Engineering Tripos.

In 1975 he was awarded the Royal Aeronautical Society's Silver Medal. He also served on the Aeronautical Research Council and was on the editorial board of the Aeronautical Quarterly, which he chaired. He was appointed CBE in 1969, elected to the Fellowship of Engineering (later the Royal Academy of Engineering) in 1984 and awarded an honorary DSc by the Cranfield Institute of Technology in 1990. He was a fellow of Downing College from 1953 and was elected an honorary fellow 30 years later. In retirement he worked as an engineering consultant, and published a book; Aircraft Performance (with D L Birdsall).

Professor Austyn Mair

He is survived by his wife Mary, whom he married in 1944, and by their two sons. One of his sons, Professor Robert Mair, is Professor of Engineering at Cambridge and Master of Jesus College.

Cambridge and Nokia introduce new stretchable and flexible mobile phone concept

The concept for a new stretchable and flexible mobile phone developed by the University of Cambridge and the Nokia Research Center (NRC) was unveiled earlier this year.

Morph, the joint nanotechnology concept, was launched earlier this year alongside the new Design and the Elastic Mind exhibition at The Museum of Modern Art (MoMA) in New York City in which it was profiled.

Morph is a concept that demonstrates how future mobile devices might be stretchable and flexible, allowing users to transform their mobile devices into radically different shapes. It demonstrates the ultimate functionality that nanotechnology might be capable of delivering: flexible materials, transparent electronics and self-cleaning surfaces.

Professor Mark Welland, Head of the Department of Engineering's Nanoscience Group at the University of Cambridge and University Director of Nokia-Cambridge collaboration, commented: "Developing the Morph concept with Nokia has provided us with a focus that is both artistically inspirational but, more importantly, sets the technology agenda for our joint nanoscience research that will stimulate our future work together."

Dr. Tapani Ryhanen, Head of the NRC Cambridge UK laboratory, Nokia, added: "We hope that this combination of art and science will showcase the potential of nanoscience to a wider audience. The techniques we are developing might one day mean new possibilities in terms of the design and function of mobile devices. The research we are carrying out is fundamental to this as we seek a safe and controlled way to develop and use new materials."

The partnership between the University of Cambridge and Nokia was announced in March, 2007 – an agreement to work together on an extensive and long term programme of joint research projects. NRC has established a research facility at the University's West Cambridge site and collaborates with several departments – initially Engineering's Nanoscience Centre and the Electrical Division – on projects that, to begin with, are centered on nanotechnology.

The Nanoscience Centre provides open access to over 300 researchers from a variety of University Departments to the nanofabrication and characterisation facilities housed in a combination of Clean Rooms and low noise laboratories. Research is aimed especially at multidisciplinary projects where engineering, biology, physics, chemistry and materials science meet.

The Electrical Engineering Division of the Department of Engineering builds on Cambridge's history of world-leading research in Photonics and Electronics by significantly enhancing collaboration with industry and by providing a focus for multidisciplinary research involving over 200 engineers, as well as chemists, physicists, materials scientists and bioscientists. It includes the 'Centre for Advanced Photonics and Electronics' (CAPE) and the 'Cambridge Integrated Knowledge Centre for Advanced Manufacturing Technologies for Photonics and Electronics'.

A video on this new technology is available to watch on the Nokia website: www.nokia.com/A4879144

More information on The Department's Nanoscience Centre can be found at: www.nanoscience.cam.ac.uk/

Morph Wrist Mode

Morph Phone Mode

The Electrical Engineering Division of the Department of Engineering builds on Cambridge's history of world-leading research in Photonics and Electronics

Professor Dame Ann Dowling elected foreign associate of US National Academy of Engineering

Professor Dame Ann Dowling

The Department's Professor Dame Ann Dowling has been elected a foreign associate of the US National Academy of Engineering.

Election to the National Academy of Engineering is amongst the highest professional distinctions accorded to an engineer. Academy membership honours those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education." There are 194 foreign associates.

Ann has been elected for advances in acoustics and unsteady flow, and for leadership in collaborative research between industry and universities.

Cambridge University groups join forces to help budding entrepreneurs

Sixteen Cambridge University groups involved in the support of enterprise and innovation are working together to improve support for would-be entrepreneurs.

The new initiative – known as the Cambridge University Enterprise Network (CUEN) – aims to increase the flow of information between the growing number of organisations supporting enterprise and innovation in the university. CUEN recently held a meeting at which 30 representatives from 16 organisations came together to learn about each other's activities and spot opportunities for collaboration.

The groups involved include those organising student business plan competitions, or providing direct support for inventors trying to bring a product idea to market. Other groups are offering courses in entrepreneurship or providing advice to high-tech start-up companies.

CUEN plans to:

- organise regular update events
- provide a website to share resources and plan joint projects
- publicise information about the wide range of enterprise and innovation activities via a jointly developed wiki. A wiki is a collection of web pages designed to enable anyone who accesses it to contribute or modify content, using a simplified markup language. Wikis are often used to create collaborative websites and to power community websites.

The launch of CUEN has been coordinated by the Technology Enterprise Group (TEG) – part of the Department's Institute for Manufacturing's Centre for Technology Management (CTM). TEG organised an event in partnership with the Centre for Entrepreneurial Learning and Cambridge Enterprise. Initial support has been provided by St John's Innovation Centre and the Gatsby Charitable Foundation.

CTM's Tim Minshall said "There is now a diverse and increasing range of entrepreneurship support activities across the University and throughout the region. Helping forge links between these activities will enable groups to spot opportunities for collaboration, avoid duplication of effort and communicate a clear message to actual and would-be entrepreneurs about these activities."

FACT BOX

Cambridge Engineers won the international 'Next Generation Entrepreneur Forum' with their Touch Sight Vision Mitt, and are set to improve the lives of millions of people with sight deficiencies.

Life Sciences Week

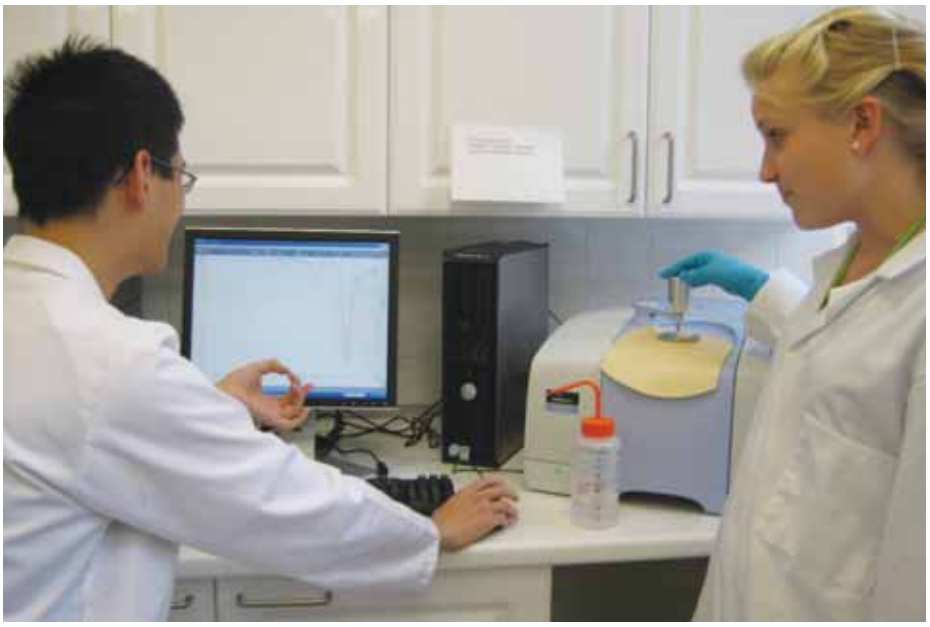
The Mechanics, Materials and Design Division's new bioengineering research laboratory opened in March, and was celebrated during "Engineering for Life Sciences Week" which included a reception with laboratory tours and two guest seminar speakers.

Michelle Oyen spearheaded the Engineering for Life Sciences Week.

Engineering for the Life Sciences is a major initiative in the Department and key to the Department's strategy which seeks to address major global challenges. There is a growing need for a more integrated approach to the understanding of biological systems, providing many opportunities for the application of engineering to clinical and life sciences. Engineering for the Life Sciences is a rapidly growing field encompassing the use of engineering tools to solve problems in medicine and biology as well as new quantitative approaches to biological systems based on engineering principles.

The new laboratory is a three-room suite, and is a biological containment facility (Biosafety Level 2) equipped for cell and tissue culture. Additional facilities in the laboratory include an Instron for small-scale mechanical testing, including an integrated water bath for keeping biological samples hydrated, as well as new equipment for infrared spectroscopy and microscopy.

Current activities in the laboratory include a number of independent projects directed at biologically-relevant materials synthesis and characterisation, such as bone-like biomimetic composite materials and of protein- and sugar-based hydrogels. Other projects consider tissue biomechanics, how healthy and diseased tissues respond to mechanical loading, including both experimental characterisation of tissue mechanical behaviour and computational modelling of physiological functions. A growing effort concerns fluid-structure interactions in the cardiovascular system, both in adults and in placental development. The scope of current bioengineering research projects includes both seeking basic science understanding and clinical application, including diagnostic and tissue engineering applications. Researchers in the Division have collaborative projects ongoing with the Department of Physiology as well as several different groups within the clinical school, including (but not limited to) Urology, Obstetrics, Clinical Pharmacology and Radiology.



The Engineering for the Life Sciences new laboratory

Cambridge academic appointed new Chief Scientific Adviser for the Ministry of Defence

The Prime Minister named Professor Mark Welland FRS FREng as the new Chief Scientific Adviser at the Ministry of Defence.

Professor Welland, Head of the Nanoscience Group at the Nanoscience Centre and Professor of Nanotechnology at the Department of Engineering, took up his new appointment as Chief Scientific Adviser on Monday 7 April. He will continue his innovative research at the University, splitting his time between Cambridge and London.

He succeeds Professor Sir Roy Anderson, who has left to rejoin Imperial College, pending his appointment as Rector this summer.

Secretary of State for Defence, Mr Des Browne said: "I am delighted to welcome Mark Welland as our new Chief Scientific Adviser. His extensive experience and his wide ranging scientific interest, together with his strong links to academia will prove invaluable to his successful tenure in this role.

"I would also like to pay tribute to Professor Sir Roy Anderson FRS whose work as Chief Scientific Adviser has significantly improved the way the MOD's research programme is developed and managed."

Vice-Chancellor Professor Alison Richard said: "This is a wonderful opportunity for Mark and we are delighted that he has been recognised with such a prestigious position. He has made, and continues to make, significant contributions to the advancement of nanoscience; and he will be a huge asset as the Ministry of Defence attempts to tackle complex scientific issues."

Professor Welland said: "I am delighted to have been offered the opportunity to lead Science and Technology within the Ministry of Defence. As CSA I look forward to working with professional and dedicated staff from both the Armed Forces and Civil Service to ensure science contributes fully in supporting the role of the Armed Services."

Dr Andrea Ferrari receives the Brian Mercer Award for Innovation in Nanotechnology from The Royal Society, a Marie Curie Award and a European Research Council grant

Dr Andrea Ferrari and his team at the Department have received three prestigious awards this year.

Andrea and his team have received the Brian Mercer Award for Innovation in Nanotechnology from The Royal Society. The team's work in nanotube-based polymer optoelectronics will seek to combine polymers and carbon nanotubes. This will have the benefit of reduced cost and greater flexibility of use over conventional inorganic semiconductors. The work is expected to have practical applications in optical communications, bio-medical instruments, chemical analysis, time resolved spectroscopy, electro-optical sampling, microscopy and surgery.

The £250,000 Prize was presented at the annual Royal Society 'From labs to riches' event. The awards are given to encourage innovation in science and technology and promote its commercial application.

Andrea said "Nanotechnology is one of the most exciting areas in modern science. The potential of substances such as carbon nanotubes is massive. The UK has to ensure that it invests in the technology now so that we are not left behind. The ability to manipulate the structure and composition at the nano-scale opens huge opportunities to create materials with superior performance for new products and devices. The introduction of a wide range of new low-cost materials, encompassing polymers and nanostructures, including nanotubes and nanowires, is set to have a disruptive impact on current products which use conventional inorganic semiconductors, not only because of cost/performance advantages, but also because they can be manufactured in more flexible ways, suitable for a growing range of applications."

Sir Peter Williams, Vice-President of the Royal Society said; "Science may well hold the key to solving many of the challenges the world is facing but that will not happen if we do not invest in people and ideas. With the Brian Mercer Awards we are backing up our words with actions."

Andrea has also been awarded the Marie Curie Excellence Award for his research on carbon nanotechnology. During his Marie Curie-sponsored PhD here at the Department, he worked on ultra-thin carbon films, a critical part of the hard drive technology, at the heart of many consumer electronics. This was just the start of a successful career for the young researcher that combines fundamental multi-disciplinary science with a keen eye for application and innovation.

Dr Andrea Ferrari (left) EU commissioner Janez Potocnik and the Slovenian Ministry of Higher Education, Science and Technology, Mojca Kucler Dolinar who presented the awards

For the first time, the EU's three most prestigious science awards have been presented together – the Science Communication Prizes, Marie Curie Excellence Awards and the Descartes Research Prizes. Describing the winners as "the best Europe has to offer", science and research commissioner Janez Potocnik said the awards honoured excellence, openness and creativity.

Established in 2003, the Marie Curie Excellence Awards recognise outstanding achievements by scientists that have reached a level of exceptional excellence in their field. Researchers of any nationality and in all fields of research are eligible provided they have benefited from one of the EU-funded researcher career support schemes. These Marie Curie Actions aim to widen researchers' prospects and promote excellence in EU research. Five winners, who each receive a EUR 50,000 prize, come from four different countries.

The third award for Andrea this year is a prestigious grant from the European Research Council (ERC) to develop a new class of polymer-based optoelectronic devices.

The ERC encourages researchers to take risks in their research and go beyond established frontiers of knowledge and the boundaries of disciplines. The Starting Independent Research Grant scheme targets promising researchers in Europe who have the proven potential of becoming independent research leaders. It provides them with between EUR500K and EUR2M over five years to study at an institution of their choice. From over 9000 applications for a Starting Independent Research Grant only 220 were successful; a proposal success rate of just three per cent.

Andrea's award of EUR1.8M will enable him to further his research into novel materials at the nano-scale level. Andrea explains, "Fundamental science plays a crucial role in underpinning and generating future technologies. The ability to manipulate the structure and composition at the nano-scale opens new horizons and huge opportunities to create novel materials with superior performance. The introduction of a wide range of new low-cost materials, encompassing polymers, advanced liquid crystals, and nanostructures, including carbon nanotubes (CNTs) and nanowires (NWs), will have disruptive impact on a variety of devices based on conventional inorganic semiconductors, not only because of cost/performance advantages, but also because they can be manufactured in more flexible ways, suitable for a growing range of applications."

The aim of Andrea's research is to develop a new class of polymer-based optoelectronic devices embedding the optical and electronic functionalities of CNTs. These devices will combine the fabrication advantages of polymer photonics, with the tunable active and passive optical properties of CNTs. Such devices are expected to find a wide range of applications not only in optical communications but also in bio-medical instruments, chemical analysis, time-resolved spectroscopy, electro-optical sampling, microscopy and surgery.

This is an ambitious frontier research programme, with a strong interdisciplinary nature, across engineering, physical, chemical and soft matter sciences. Basic physics and chemistry research will be stimulated by the challenges of practical implementation in devices; new directions for applications will be suggested by basic science results.

The ERC grant will also consolidate his newly established research group "Nanomaterials and Spectroscopy" at the Centre for Advanced Photonics and Electronics (CAPE).

For further information please contact Dr Ferrari: acf26@cam.ac.uk or visit the websites of the Electronic Devices & Materials Group (EDM Group) www-g.eng.cam.ac.uk/edm/index.html and the Nanomaterials and Spectroscopy Group (NMS Group) www-g.eng.cam.ac.uk/nms/

New home for the Department's Institute for Manufacturing

Work is underway on a new, £15 million home for the Department's Institute for Manufacturing (IfM).

The building, designed by world-famous architects Arup Associates, will create an international centre for industrial innovation, reflecting the IfM's integrated approach to global industrial issues.

A generous donation from leading British industrialist Dr Alan Reece provided the funds needed to complete the project and the building will be named in his honour. Dr Reece officially launched the construction phase at a start-on-site ceremony on Tuesday 26 February.

Professor Mike Gregory, Head of the IfM, said: "We are extremely grateful to Dr Reece for his great generosity which has enabled us to build a state of the art home for our work."

The new building will accommodate students, staff and industrial partners at the heart of the University's growing science and technology campus at West Cambridge. It will provide a forum in which global industrial issues can be pursued in a multi-disciplinary and practical way involving industrialists and policy makers as well as academics.

The design of the building reflects the IfM's established cross-disciplinary approach, with large communal areas, shared study rooms, open plan work areas for students and researchers and world-class meeting and communication facilities. The IfM was established in 1998 with the aim of linking education, research and practice and engineering, management and economics with a strong industrial orientation.

New facilities for the IfM's technical research groups will include workshops for the design of new commercial products and laboratories for research into new applications of laser, radio-identification, and inkjet technologies.

Dr Reece has contributed £5 million towards funding the building, which will be named the Alan Reece Building in his honour.

Dr Reece left his readership in Agricultural Engineering at the University of Newcastle upon Tyne in the 1980s to focus on invention.

His innovative designs included a highly efficient undersea plough, which greatly reduced the cost of installing the cables and pipelines vital for the telecoms and oil industries, amongst others, beyond the reach of trawler dragnets.

Since then, his companies have brought over £400 million of business to Tyneside, employing several hundred people.

Dr Alan Reece (left) and Professor Mike Gregory

He has made substantial charitable donations to numerous educational and community projects in the Tyneside region. One of his companies, Pearson Engineering Ltd has also supported humanitarian organisations who work to remove land mines in former war zones.

More recently, they were awarded the world's first contract for a mining machine designed to operate in extremely deep water.

Dr Reece is still passionately concerned with engineering and manufacturing. In 2006 he published a paper arguing that the decline in manufacturing in the UK has led to a decline in the demand for highly-paid technologists, which is in turn partially responsible for current problems in the teaching of maths and the sciences.

Funding for the £15 million building has also come from the Gatsby Charitable Foundation and the Government's Scientific Research Infrastructure Fund.

The Alan Reece Building's location on the West Cambridge site will help foster links with other researchers in the University. These include the Computer Laboratory, the Nanoscience Centre and the Centre for the Physics of Medicine.

Several research groups from the Department of Engineering, of which the IfM is a part, are also based nearby, including the Whittle Laboratory for research in turbomachinery the Schofield Geotechnical Centre and the Electrical Engineering Division.

More information about the building, plans, maps and photographs please visit: www.ifm.eng.cam.ac.uk/westsite/

Honorary Degree for Professor Jacques Heyman

Professor Jacques Heyman, formerly Head of the Department and a leading figure in church architecture and restoration was awarded a degree Honoris Causa by the Universidad Politécnica de Madrid on 28th January 2008.

Professor Jacques Heyman

The degree was proposed by the Spanish University's School of Architecture in recognition of Professor Heyman's work in the engineering analysis of masonry structures.

Professor Heyman read engineering at Cambridge and in 1946 joined a Cambridge-based research team working on the plastic (i.e. inelastic) design of steel buildings. The work led to a PhD, and he then spent a post-doctoral year at Brown University. He returned to Cambridge as a University lecturer and Fellow of Peterhouse.

Professor Heyman made a name for himself by applying the plastic principles of steel structures to the analysis of masonry buildings. This introduction of modern techniques into older masonry buildings made him the world's leading expert in cathedral and church engineering. In 1971 Professor Heyman was responsible for the restoration of Ely Cathedral's Great West Tower.

After his retirement Professor Heyman became a consultant and is still concerned with cathedral and church restoration projects. He gave courses of lectures at Florence University and has also served as a member of the Architectural Advisory Panel for Westminster Abbey, as well as the Cathedrals Fabric Commission for England. The Archbishop of Canterbury recognized his work by the award of the Cross of St. Augustine in 2005.

He arrived in Cambridge in 1941, at the age of 16, with the intention of studying mathematics, but the following year he changed to engineering

The oration by Professor Aroca at the award ceremony in the Spanish capital spoke of his major contribution in recognising the applicability of plasticity theory to masonry structures:

Full oration by Professor Aroca (Translation by Alejandra Albuerne)

"It is a great honour for me to address you on behalf of the Polytechnic University of Madrid in this ceremony to honour Professor Jacques Heyman by conferring a Doctor Honoris Causa Degree on him, following the proposal of the School of Architecture.

"To understand the crucial role Professor Heyman has played in understanding the structural behaviour of buildings we should go back in time.

"Until the 19th Century Construction was an empiric art based on geometrical rules; its structural side started to appear in the scientific field in 1638 with the publishing by Galileo of his "Dialogue about two new sciences". (Galileo had some problems with the Church, who had serious, and mistaken, opinions about the mechanics of celestial bodies, but fortunately didn't have an opinion on the mechanics of solid bodies).

"In the western tradition, there is an underlying certainty, as a Greco-Judaic legacy, that the world is ruled by simple laws that are waiting to be discovered (now we would say all the laws are only mental constructions that enable us to approximate or describe natural phenomena). The work started by Galileo, which discredits the rules of proportion and establishes the basis for the modern understanding of structures, is continued by other philosophers (in the 17th century, the scission of the natural philosophers, later scientists, hadn't taken place yet, giving up metaphysics to future self-named "philosophers").

"The 18th century and most of the 19th century witnessed the development and nearly the end of the science of structures; towards the end of the 19th century, the laws and concepts of the elastic theory of structures are expressed extremely clearly, only some technical aspects were still pending on the mathematical resolution of differential equation systems, equations that were not solved until the second half of last century. Some of us present here today had the privilege of witnessing the spectacular development of numerical analysis, having far exceeded the point from which the designer was able to ignore annoying calculations, it has reached the extreme of making them believe that it is not even necessary to dominate the concepts, but despite its impact, this has been only a technical development on the scientific base established in the 19th century.

"Without wishing to show any disrespect for the fantastic technical progress in analysis: In my opinion, there has been only one essential contribution to the science of structures in the 20th century.

"From the later years of the 19th century, steel structures were being built but nobody thought it necessary to verify if their behaviour corresponded to the theoretical predictions.

"Between 1931 and 1936, as part of the work editing a design code for the elastic analysis of steel frames and under the auspices of Baker, a series of measurements of real structures were made. The results of these showed a serious disagreement between the perfect theoretic model, which was the basis of the science of structures, and reality. This was directly related to the initial state and the boundary conditions.

The easiest way to illustrate the problem is:

- When someone sits on a three legged stool, it is possible to calculate the ground reaction on each of the legs.
- For a four legged stool, it is impossible; the geometrical perfection of the stool, the ground topography and even the cleanness of the stool (data impossible to introduce in the model) have a decisive effect on the result.

"Real structures are stools with many legs, imperfectly constructed and resting on a ground that defies any precise/exact definition.

"In 1936 it was evident for Baker that a new approach in the analysis of structures was necessary. Predictions in a closer agreement with the actual results, which were considerably less random than the elastic measurements, could be obtained if the possible deformations/strains in the plastic range of steel were considered. The Second World War interrupted the work. However, by 1948 Baker had a calculation method but it still lacked a solid conceptual base. The contribution of Prager, at the time with the American University of Brown, was decisive to the progress of developing it. The theorems of the "ultimate load" are the latest theoretical contribution to the science of structures.

"The collapse load of a structure has a specific value, equal to or larger than that obtained from equilibrium equations, and equal to or smaller than the value obtained from a possible mode/mechanism of plastic displacements/movements.

"Limit analysis, whose practical application preceded the rigorous enunciation of the theorems, allows us to obviate the issues of the the initial state and the boundary conditions. Heyman was there at the time this crucial contribution was formulated. He arrived in Cambridge in 1941, at the age of 16, with the intention of studying mathematics, but the following year he changed to engineering and graduated in 1944, when the world was still at war and was demobilised in 1946. He returned to Cambridge and joined Baker's team as a research assistant, gaining his doctorate in 1949. Except for a very short period of time spent at Oxford, he developed his academic career, which reached its peak as head of the Engineering Department, back at Cambridge.

"While working in Baker's team he collaborated in the development of the mathematical basis of plastic theory. It is not in his nature to claim merits, but he cannot conceal that he was able to understand and publish in 1966, in his fundamental work "The Stone Skeleton", that an approach to the analysis developed for steel structures was perfectly applicable to masonry structures. Hence he had proved the general applicability of the theory, beyond the material, endowed traditional systems of verification with a solid theoretical base and established a rational process of analysis that he has applied to several extraordinarily important buildings.

"Quoting him, not literally: In 1638 Galileo breaks away from geometrical rules and opens the way allowing us to check structures based on strength and stiffness; fabric structures are much more rigid/stiff than strictly necessary, so it is not necessary to check either of those aspects; the analysis should be based on equilibrium, which finally leads to a correct understanding of its geometry in order to verify its safety through the consideration of limit states.

"At this point, I can't avoid telling a story that happened some 25 years ago: Saez de Oiza was in charge of maintaining and restoring the Cathedral of Leon and he came up to me amazed: "I have had a finite element analysis of the cathedral done and the cathedral stands because the top, straight, layer of the flying buttresses is made of granite, which has a higher elastic modulus than sandstone." I tried without success to convince him that, without even taking into account other problems, at that moment in time it was not yet possible to solve equation systems, other than plane ones. Therefore, for a gothic structure, not even a reasonable geometric modelling could be done.

His technical and scientific contributions are full of clarity and common sense with the intention of finding and explaining the essential questions/issues and putting them forward in the simplest possible manner

"Some days later, very worried, he told me, "after all, it is not granite but sandstone painted grey". I replied: "then it will collapse and at last you will have the certainty of going down in history as the person responsible for the collapse of the Cathedral of Leon". To my surprise the following day, while the cathedral was still standing, he resigned from the job.

"Professor Heyman is the author of a large number of important books and articles; he has worked and works as a consultant on masonry structures; he was until his retirement, Head of the Engineering Department of Cambridge University, where he succeeded Baker in the post, although the formal succession was delayed for a few years, and at the age of 82 he enjoys an extraordinary physical and mental health; it is hard to believe that he was already actively collaborating on a fundamental advance in the theory of structures, when the majority of you here today weren't born and some of us, who are no longer young, were only children.

"His technical and scientific contributions are full of clarity and common sense with the intention of finding and explaining the essential questions/issues and putting them forward in the simplest possible manner. Like him, some of us still believe that complex set ups based on calculation subtleties are capable only of offering an unreal accuracy, given that it is not possible to work from hypothesis with suitable reliability, and therefore cannot be useful unless the behaviour of the structure is also understood.

"It is a great honour, for the Polytechnic University of Madrid, that Professor Heyman joins our Doctors Honoris Causa."

FACT BOX

The University has a 98% retention rate for students, the lowest drop-out rate in the country.

Three recent Fellowships in the Department

Dr James Dawson an EPSRC Advanced Research Fellow

Dr James Dawson

Dr James Dawson in the Energy, Fluid Mechanics, and Turbomachinery Division of the Department has been awarded an EPSRC Advanced Research Fellowship. The EPSRC offers up to 50 Advanced Research Fellowships annually to outstanding researchers across its whole remit. Fellows devote themselves to research for the period of the award (in James' case five years), with the expectation that they will have established an independent research career of international standing by the end of their award. These are highly prestigious awards open to both outstanding new researchers and those already established in research careers.

The title of James' EPSRC Fellowship is: "Enhanced mixing by vortex dynamics". Describing his research he says: "Considerable media attention has recently been given to the growth of air travel and its environmental impact. The Future of Transport white paper points out that air travel has increased five-fold over the last 30 years and is expected to triple over the next 30 years.

"The fellowship has been awarded to investigate new mixing enhancement techniques for the next generation of low-emission gas turbine combustors. The success of low-emission technology, often referred to as 'lean-burn', hinges on our technical ability to control the rate and uniformity of fuel-air mixing in order to lower flame temperatures and minimise emissions. Mixing is normally achieved at a rate determined by the turbulence of the flow. However faster mixing over very short distances is needed. A possible solution for this is to introduce vortices locally to augment turbulent mixing and droplet dispersion. Recent developments in high-speed laser diagnostic techniques will be used to conduct fundamental studies into how vortices can benefit the mixing process and provide both a framework for model development and aid in a technological step-change."

For further details please visit James' webpages: www.eng.cam.ac.uk/~jrd37/

Dr Katherine Heller an EPSRC Post Doctoral Research Fellow

Dr Katherine Heller

Katherine Heller who has recently joined the Information Engineering Division of the Department has been awarded an EPSRC Post Doctoral Research Fellowship in Theoretical Computer Science.

The title of Katherine's EPSRC Fellowship is: "Beyond Clustering: Unsupervised Modelling with Complex Representations" Describing her research she says: "The field I work in, Machine Learning, strives to develop new theory and algorithms that improve the ability of computers to recognize patterns, make autonomous decisions, and make predictions based on data. Clustering is an important unsupervised Machine Learning tool for a variety of problems. Automated clustering tools have been used to cluster gene expression data in order to elucidate gene function, automatically group news articles on the web by topic, and spatio-temporally cluster climate data to improve climate prediction.

"While clustering is a wonderful tool for many applications, it is actually quite limited. In many situations the data being modelled can have a much richer and more complex hidden representation than the simple assignment of each data point to a cluster. For example, the data being modelled might have multiple latent features (like images which can contain multiple objects). Moreover, the total number of latent features might not be known, and therefore should not be specified or limited a priori. This flexibility is provided by the use of nonparametric Bayesian methods, which will play a fundamental role in my work. My main goal is to advance the state-of-the-art for unsupervised machine learning, by developing principled, theoretically sound, probabilistic models and algorithms, which extend a clustering paradigm to problems which need richer representations."

For further details please visit Katherine's webpages: www.gatsby.ucl.ac.uk/~heller/

Dr Stephan Hofmann a Royal Society Dorothy Hodgkin Research Fellow

Dr Stephan Hofmann

Dr. Stephan Hofmann, in the Electrical Engineering Division of the Department, has recently been awarded a Royal Society Dorothy Hodgkin Research Fellow by The Royal Society. The Dorothy Hodgkin Fellowship scheme supports excellent scientists and engineers at an early stage of their career.

Describing his research he says: "Today, nanoscience and technologies attract a global investment in excess of 5 billion and are becoming a central interdisciplinary research area with diverse applications, e.g. drug development, water decontamination, information and communication technologies and the production of stronger and lighter materials. The trend of miniaturisation reflects the growing demands of information technology, helping people around the world to share an ever increasing amount of written word, images and sound.

"Accurate downsizing of bulk materials or thin films into the nanometrescale, referred to as the 'top-down' approach, to date remains challenging and costly. My project proposes chemically to synthesise nanostructures that intrinsically provide the desired optical and electronic properties, and assemble them into novel optical device architectures. A major challenge of such a 'bottom-up' approach, and a fact that never fails to fascinate me, is the size-scale of operation. Some structures are the size of a DNA strand. Using these structures, this whole text could be written on a human hair. I am excited about integrating light sources with dimensions smaller than the wavelength they emit. Subwavelength photonics will allow optical communication to share the logic of miniaturisation that revolutionised electronics before.

For further details please visit Stephan's webpages: www-g.eng.cam.ac.uk/edm/people/sh315.html

Outreach work by the Department of Engineering wins national accolade

The educational outreach undertaken by the Department of Engineering to engage children and young people in the challenge of hands-on activities – such as building rockets and planes, skyscrapers and bridges – has been recognised by a prestigious national award.

Joy Warde, Outreach Officer here at the Department of Engineering, was one of a small group of practitioners to receive special commendation from the Science, Technology, Engineering and Mathematics Network (STEMNET) for an outstanding contribution to initiatives that encourage young people's interest in engineering.

Funded by the Department of Trade and Industry, STEMNET works with partners in industry and education to run initiatives that encourage a flow of creative young people into the science, technology and engineering sectors.

The 2008 awards for Science and Engineering Ambassadors (SEAs) were presented by Ian Pearson, Minister for Science and Innovation, Lord Sainsbury and Jon Tickle, presenter of the TV show Brainiac at a ceremony at the House of Lords.

Joy was nominated for an SEA award by SETPoint Cambridge and St Alban's RC Primary School in Cambridge. In its nomination St Alban's wrote that, as a female engineer, Joy had challenged pupils' stereotypical views of the profession, and had inspired them to discover new skills, such as team work and problem solving.

Working with more than 120 undergraduate and graduate volunteers, Joy stages a busy programme of outreach activities at the Department of Engineering for children, families and young people. Each year these attract participation by around 2,000 people, many of whom come from a 20-mile radius of Cambridge.

Some activities are staged for schools and groups; others are open to the general public. Regular free events such as the Discover Engineering family workshops are so popular that they are booked up well in advance. "Events like this are a great opportunity for local families to visit the Engineering Department, meet some real engineers and complete a fun hands-on challenge," said Joy.

The overall emphasis is on hands-on activities that encourage participants to get to grips with basic concepts such as flight and strong structures. The success of interactive sessions stems from well-planned projects, a plentiful supply of materials, and interaction between participants (who may be as young as six) and enthusiastic volunteers.

"Volunteers get involved to share their enthusiasm for engineering with visiting school pupils and families, and also to get involved in the kind of activities many of them wished they could have done at school," said Joy.

Joy Warde, Outreach Officer at the Department of Engineering

Around 50 volunteers took part in the Rocket Car Derby session organised as part of Cambridge Science Festival. "It was fabulous to see families using some basic engineering principles to design, build and test a rocket car – and also have lots of fun," said Joy.

For details of events and activities run by the Department of Engineering visit the Outreach web pages at: www.eng.cam.ac.uk/outreach/.

Student exchange programme with École Centrale Paris

For eight years we have had a hugely popular undergraduate exchange programme for third year students with Massachusetts Institute of Technology (MIT). We have been working to set up a parallel exchange with École Centrale Paris, one of the Grandes Écoles most distinguished in Engineering, boasting Henri Schlumberger, Gustave Eiffel, Andre Michelin, Robert Peugeot and Jean Pierre Peugeot amongst its alumni.

The wording of the legal agreement between the two universities has been finalised and the first students went to France in September this year. Two students will go in each direction in the first year.

The students were chosen based on both academic and linguistic ability. The academic selection process is similar to that currently used for the MIT exchange. The linguistic selection is managed by the Department of Engineering's Language Unit. Only students at an advanced level of ability in French will be allowed to participate in the exchange. As students who have participated in the MIT exchange programme agree, the opportunity to work abroad and get a global perspective is invaluable.

The launch of the exchange programme is timely and in keeping with the 'entente amicale' that Mr Sarkozy and Mr Brown wish to nurture between the two countries.

École Centrale Paris

Daleks at the Department

Dalek builders David James (left) and Adam Strawson
Photo courtesy of Cambridge Evening News

Adam Strawson, a Technician in the Computing Group and David James, who was an undergraduate and a PhD student, here at the Department, are both members of The Dalek Builders' Guild, which is less a trade organisation than a loose affiliation of interested parties swapping hints and tips about making Daleks. Dalek building, it turns out, is something of a thriving pastime in the toolsheds and garages of Britain.

Adam and David have been building life-size replicas of the Universe's most tyrannical fascist dictators for some year's now. Their creations are works of art created with highly skilled craftsmanship and an incredible eye for detail.

"I've been a Doctor Who fan all my life, but it was only when I had my own house I thought, you know what would look good in that corner – a full-size Dalek," says David with a grin.

David, a speech technologist, reckons he spends "hundreds of pounds a year" on his hobby. Adam is more specific: his new series Dalek - which took 18 months' worth of evenings and weekends to complete ("I spend as much time as I can, but real life gets in the way sometimes") - cost him £475, with parts ranging from a child's magic eight ball (£5) to a piece of magnified glass (a snip at 80p).

"We kind of evolve the best way of doing things," explains David.

"For a classic Dalek eye-piece, you can't go wrong with a sugar bowl from Wilkinson's, which costs £3. And if you go to Ikea you can buy three waste bins in powder-coated diamond shaped mesh that are perfect for the neck."

"Both David and I build our own Daleks purely for our own pleasure, although we do take them out and about when we can. We both attended an invasion of the Manchester Museum of Science and Industry last year where we helped set a record of 70 Daleks in one place. There are often event days at the National Space Centre in Leicester that we attend: www.spacecentre.co.uk/whatson/specialevents.htm

Dr Who series 4 started earlier this year and Daleks have been featured. I'm sure that both David and Adam have been watching avidly to pick up the latest design features ready for their next creations.

More of Adam's Daleks can be seen on his website at: www.strawson.freeuk.com/dalek/

Women in engineering

The engineering sector is calling for more female recruits. Despite bright ideas and bold initiatives designed to attract more women into science, engineering and technology (SET), statistics prove that the gender gap is not lessening.

Nationally, the proportion of women opting to study engineering and technology at degree level is static at around 15 per cent. However, this does not reflect a simple humanity/science divide as men no longer dominate all SET subjects at degree level; biological sciences boast an impressive 63 per cent female studentship, physical sciences attract 41 per cent women and computer sciences manage 17 per cent.

"One of the problems is the reducing numbers of students, both male and female, willing to study maths and physics, which is the precursor to getting into engineering," says Dr Sue Ion, vice president of the Royal Academy of Engineering and former director of technology at British Nuclear Fuels.

The difficultly in attracting women to engineering appears to be one of image and the misconception that engineering is synonymous with car mechanics and greasy overalls.

Helen Randell is studying engineering at Cambridge, where 27 per cent of the students on the engineering courses are female, well above the national percentage of female studentship. She picked the programme after attending Headstart, one of a number of education programmes run by the Engineering Development Trust. Headstart, says Helen, opened her eyes to the possibility that engineering could be a "legitimate career choice".

She followed this up with a Year In Industry placement at Nottingham East Midlands Airport, where she was charged with extending the existing fire training rig. "This really confirmed that I wanted to do engineering," she says. "I like the fact you're doing something different everyday and have to come up with new solutions all the time."

Helen has chosen to specialise in civil and structural engineering and spent last summer's placement working on a junction of the A1. "People think I'm mad because I am so excited about this," she says. "But I can now drive up the A1 and point to the junction and say I did that."

Helen Randell is studying engineering at Cambridge

This is the real satisfaction of a career in engineering: coming up with practical solutions, be it traffic flow or global warming. Helen says it's frustrating that so many young women don't even consider it as a career. "They are losing out on so many opportunities," she says. "Once you have a go you find it's so different from how you imagine it to be."

Despite the more promising figures in some SET subjects, we must not become complacent. The general picture in Cambridge is one of continuing under-representation of women in SET. There has been little significant change to the occupational hierarchy in all these disciplines where numbers of women fall away at each level (undergraduate, graduate, post-doctoral, permanent staff), whether the baseline is low (e.g. in engineering) or high (e.g. biochemistry).

To help address this problem, the University has become a Gold Sponsor of Cambridge Association for Women in Science and Engineering (AWiSE). Our sponsorship will allow AWiSE to continue providing support, inspiration and information to women working in SET. The University actively encourages female staff and students in SET through our Women in Science, Engineering and Technology Initiative (WiSETI). WiSETI's remit is to improve the number of women studying SET, improve the retention and promotion rates of women in SET and to raise their profile and increase their self-confidence.

For more information please visit:
www.etrust.org.uk
www.yini.org.uk
www.setwomenresource.org.uk
www.headstartcourses.org.uk

Rocket Car Derby a soaring success

The Department's Rocket Car Derby held in March as part of the Cambridge Science Festival 2008 was described as "an enormous success on all fronts" by Professor Keith Glover, Head of Department.

The event, sponsored by Research Councils UK, was a hands-on activity day in which family teams designed, built and tested rocket powered cars. The activity was aimed at children aged 6-13 to show them the fun, creativity and relevance of engineering.

Over 900 people participated in the event resulting in the construction of 600 rocket cars. Carol Vorderman, Patron of the Festival, also attended.

The cars were constructed around a simple rolled paper tube capped at one end. They were propelled up and off a ramp using an electrically-controlled compressed air launcher. Participants investigated the variables which affect the distance travelled; these include wheel position, body design, car weight and the addition of wings! All teams were able to take home a 'what next?' ideas kit which will allow them to tackle further propulsion challenges at home.

Participant feedback after the event was glowing

"We had a fantastic time and loved the fact we could continue designing and making at home with the plastic bottle rocket idea and materials. Thank you."

"A super set-up and activity for science festival. Well done everyone involved!'"

"Brilliant, inspiring and very well organised."

The support of volunteers, striving to inspire the next generation of engineers and scientists whilst developing their own transferable skills, was crucial to the success of the event. A team of 50 Cambridge University engineers (staff, students and alumni) assisted the teams with their design and construction.

Joy Warde, the Outreach Officer here at the Department who organised the event, said, "It was fabulous to see families using some basic engineering principles to design, build and test a rocket car – and also have lots of fun."

Details of how to make your own rocket car and a "try this at home" ideas leaflet can be downloaded at:
www.eng.cam.ac.uk/outreach/CUEDresources/RocketCarDerby/index.htm

Young eco footprinters present findings to the Department

The Department of Engineering hosted a pilot secondary education programme aimed at stimulating informed change to consumption practices through Ecological Footprinting.

Footprinting is a tool for estimating the land area required to sustain a population's life-style. It tackles a central sustainability question: just how much of the earth's bio-productive capacity do humans use? Answer for a UK citizen: 314% of their fair share. Footprinting can reveal the components of our life-style that have the biggest ecological impacts. This data is the stuff of informed change: how far could recycling and other initiatives take us, what would it really take for us to achieve 'One-Planet Living'?

The potential for footprinting to stimulate learning and change is being researched by Chris Cleaver as his fourth year project. Chris, an undergraduate who is supervised by Peter Guthrie, engaged a group of 14-15 year old students from Harry Carlton Comprehensive School in collecting data to estimate and interpret their own school's Ecological Footprint. After an intensive eight weeks of surveying, sampling and processing the student group came to the Department to present their findings to a four-person panel, which was chaired by Philip Guildford, Director of Research, and included Professor Peter Guthrie, Dr. Joy Warde, from the Department, and Dr. Kate Billings, Faculty of Education.

Year 10 students from Harry Carlton School

Participating in the footprinting process

The Harry Carlton year 10 students had split into three groups, each collecting primary data for a different broad category of consumption. Faced with the task of estimating components of the school's food consumption, a group member described their approach. "We decided the best way of doing this was to design a questionnaire to discover how much pupils would eat in a school day…we first created a questionnaire and tested it, gave it out, then used Microsoft Excel to process the data". Despite testing, not all the problems were ironed out. "We weren't specific enough about how to answer some of the questions; we'd be asking how much fruit juice do you consume a week and they'd write 3 down rather than a specific measure!"

Revealing results for the school's governors

Each group's results were then combined and the total school footprint was estimated at 0.8 global hectares per pupil. This is 45% of a pupil's fair earth-share, to sustain an activity taking less than 20% of their time. The students showed that the life-style areas contributing the most were 'Shelter', including the school's electricity and gas usage, and 'Mobility', covering car and bus transport to and from school (both 35%). Meanwhile, paper and meat consumption were singled out as the big-hitters for 'Goods' and 'Food' life-style areas respectively.

For each area, the student footprinters had identified in their presentation simple actions that could lead to significant reductions in ecological footprint. Will these actions materialise? The lead-presenter thought so: 'we're going to continue the project, and we're going to deliver the results to the school governors…we must educate staff and students on all these issues and how they can reduce our ecological footprint'.

Joy Warde's words of commendation are telling of how the panel viewed the presentation: "I'm really impressed. You've done a really good job of doing the presentation with confidence; it's nice to see'.

Group-engagement in Footprinting: A strong concept

When the students and panel later sat down to reflect on the programme, one thing rang clear: the concept of participative footprinting was a good one. As one student put it, "probably the best way to learn it is to actually do it yourself; it helped a lot to find out exactly how you can cut down all these things, not just individually but as a group of people as well". Perhaps there was a wider lesson here about the value of engaging groups in change, something Philip Guildford acknowledged to Harry Carlton's footprinters. "Personally, I found it quite inspirational, because I'm helping with changes on this site".

Can the programme go further and wider? Peter Guthrie has little doubt: "there is in here the potential for a national scheme to be developed to change the attitudes in schools in a reasonably scientific and analytical way". Those optimistic words seem a fitting response to the day the young footprinters held centre-stage in the Department of Engineering.

About the Author

Christopher Cleaver, a fourth-year engineering student, conceived, designed and helped to implement the school footprinting programme. After graduating, he intends to develop the concept further, and is pondering models of dissemination. Chris did some eco footprinting last year with schools in Mauritius and this is an extension of that work. He is supervised by Professor Peter Guthrie, Head of the Centre for Sustainable Development.

For further information please contact Chris, email: cjc82@cam.ac.uk

Project Expo 2008

For the second year running, students from the Department have exhibited projects to visitors from across the University and from industry.

Organised by the Department's Staff-Student Joint Committee and Cambridge University Engineering Society, this year's Project Expo in May was a great success. It was bigger and more diverse than the inaugural event last year, with 19 displays from both the undergraduate and postgraduate communities. The exhibits included projects, Undergraduate Research Opportunities Programme (UROPs), entries into international engineering competitions and hobbyist projects from individual students. Prizes were awarded to the top three exhibitors, as judged by the Department's Dr Rob Bracewell.

David Wyatt, the lead organiser of the event, said, "There are many innovative and fascinating projects taking place in the Department, both within and in addition to formal research and teaching. We hope that by showcasing some of them at the Expo, we have not only given members of the Department a better appreciation of its activities but also shared our technical pre-eminence and our enthusiasm for hands-on engineering with the wider community."

The date for next year's Project Expo will be announced in the Spring 2009 issue of the newsletter – all are welcome to attend!

The full list of exhibitors is as follows

First prize: Luke Humphry:
Flat panel speaker optimisation
Second prize: David Hodgson:
Freehand 3D ultrasound
Third prize: Zareen Sethna:
A sustainability approach to standards for rammed earth construction in Bhutan

Other exhibitors

- Cambridge AUV
- Cambridge University Eco Racing
- Cambridge University iGEM2007 team
- Cambridge University Spaceflight
- Full Blue Racing
- Jenny Auton: Optimising Ceramic Water Filters for the Developing World
- Chris Cleaver: School ecological footprinting
- Neil D'Souza-Mathew: Balancing of a Robotic Unicycle
- Paul Dickenson: Multiphase Flows at Pump Inlets
- Richard Marchant: Robot races
- Andrew Nowell: RCISS - Remote Computer Interface and Security System
- Sithamparanathan Sabesan: TINA – The INtelligent Airport
- Hugo Scott Whittle: PICOSWARM – PIC Online System for Weather, Automation and Remote Monitoring
- Fred Spaven: The Shed – an industrial revolution in a semi-detached garden
- Jurgen Van Gael: Finding Software Bugs with Non-Parametric Bayesian Methods
- Hongwei Wang: Towards collaborative simulation on the Internet

For more details on any project, please email David Wyatt: dw274@cam.ac.uk or visit the Project Expo website: www-g.eng.cam.ac.uk/ssjc/Activities-projectexpo2008.html

Student Staff Joint Committee website: www-g.eng.cam.ac.uk/ssjc
Cambridge University Engineering Society website: www.cues.org.uk

Pilkington Prizes honour teaching excellence

Dr Tim Wilkinson, front row, second from left, with the other Pilkington Prize winners

Eleven of the University of Cambridge's finest teachers were honoured at a reception last month.

The Pilkington Prizes are awarded each year to academic or academic-related staff who have distinguished themselves in teaching. This year's winners include an earth scientist, a 17th-century literature expert and an electronics and photonics engineer, all of whom have conveyed their enthusiasm and love of their subjects to countless students.

The Vice-Chancellor Professor Alison Richard awarded the prizes at the Møller Centre, followed by supper at Churchill College.

"Dr Tim Wilkinson of Jesus College, a University Senior Lecturer in the Department of Engineering, working in the Electrical Engineering division, has a natural gift for teaching and delivers his courses with clarity and with humour.

He can inspire first-year students with fundamental electromagnetism and also explain complex specialist material on optics and telecommunications to fourth year Masters' students. Tim has an impressive record in teaching innovation, including his contribution to 'Displaymasters' – a unique multi-centre Masters' programme focused entirely on display technology."

Photography competition winners

There are two categories in the Department's photography competition, one for staff and students the other for alumni. As you will see on these pages the quality of the images entered was exceptionally high, revealing some of the hidden beauty that lies within engineering.

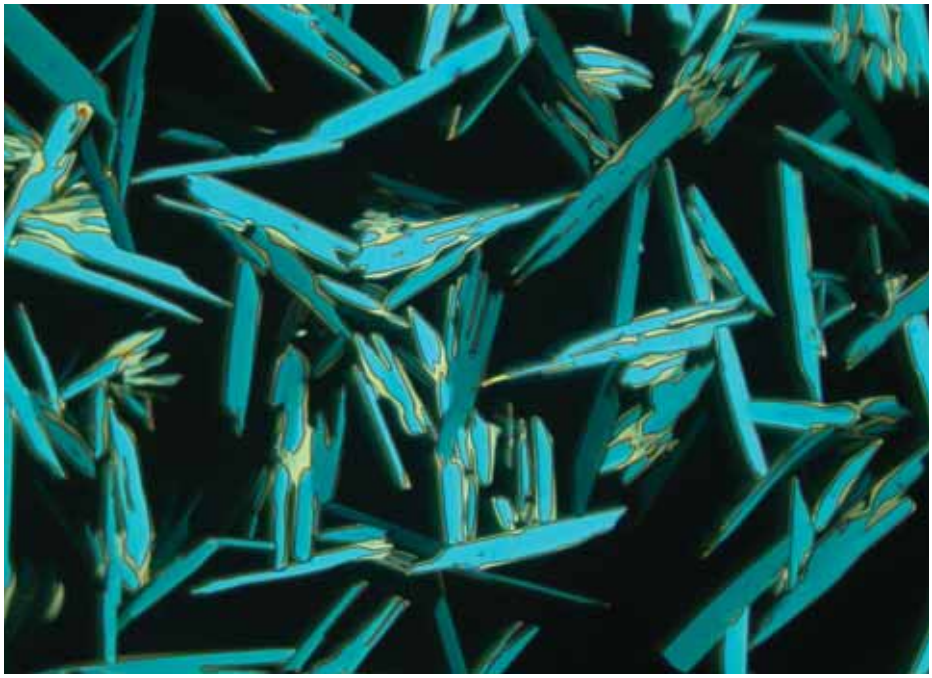
The pictures range from shots of towering wind turbines to rarely-glimpsed visions of tiny structures growing under laboratory microscopes. All were taken by staff and students at the University's Department of Engineering as part of an annual photography competition that encourages them to explore the artistic side of cutting-edge technological research.

Entries can reflect any aspect of the Department's work, whether it takes place in the lab or in the field, but all try to show aspects of the subject which are beautiful, intriguing, amusing, or possibly all three.

The competition, now in its fifth year, was sponsored by Microsoft and judged by senior academics from within the Department. The entries can be viewed online by visiting www.eng.cam.ac.uk/photocomp/2008/

Other entries that were highly commended by the panel of judges reveal the fantastic inner structures of everyday objects, offer glimpses into microscopic nano-worlds, or simply give a new, perhaps unusual perspective on the experiences of engineers working in the field.

First prize



The winning entry, 'Blue Spikes' was captured through a polarising microscope, this delicate image of liquid crystals is one of dozens that are being exhibited online to reveal the inner beauty of engineering

'Blue Spikes' was taken by PhD student Sonja Findeisen-Tandel, and shows liquid crystals in their "mesophase" – the point at which they have ceased to be liquid but have yet to crystallise fully. As the phase grows in the drop of liquid crystal material, molecules align in different ways. Their alignment interferes with the passage of light causing it to twist and turn. In a microscope that uses polarising light, this is revealed as colours and textures – this interaction of liquid crystals and polarised light is commonly used in television screens and the displays on our mobile phones. Sonja has the expertise to interpret these images and identify the mesophase. Sonja explains, "I have synthesised a lot of mesophases to investigate property-structure relationships and I was thinking it would be a good idea show my best photographs to people who are not working on liquid crystals and amaze them with these beautiful images".

For more information contact:
Dr Sonja Findeisen-Tandel email: sf386@cam.ac.uk

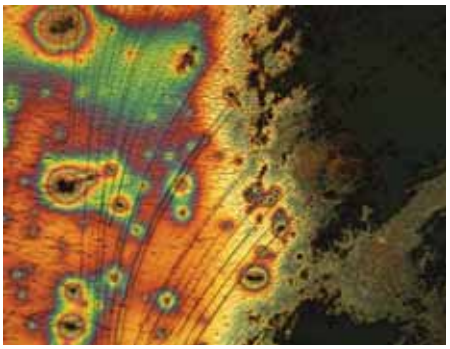
Second prize

Second prize, 'First Light' by Sam Cocks

'First Light' was taken by Sam Cocks, then a first year student at the Department. It was taken at sunset, on 15th March 2007 to capture the first night of power for the secluded Masai village of Essilanke. Tom says, 'The village school provided the site for the first trial of a project that I spent three months working on in Kenya: developing a small-scale wind turbine capable of providing a practical solution for electrifying remote regions.'

For more information contact:
Sam Cocks email: sjc238@cam.ac.uk

Third prize

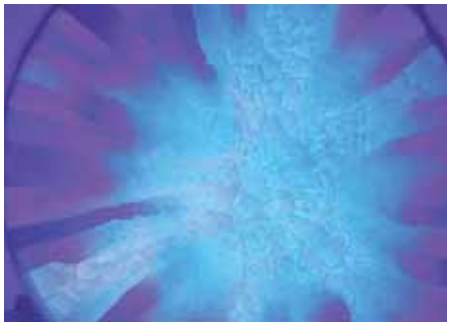


Third prize, 'Moth' by Dr Ingrid Graz

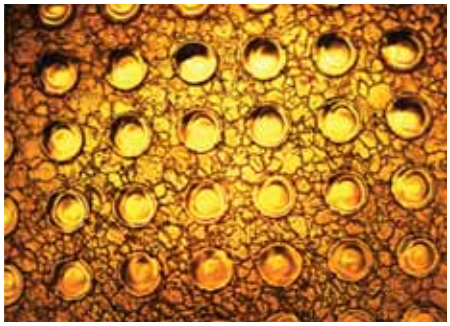
'Moth' by Dr Ingrid Graz a Research Associate at the Nanoscience Centre in the Electrical Engineering Division, 'My topic is stretchable electronics. I create thin metal films that can be reversibly stretched and remain conductive. PDMS serves as our platform/substrate. PDMS is Polydimethyl-siloxane a elastomeric polymer and after being reversibly stretched, comes back to its orignal size and form. These thin-metal films provide a platform for the realization of stretchable electronic circuits. We cast the PDMS into petri dishes by mixing the liquid polymer with a curing agent and after stirring, the mixture is cured for 24 hours at 70 degree Celsius. This photograph shows a multilayer sandwich of gold and PDMS. The image was taken by optical microscope.

For more information contact:
Ingrid Graz email: img21@cam.ac.uk

A selection of competition entries

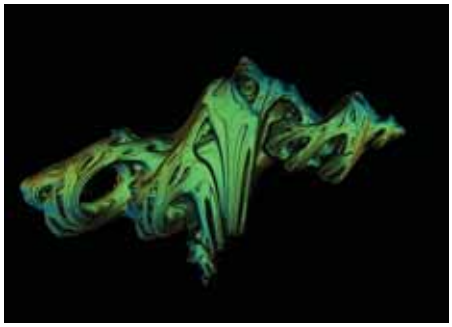


'Beautiful Blue Phase' by Carrie Gillespie

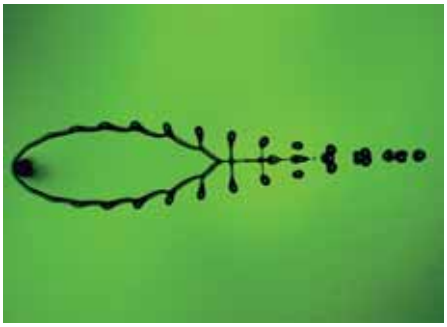


'Laser drilled micro-sized hole array' by Kun Li

'Pouring the Critical Joint' by Robin Firth

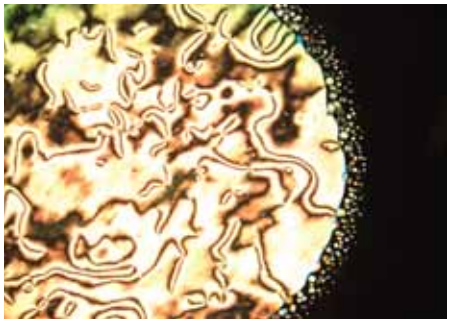


'The surface of a hyper-complex escape-time fractal' by Rich Wareham



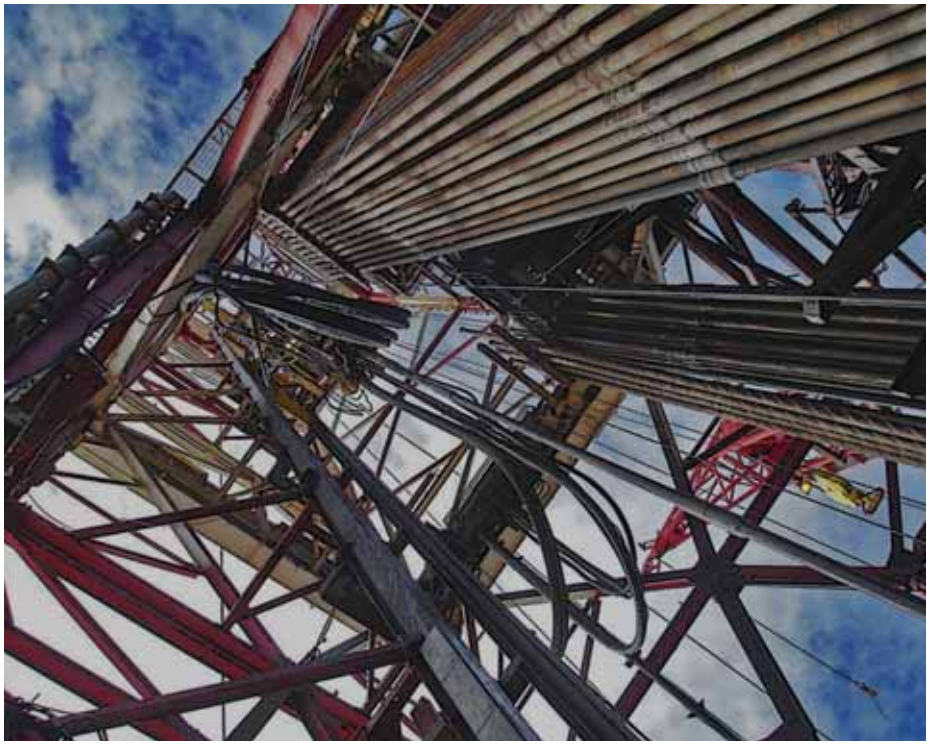
'Fishtail in the green sea' by Sungjune Jung

'Larger lenses' by Timothy Wilkinson



'Growing of a nematic mesophase' by Sonja Findeisen-Tandel

Alumni Photography Competition Winner



Edith Lagendijk, 'Rocks, Rigs and Roughnecks'

The winning image in the Alumni Photography Competition was taken by Edith Lagendijk entitled 'Rocks, Rigs and Roughnecks'.

Edith describes the photo as 'View of the derrick from the dog-house. All machinery in the derrick is remotely controlled by the driller in his little shack (dog-house) on the drill floor. A massive pulley system (top drive) is used to connect the drillpipe to drill a hole to explore for and produce oil and gas. On this rig we were drilling a 4 kilometre long production well for an oil development off the North-west coast of Australia.'

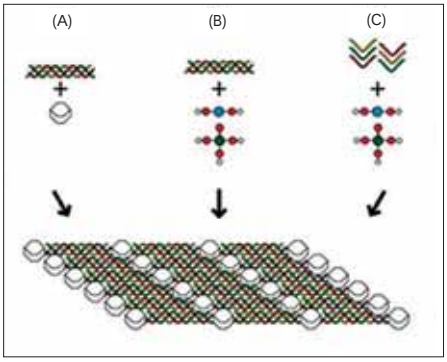
She went on to say, 'As a reservoir engineer I have worked in the oil and gas industry all over the globe and, after 14 years, I am still fascinated by the industry; its grandeur, its multi-cultural people and its ever-developing technology.' Edith graduated in 1994.

Other entries in the Department's 2008 alumni photography competition can be seen at www.eng.cam.ac.uk/photocomp/2008/alumni_entries/

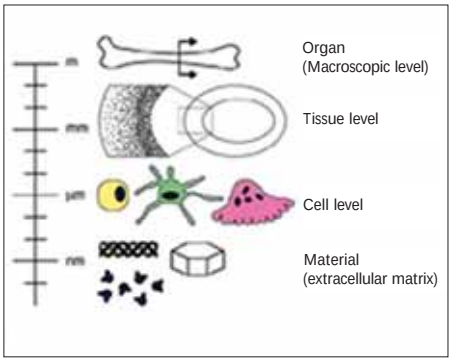
FACT BOX

Many of the photographs can be viewed, along with the winning and commended entries from previous years, on the Departmental website at, www.eng.cam.ac.uk/photocomp/2008/ www.eng.cam.ac.uk/photocomp/2008/alumni_entries/

Engineers "bone" up on biological materials



Cell-free synthesis



Bone material can be described at four levels of detail

In a recent feature article published in Materials Research Society's Bulletin, Dr Michelle Oyen explores the potential uses of synthetic bone-like material.

Michelle suggests that these materials will be too expensive to replace materials in typical construction and building applications but can be developed for use in particularly demanding sections of advanced architecture as well as other specialist structural applications. In addition, the principles involved might be used to make materials that have bone-like qualities without being so obviously directly like bone. Michelle is interested in the general principles found in bone, not just the specific details of collagen-mineral or gelatin-mineral materials.

There is growing interest in materials and systems which imitate nature. Researchers are looking towards nature for inspiration because natural materials are composites, harnessing the best features of several different material types and combining them into a material that is more than the sum of its parts. Biomimetic materials synthesis aims to take the attractive features of a biological system and mimic either the material itself or the process that naturally occurs when the material is made.

Natural bone is of particular interest to researchers because of its unusual combination of mechanical properties: bone is stiff and tough, but it is lightweight.

Bone material

Bone material can be described at four levels of detail:

- Macroscopic: bone as seen by the naked eye
- Tissue level: there are two main categories of bone tissue: spongy bone (trabecular bone) which makes up the interior of the bone and compact bone (cortical bone) which forms the surface
- Cell level: the tissue is made up of cells which are continually being formed and resorped
- Material (extracellular matrix): a mixture of nonliving material which acts as scaffolding for the bone. This consists of inorganic and organic parts; collagen fibres, ground substance, and bone salts.

Fabricating bone-like material

Traditional tissue engineering uses foreign living cells seeded onto an artificial scaffold structure and small molecules, such as growth factor, to create bone-like material. Novel approaches to biomimetic material synthesis can be described as "bottom-up", and emphasize cell-free pathways to create bone-like structures. There are at least three different approaches:

The first method involves mixing nanoscale organic and inorganic material to create a composite. Mineral particles are mixed into a string of molecules known as a polymer network. This method is similar to traditional composites technology but here self-assembling biological polymers (collagen) are used. This method creates a simple bone-like material.

The second method is to add the components of the mineral phase (rather than formed mineral particles) to the self-assembling biopolymer network. The aim is that the mineral nucleates on specific sites in the network and forms an organised composite on a finer scale.

The third method involves mineral formed in situ simultaneous to formation of the biopolymer network. Mineral components are added to monomers, the small molecules that link together to form the biopolymer. The biopolymer and the mineral phase grow together "naturally", creating a material which further resembles bone.

In all three cases the biopolymers autonomously build themselves from the bottom up as the individual components contain enough information to build a template for a structure composed of multiple units. Self-assembling biopolymers reduce the need for energy-intensive processing steps. It is hoped that for all three of the above approaches the self-assembly of the biopolymer will lead to a well-ordered structure with few defects.

Researchers are using biomimetic processing to create a wide variety of bone-like materials. They commonly use collagen and gelatin, but other materials such as silk and synthetic peptides have also been used. Future studies will include multi-component organic matrices with both protein and sugar components.

Applications of bone-like material

Historically, the creation of bone-like materials has been driven by clinical and medical research, emphasising the medical uses for bone replacement. Michelle's research focusses on other possible uses for materials that have bone-like properties, where although the materials information is obtained from natural objects, including biological tissues, the end-applications are industrial.

With such potential for biosynthetic materials, this interesting area of research is set to become increasingly popular.

Bone-like material could push the current limits of architecture, where the ideal material would be very structural with exceptional mechanical properties but also very lightweight. Michelle anticipates that as this "killer combination" is found in bone and other natural materials, we should expect to see biosynthetic materials used in buildings of the future. Michelle explains that "anywhere you have something heavy and brittle, like bricks or concrete, you might be able to use a bone-like material as a replacement where you would need less material (i.e. thinner and lighter sections) but still have excellent mechanical integrity. Michelle suggests that the first architectural application of bone-like material could be domes or other larger vaulted structures. Further applications appear limitless. With such potential for biosynthetic materials, this interesting area of research is set to become increasingly popular.

For further information, please email Michelle: mlo29@cam.ac.uk

Irene Vidyanti receives a Sir William Siemens medal

Irene Vidyanti, whilst a final year student at the Department, received a Sir William Siemens medal from Tom Young, Chief Executive of Siemens plc, at a ceremony held at Siemens' new corporate headquarters at Frimley, Surrey. Irene was nominated for the award in recognition of her excellent project work in the third year coupled with her impressive progress in other parts of the Electrical Engineering course. Irene's third year projects are image processing and data analysis.

Irene Vidyanti with Tony Young, CEO of Siemens plc

Image processing project

The project aim was to find an image compression technique that produces compressed images with the best subjective quality. In image compression, the goal is to reduce as much information redundancy in the image as possible for efficient storage or transmission. A well-known and commonly used image compression standard is JPEG.

Irene's project focussed mainly on transform coding, in which knowledge of the application is used to choose which information to discard for compression. First, several signal representation/transform methods were explored. These transforms were then followed by quantization (in which a range of values are compressed to a single value, for example, in the reduction of colours necessary to represent a digital image) and entropy coding (in which rarely occurring patterns carrying more information are coded with many bits and common patterns which impart less information are coded with few bits).

Data analysis project

The project was an investigation into methods of analysing data. Several data analysis methods were explored and applied on several data sets, such as the temperature of ice in the North Pole, or the number of lynx in a certain area. Both parametric methods (in which model structure is specified prior to the analysis) and non-parametric methods (in which the model structure is determined from the data) were investigated.

Among the non-parametric methods Fourier Transform was found to be an efficient tool to compute the frequency of the signal. However, its performance degrades significantly as noise level becomes comparable to the signal. Different filters were designed to filter out noise. As each filter type has its own characteristics, choice of filter type depends on the output requirements. There are also trade-offs to be considered such as computational cost. Data smoothing, which is useful to extract long-run trends in the data, was also investigated.

Among the parametric models Bayesian analysis was found to result in a more accurate probabilistic estimation if there was strong prior information. The use of maximum entropy regularization in deconvolution (in which additional information about the solution is introduced in the process of reversing the effect of convolution to the original data) is studied and its robustness under noise assessed. Its use in practical applications, such as optical deconvolution (deblurring of an image or image restoration), was also investigated.

The Siemens Medal was first inaugurated in 1883; at that time only one was given annually. This year 18 of the leading Universities in the UK were each invited to nominate a student to receive one of these prestigious awards. The two- inch bronze medals are struck at the Royal Mint as replicas of the original medal first awarded in 1883, and the award includes a generous cheque. The Siemens company offers these awards to raise the profile of science and technology, and to encourage students into the profession of electrical and electronic engineering.

FACT BOX

The Cambridge Science Festival attracted over 23,000 people; and the four podcasts were downloaded by 70,000 people in the first two months alone.

What makes a good lecturer? A third year student's view

Warren Rieutort-Louis, a third-year Engineering student, is the overall winner of the Higher Education Academy Subject Centres' Student Essay Competition for 2008.

Warren Rieutort-Louis

Warren's essay, entitled "What makes a good lecturer", points to factors such as enthusiasm, drive and passion when assessing their attributes, and praised exceptional educators who generously give of their time after lectures.

But the idea to which Warren returned throughout the essay was the simple fact that education is a sharing process.

"Many lecturers receive very little feedback on their courses and in particular get hardly any expressions of gratitude", commented Warren. "Students must take the effort to give something back, to play their part in the sharing experience of education."

In his essay, Warren recalled lecturers who used Plasticine and Lego to demonstrate complex engineering challenges and especially remembered his mechanics and structures lecturers playing Swingball in class to illustrate moment of momentum. He also praised the use of real-world case studies to illustrate the challenges within the discipline.

"Engineering lecturers can gain considerable insights from Warren's essay that not only highlights memorable moments but also stresses that a good lecturer understands the learning perspective of students," suggests Carol Arlett, Manager of the Engineering Subject Centre.

Run by the Academy's Subject Centres, the winner from each participating Centre receives prize money of £250 and is entered into the main competition. It is at this stage that Warren's essay went on to win the overall Subject Network prize of a Toshiba laptop.

The Academy received over 400 entries to the essay competition.

You can read Warren's essay below.

Engineering is by its very nature a technical subject, where it is often all too easy for lecturers to succumb to the classic here-are-my-notes-which-are-a-carbon-copy-of-this-textbook approach to teaching. After all, how many ways can there possibly be of teaching Fourier transforms? And how many times have we students heard "Unfortunately, this is quite a boring part of the course but it really is important", a catch phrase commonly identified by generations of young engineers as the beginning of... an extremely tedious and dull hour...

Nonetheless, it must be said that it is in no way true that 'good' engineering lecturers have become as rare as the Mauritian dodo bird and I'm fortunate to say that in my experience I have met several inspiring instructors; their influence on our vision of engineering is incalculable.

Good lecturers trigger enthusiasm and are often passionate themselves about their subject, even if that subject happens to be the design of operational amplifiers. Motivating 300 students at 9 o'clock on a wet Monday morning is indeed no easy task and of course people learn differently, so what general methods catch students' attention?

Indubitably, humour is an important factor in grabbing students' interest, but I would say that a good lecturer goes beyond that stage. They are the ones that realise the power of visual demonstrations that are so frequently overlooked. A materials lecturer who demonstrates crack propagation with plasticine, a fluids lecturer who demonstrates a wind tunnel, a control systems lecturer who demonstrates proportional control with Lego®: those are some experiences that made my lectures entertaining and memorable.

Not used enough, I believe, is the power of graphic imagery. We are lucky in that engineering is a very visual subject. Pictures and even short videos illustrating real-life applications and perspectives are always welcome. Not just once at the start of the course but throughout all lectures! Lecturers are often engaged in fascinating research, which can form the basis of interesting examples. Some go to great lengths to prepare learning tools that complement teaching, like short software simulations or MATLAB® demos, demonstrating for example the closed-loop flight behaviour of a jet fighter. Some lecturers even set up online workspaces for their courses, and use Tablet PC technology allowing them to record and broadcast online additional worked examples, fully narrated by the lecturer. These tremendous resources really make a difference, and it's even better when lecturers make these available for students outside lectures.

> In my first year, I set up a website uploading interesting links that I found relevant and helped me understand the course material better.

Equally engaging are lecturers that discuss real-world case studies such as the collapse of a particular structure, the design of a working radio, the selection of materials for a 400 tonne aircraft. One I found particularly stunning was when a lecturer described the structural failure of a pipe in a cyclohexane plant, and demonstrated that any first year engineer could have spotted the initial pipe's design flaw. What is that famous saying, again? A case study is worth a thousand words?

Exceptional educators implement a variety of these techniques in their lectures. Good lecturers are also the most

approachable and understand the learning perspective of students. They are the ones who generously give of their time after lectures to answer the questions of the hoards of students who have no idea where equation 5 on page 6 of the notes came from, or of that odd student in the back row who thinks he has invented a perpetual motion machine. Open-minded lecturers contribute so much to our learning experience and gain remarkable respect with students.

Realistically speaking though, many of the comments I have discussed seem to require a great deal of commitment on behalf of the lecturer and infinite teaching time given that, of course, the hard maths has to be done at some point... But, surprisingly perhaps, I firmly believe that it's not only up to the lecturer. It's all too easy for us students to take for granted what we have and always ask for more demos, more videos, more recorded lecture podcasts, more filled in notes, more worked examples. It surprised me last year to find out that many lecturers get very little feedback on their courses, and in particular get hardly any expressions of gratitude from students on extras they may have put in place to try and make, say, thermodynamics more appealing. So why bother? It's a great shame. We as students must also make the effort to 'give something back' so to speak, even if it is just an expression of thanks or, for example, sharing ideas and resources that we encounter in our private study. In my first year, I set up a website uploading interesting links that I found relevant and helped me understand the course material better. Some lecturers now link to this site. Education is a sharing process and motivated lecturers are good lecturers.

Interestingly from another perspective, many lecturers underestimate both their students' eagerness to learn about their subject and more importantly don't realise their own abilities to be a 'good' lecturer. Some of the best lecturers I have had are not stand-up comedians, intent on making semiconductor engineering hilarious, but on the contrary they are people that give students a chance to develop and learn by guiding them in the right directions, adding links to interesting web-pages in handouts, posing interesting challenges in lectures. One of my lecturers encourages creative thinking and independent learning by handing out chocolate bars to students who find and email him interesting applications/articles/anecdotes that relate to the electromagnetics course, which he can then show other students and use to improve his lectures. Once again, a process of sharing.

Noteworthy of a mention is also the style of teaching of good lecturers. I have known good lecturers who write on blackboards, and good lecturers who use PowerPoint. Then again, I've also known lecturers who doodle unintelligibly on blackboards and others face and read PowerPoints like a recipe book. Using a variety of these teaching tools is undoubtedly best; change and diversity maintain interest.

Good lecturers have such an impact on our studies, just like good teachers at school. My experience has led me to meet many such people that have irrevocably shaped the understanding of hundreds of students, through enthusiasm, through drive, through passion. They may not all have a "Professor ABC appreciation society" on Facebook, but they will certainly have admiration and respect. As an electrical engineer, I may never in my life use the mechanical engineering knowledge I gained in my first years, but I will certainly remember that November day when the mechanics and structures lecturers played swing ball in class to illustrate moment of momentum.

Fundraising success

Over the last couple of years, the Department of Engineering has successfully brought in nearly £15 million in donations.

This results from the commitment of leading academics, the strong support of alumni and the Department's close working relationship with the Cambridge University Development Office (CUDO) for the University's 800th anniversary campaign. Only one other department in the University has matched this performance.

Dr Alan Reece's £5 million donation for the Institute for Manufacturing's new building was the largest one-off gift given to a Department this year, matching an earlier donation from the Gatsby Charitable Foundation for this project. Also thanks to philanthropy, Dr Garth Wells has been appointed as the first Hibbitt Lecturer in Solid Mechanics and Dr Graham Treece has become the new Lecturer in Engineering for Clinical Practice. The Ashby Scholarship and two other research posts in Water and Gas Engineering have been recently funded, along with a number of other projects.

Looking forward, we are about to identify and define a series of new fundraising projects for a variety of posts and studentships in line with the core academic strengths of the Department and its strategic themes. We are gearing up for fundraising for the development of the Trumpington Street site, once the University gives the go ahead. We are also seeking support for outreach to schools.

The Department is deeply grateful for philanthropic funding for specific projects as well as funding that allows Engineering students and staff 'The Freedom to Discover' – a critical 800th Campaign Goal. The latter enables our world-leading academics and students the unrestricted funding to pursue new ideas and push the boundaries of engineering in unexpected ways. While we have done very well so far in the 800th campaign, we have the ambition to do much more.

The Department is now in touch with over 15,000 of its graduates around the world. Quite a number have helped our campaign with not only money, but also ideas and networking.

More news of fundraising plans and successes will be forthcoming. Please do not hesitate to contact the Department if you want to get involved.

Dr Alan Reece

For further information please contact, Philip Guildford email: pg28@cam.ac.uk or Liffy Gorton email: eag26@foundation.cam.ac.uk.

“Flying wing” model aircraft exhibit at The Science Museum, London

A model of SAX40, the aircraft conceptual design developed as part of the Cambridge and MIT collaboration the “Silent Aircraft Initiative”, is on display at the Science Museum, London, for six-months as part of an Antenna exhibition “Does Flying Cost the Earth?” about the environmental impact of aviation.

“Does Flying Cost the Earth?” presents the most promising technologies scientists and engineers are working on to reduce the impact of aviation on climate change. SAX40 is one of the designs in the spotlight. In addition to displaying the model, the exhibit describes the technologies that lead to its low fuel burn.

Ann Dowling, the UK lead of the Silent Aircraft Initiative, explained that “the project was originally to come up with a concept design for a ‘silent’ plane, but in doing so, we also found that the design is up to 25% more fuel efficient.”

The exhibition runs until Saturday 15 November 08. Museum director Professor Chris Rapley said, “This exhibition is an ideal opportunity for visitors to see how scientists and engineers are working together to tackle aviation's environmental impact and produce the aircraft of tomorrow.”

The SAX40 exhibit has already received significant publicity, with coverage in the Financial Times, the Evening Standard, BBC Radio 4, the Observer, and Smartplanet.

More information about the exhibition can be found on The Science Museum website: www.sciencemuseum.org.uk/antenna/flying/technology/future_flight/

More information about the Silent Aircraft Initiative can be found on the Silent Aircraft website: http://silentaircraft.org/

Flat-screen TVs… and beyond

It's not every day that Microsoft buys your latest invention, but that’s what happened to Dr Adrian Travis, a Cambridge Engineering academic. His idea for thin, wedge-shaped light-guides has been snapped up by the computer industry colossus to drive a whole new way of interfacing with computers. The new light-guides can project and image light at the same time, enabling a host of products to improve the human-computer interface.

Adrian, now a Senior Scientist at Microsoft Corporation in Redmond, USA, has won a prestigious Royal Academy of Engineering Silver Medal for his outstanding personal contribution with a commercial benefit to British engineering. Academy President Lord Browne of Madingley presented him with the medal at the Academy Awards Dinner in London in June.

Adrian, aged 45, invented a new class of light-guide that works as a flat lens and essentially eliminates the distance a projector needs to be placed from its screen. This opens the way to flat projection and imaging devices.

Cambridge FPD Ltd was set up in 1999 to commercialise Adrian’s ideas. It developed and licensed its optical technology for a new, portable X-ray security scanner that is so thin it can even be slid down behind bags left beside walls.

“Adrian is a great innovator,” says Professor John Carroll FREng, who was Adrian’s PhD supervisor. “At university he invented toy bricks that could be stacked up into simple electrical circuits to teach children about electricity. He has an excellent record of patenting and commercialising his inventions and his ultra-thin light-guides are revolutionary.” Adrian comments “I am delighted to receive this award, which I hope will be seen to acknowledge work by a remarkable group of forward thinking people on some ideas I had.”

Further information on the awards can be found on The Royal Academy of Engineering website: www.raeng.org.uk/prizes/silver/

Cambridge University Eco Racing solar car drive across Britain

CUER prototype vehicle Affinity

This year Cambridge University Eco Racing (CUER) have designed and built the first solar-powered car to drive legally on UK roads.

CUER was formed in January 2007 and now consists of over forty Cambridge University students including Engineers, Judge Business School MBAs, Economists and Natural Scientists. The student team is supported by the Department's Professor Peter Guthrie, the Project Ambassador, and final year project supervisors from the Department.

On 8 June 2008 CUER embarked on the first solar-powered journey from Land's End to John O'Groats: the 'End to End trip'. The 934 mile route was undertaken in the CUER prototype vehicle Affinity, which has a top speed of around 50mph. During the week-long journey the team engaged and educated the public in the area of sustainable transportation by displaying the car at schools and public attractions. Scheduled stops included the city centres of Edinburgh and York, as well as the Eden Project in Cornwall.

Team captain Martin McBrien said, "Designing and building the car has been an exhilarating experience for all involved, with the many ups and downs, late nights, and breakthrough moments making the whole project worthwhile. Underpinning everything is the knowledge that the technologies being applied – batteries, electric motors, advanced materials and photovoltaics – will become more and more relevant. Sustainable transportation is no longer an issue for the future, but for today. Oil prices are high so knowing that travelling on free energy from the sun is possible, brings real hope."

Jia-Yan Gu, CUER Outreach Officer, said, "It was a great opportunity engaging with school children and the public along the End to End route. We were able to spread our enthusiasm about applying technology to help solve environmental issues."

CUER is now developing a second vehicle to compete in the World Solar Challenge in Australia in October 2009. The challenge is to design and build a Solar Electric Vehicle to complete a gruelling 1,850 mile race across the Australian outback using solar energy as the only fuel. The challenge is known as the 'Formula One of environmentally-friendly motorsport' and CUER will take on 40 solar racing teams from around the world. The CUER entry will showcase cutting-edge technology developed in the Engineering Department through 15 research projects, carried out by final-year undergraduates.

CUER is currently seeking sponsorship to fund manufacture of their World Solar Challenge vehicle, and would welcome anyone who is interested to contact the team, email: sponsorship@cuer.co.uk, or download the sponsorship brochure from the team's website.

CUER is supported by Platinum sponsors Pilkington and Hewlett Packard.

Please see the CUER website: www.cuer.co.uk for a complete list of sponsors, or email: contact@cuer.co.uk.

Professor Amaratunga has produced a novel memory device set to rival transistor-switched silicon-based memory

Working with an international group of researchers, Professor Gehan Amaratunga has produced a novel memory device which is set to rival transistor-switched silicon-based memory.

In the world of technology, expanding knowledge results in shrinking products. Laptops, mobile phones and MP3 players are as small as their components allow. Companies are constantly battling to make their products faster, smarter and smaller. Conventional memory chips in electronic devices are made up of transistors, resistors, and capacitors built in layers on a silicon wafer through a photolithographic process, during which precise patterns are etched on the silicon to form the chip. Today's technology allows several million transistors to be built on a piece of silicon the size of a pinhead, but many researchers believe this form of memory has been pushed to its limits.

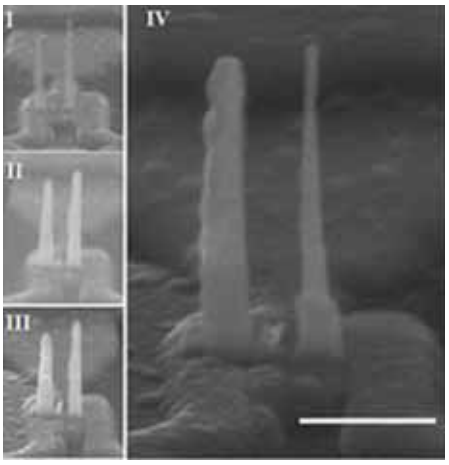
In computing, information is stored in bits which can have one of two possible values or states: 1/ON or 0/OFF. The most common type of memory in use today is volatile random-access memory (volatile RAM) which requires a power source to store data. Volatile RAM may be divided into two types: dynamic and static (DRAM and SRAM). In DRAM each memory cell can consist simply of one capacitor and one transistor. The capacitor holds the bit of information, the transistor acts as a switch, letting the control circuitry on the chip read the capacitor or change its state (e.g. from ON to OFF). Reading the state of the capacitor destroys the information in it and so the read operation must be followed by a write operation in which the state of the capacitor is restored. The capacitor consists of two charged layers separated by an insulator. The capacitor leaks charge and the information eventually fades unless the capacitor charge is refreshed. The thinner insulators get the more they allow charges to tunnel through.

The second type of volatile RAM, SRAM does not need to be periodically refreshed and so has significantly faster access times than DRAM. It also requires less power in operation. However, six transistors are required to form a single SRAM cell. Although inferior to SRAM, DRAM is used because the small number of components required means that a cell can occupy less area on a silicon chip. Another factor affecting the area a cell requires is the size of the components themselves. Decreasing component sizes and increasing silicon wafer sizes are the major factors in driving down the cost of silicon devices. However, it is becoming increasingly difficult to achieve reduced feature sizes in the manufacturing process. Complex and expensive fabrication techniques have been developed to keep pace with the demand for cheaper and faster silicon-based memory.

Researchers have been trying to create electromechanically driven switches small enough to rival transistor-switched silicon-based memory. Unlike transistors, electromechanically driven switches contain moving parts. Not only do electromechanical devices have excellent ON-OFF ratios and fast switching characteristics, but the physical separation between the switch and the capacitor in such devices means the data leakage problem is significantly reduced. However, until now the technology has not been a viable alternative to silicon-based arrangements because it involved larger cells and more complex fabrication processes.

> The length of time for which the nanotube is grown determines its length, which in turn determines its mechanical properties

Professor Amaratunga and his team have remedied these drawbacks by creating a novel nanoelectromechanical (NEM) switched capacitor based on vertically aligned multiwalled carbon nanotubes (CNTs). Rather than creating memory chips through a photolithographic process, nanotubes are grown in place on a silicon wafer by allowing a carbon-carrying gas to absorb onto a hot nickel surface, which acts as a catalyst for the nanotube growth. The length of time for which the nanotube is grown determines its length, which in turn determines its mechanical properties such as stiffness and resonant frequency. The resonant frequency of the nanotube structure determines the maximum switching speed of the NEM switch and its stiffness determines how much charge is needed to deflect it into contact with the other element of the cell.



NEM switch fabrication steps. I. Metallic multi-walled nanotubes are grown from catalyst dots defined by electron-beam lithography. II. The nanotubes are coated with an insulating layer of silicon nitride. III. Chromium is sputtered to form the capacitor on the source electrode. IV. A wet etch exposes the nanotube on the drain electrode, which is the moving part of the switch.

One nanotube which stores an electric charge bends toward a static nanotube. When the two touch, an electrical contact is created and charge can flow to a capacitor structure formed around the static nanotube. This charge is used to represent a bit of information; a charged capacitor represents 1/ON and an uncharged capacitor represents 0/OFF. The vertical nature of the NEM capacitor structure allows for high integration densities, reducing both process costs and size requirements. There is a sharp transition between the ON and the OFF state of the switch which means that a very small difference in voltage can change the state of the device, reducing the amount of power required for its operation.

Nanoelectromechanical devices based on carbon nanotubes have been reported previously, but this is the first time researchers have been able to control the number and spatial location of nanotubes over large areas with the precision needed for the production of integrated circuits.

These results have been reported in a paper in the December 23, 2007 online edition of Nature Nanotechnology: "Nanoscale memory cell based on a nanoelectromechanical switched capacitor". www.nature.com/nnano/journal/v3/n1/full/nnano.2007.417.html

Engineering students race off to Germany

Photo courtesy of Cambridge News

A group of students from the Department pitted their wits against top engineering undergraduates from across the globe over the summer.

The Full Blue Racing team; Barnabas Sleep, Graeme Leese, Helen Makey, James Warner, Richard Barnwell, Jon Watson, Jenni Whitfield, Katherine Ward, Nikhil Garrett and Tom Dix built a prototype Formula-style car which they raced at the Hockenheimring, the home of the Formula 1 German Grand Prix, to take part in Europe's biggest student motor sport event – 'Formula Student Germany 2008'.

Formula Student is an international design competition set up to develop the engineers of the future by developing skills in teamwork, budgeting (both time and money,) and promotions, in addition to sound practical engineering skills. The competition challenges students to design and build an open-wheeled racing car from scratch, then go racing! The team from the University of Cambridge competed against 77 other student teams from across the globe in the four day contest from 6-10 August for a chance to win this coveted title.

Fifteen engineering undergraduates set off for Germany. They spent three days running a series of tests on their car, before racing both against the clock and other vehicles in four events on the track. At the same time the team was judged on the design of the car and a full business pitch and cost report were presented.

The team was pleased with their efforts in the 2008 competition. The car lasted 19 of the 27 laps of the endurance race (only around 35% of teams complete the event). Throughout these laps the car was within 5 seconds of the fastest UK teams – an encouraging result given that setup time was limited by electrical problems early in the competition. They also came second of the UK teams in the cost event.

Nikhil Garrett was both the Team Leader and one of four drivers in the team. He said: "The competition is designed for teams of university students to compete against each other. This is the second year that we have taken part. Last year was a learning curve for us and we aimed to see if it was possible for us to build a car from scratch, and we did. This year we have a new chassis and a lot of new parts but there are one or two things that worked well last year and we have decided to carry across."

Full Blue Racing's vehicle is powered by a Yamaha R6 motorbike engine which allows the car to accelerate from 0-60mph in four seconds. Virtually all the other parts of the car are designed, developed and built in house by members of the team.

The team faced a series of tests and joined the other teams in giving presentations about their vehicles, explaining how they put them together and how they kept within their individual budgets. They also pitched to a 'dragons den' style panel, imitating a start-up company with a prototype vehicle to sell.

Teams from 5 continents then competed against each other in four races designed to test their speed, handling, endurance and fuel consumption, including a 22km race on the track.

The competition this year was won by the Technical University of Delft from Holland. The winning team is not just the team with the fastest car, but the team with the best overall package of construction, performance, and financial and sales planning.

The success of the 2008 competition has encouraged everyone to strive to improve for the 2009 event. Work has commenced on the design for the 2009 entry and in order to complete the build the team is looking to secure at least £10,000 sponsorship.

For more information on the team visit their website
www.fullblueracing.co.uk
For more information on the 'Formula Student Germany' event visit:
www.formulastudent.de

Nanoscience at forefront of collaboration with Indian Institute of Technology Bombay

Over the past 3 years, Professor Mark Welland has been working closely with the Indian Institute of Technology Bombay (IITB) to establish a long term relationship which has now come to fruition.

Cambridge and IITB have signed a joint Memorandum of Understanding (MOU) and their first collaboration agreement which focuses on Nanoscience. On the Cambridge side the collaboration is primarily between the Department of Engineering and the Department of Materials Science with Professor Mark Welland and Dr Ashwin Seshia the leads for Engineering and Professor Alan Windle the lead for Materials Science.

Under the agreement, funding will be made available for ten students to pursue three-year PhD courses at Cambridge through the Cambridge Commonwealth Trust. In addition there will be support travel by senior academic staff between the two partnering universities.

Professor Welland commented:

"The quality of research students and the new facilities at IIT Bombay provide for a world leading platform on which to establish a long term and truly reciprocal research relationship with IITB."

The MOU, which was signed by Professor Alan Windle on behalf of Cambridge Vice-Chancellor Professor Alison Richard, and IIT Bombay Director Professor Ashok Misra, paves the way for numerous future research collaborations.

For more information on the Cambridge and IIT Bombay MOU, see the Cambridge University article "IIT Bombay and Cambridge sign MOU with initial focus on Nanoscience" at www.admin.cam.ac.uk/news/dp/2008041601

Details of Professor Welland and Dr Seshia's research can be found on the Cambridge Nanoscience Centre website: www.nanoscience.cam.ac.uk/index.php

Professor Mark Welland.

Engineering Design Centre paper is a leading Design journal's most downloaded paper over 7 years

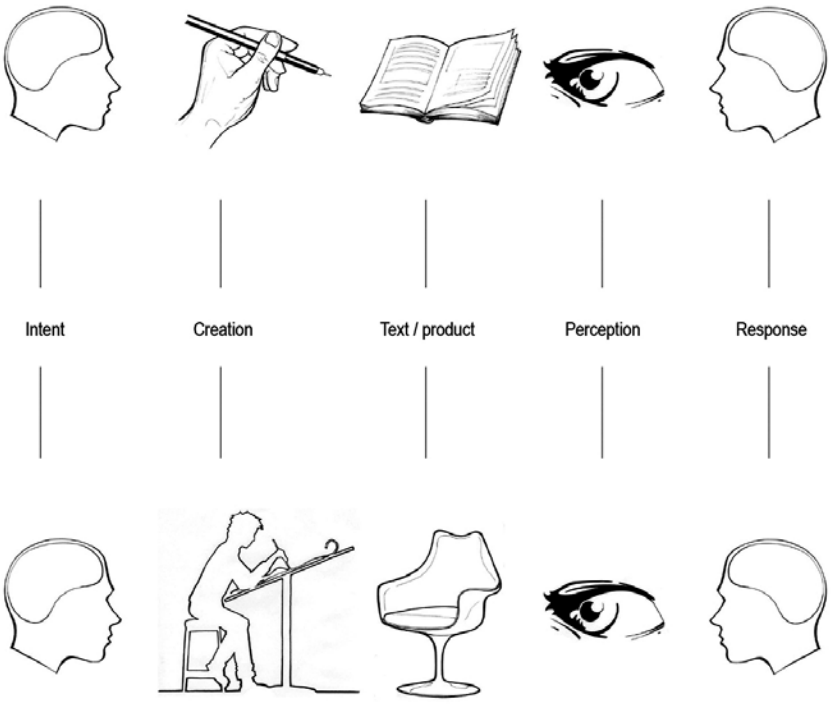


Illustration of how design and communication might be compared (art credit: Carlos Cardoso).

A paper by Nathan Crilly, James Moultrie and John Clarkson from the Department's Engineering Design Centre (EDC) is officially the most downloaded paper from the journal Design Studies' website over the last seven years. This achievement is particularly impressive as other articles in the rankings were published much earlier than the 2004 paper.

"Seeing things: consumer response to the visual domain in product design" discusses the ways in which product design can influence consumers. Despite a wide variety of literature on this subject, there lacked a coherent and comprehensive review of research

in the field. The three authors highlighted three particular concerns:

1. Researchers were presenting old concepts with new language, and as such were continually re-inventing the wheel
2. Little-known or recent texts offering significant contributions to the field were not receiving wide recognition
3. There was no general theoretical framework on consumer response to visual product design.

It is these key issues which the Design Studies paper addresses and the download figures confirm how crucial this work has been to the field.

The paper outlines the various factors which influence how and why we respond to visual product design. This process is defined as "communication through design" and encompasses the following:

- Aesthetic impression (how pleasing the process of regarding the product is)
- Semantic interpretation (what the product appears to communicate about itself)
- Symbolic association (what the product appears to symbolise about its user)
- Aesthetic, semantic and symbolic interaction (how these factors interact to create a consumer response)
- Visual references (existing forms or artefacts which consumers associate with the design)
- Moderating influences (other factors such as product quality and distractions in the environment)

The paper raises implications for further research, suggesting that it would be useful to assess whether designers are conscious of the theoretical concepts outlined above and what processes and checks are used to ensure that the visual objectives in the design have been met. The authors have recently completed a follow-up article that addresses these research questions.

The article "Seeing things: consumer response to the visual domain in product design" can be found by using the search facility on www.sciencedirect.com

For more information on the team's research, see the EDC website: www-edc.eng.cam.ac.uk/

Royal Academy of Engineering announces new Fellows for 2008

Malcolm Bolton

Norman Fleck

Professors Malcolm Bolton and Norman Fleck from the Department of Engineering, Cambridge University are among the 44 pioneering engineers elected this year to the Royal Academy of Engineering in recognition of their distinguished work in the field.

Malcolm Bolton, Professor of Soil Mechanics and Director of the Schofield Centre for Geotechnical Process and Construction Modelling, was elected for his outstanding contributions to soil mechanics and geotechnical engineering.

The author of 170 publications in these areas, his research has focused on geotechnical centrifuge testing, the fundamentals of soil mechanics, and their applications to such practical problems as retaining walls and offshore pipelines.

His work has carried him into less obvious fields, such as sugar refining and neuropathology. In the latter field, he is currently conducting collaborative work examining the deformation of a cellular matrix suffused with spinal fluid, including simulations using geotechnical software, of tumour growth and hydrocephalus.

Norman Fleck, Professor of Engineering and Director of the Centre for Micromechanics, was elected for his seminal contributions to solid mechanics.

His work established the basic understanding of size effects in plasticity, the compressive failure of composites, the optimal design of metallic foams and lattice materials, powder compaction theory, and the mechanics of ferroelectrics.

The Royal Academy of Engineering was founded in 1976 to promote the engineering and technological welfare of the UK. Its fellowship includes the country's most eminent engineers. The Academy provides independent, impartial advice to Government, works to secure the next generation of engineers and provides a voice for Britain's engineering community.

The Academy, which promotes the engineering and technological welfare of the UK, has elected leading engineers from commercial engineering and some of the country's most visionary academics.

"Our new Fellows are among the very best engineers working in the UK today," says Academy President Lord Browne of Madingley. "They are pushing the technical boundaries across the most challenging fields from medical imaging to aeronautics and energy technology. Together they demonstrate that engineering is at the heart of modern society."

Founded in 1976, The Royal Academy of Engineering promotes the engineering and technological welfare of the country. The fellowship – comprising the UK's most eminent engineers – provides the leadership and expertise for its activities, which focus on the relationships between engineering, technology, and the quality of life. As a national academy, the RAE provide independent and impartial advice to Government; work to secure the next generation of engineers; and provide a voice for Britain's engineering community.

Cambridge Manufacturing Engineering Design Show 2008

Manufacturing Engineering students at the Department's Institute for Manufacturing held their 2008 Design Show last month, displaying a range of new products that they have developed as part of their course.

Over the last year teams of three or four students have completed a major design project to develop a new product, with real business potential. Having first identified a customer need they have researched the market, developed original design concepts and created a full business plan.

The Design Show is held each year for an invited audience of local industrialists and designers. Students put together displays to explain the technical and business ideas behind the products, together with design details and prototype models of the products themselves.

The projects

Deli'tail

Deli'tail is cocktail machine that allows bars to offer cocktails fast and efficiently, whilst ensuring that quality is consistent by removing human error. It replicates the mixing process, which has been broken down into its elemental steps with a time and motion study. The machine selects ingredients from the top of the machine, adds water to mimic the effects of melting ice, thoroughly mixes the cocktail through proprietary technology, chills the mix to a refreshing temperature (around 4oC) and then pours the finished cocktail into the glass.

Team: Jonathan Thompson, Chao Wang, Corentin Roux Dit Buisson, Andreas Petsas.

Automated iron

Development of technology to enable an automated ironing appliance.

Representing a radical breakthrough in ironing technology, our product offers users an automatic means of removing creases from clothing, resulting in drastic time-saving for the busy user; unlike the traditional dry or steam irons which rely on manual operation. At the heart of the product lies an innovative contact-less technology - SteamStretch(TM) - to tackle creases regardless of garment fabric or shape.

Team: Adrien Motte, Charlie Musgrave, Christina Zhang, Kate Hunter.

PR-Radio

A giveaway promotional FM radio for use at major events.

The PR-Radio is a novel marketing tool for businesses that wish to stand out from the crowd. Our ear mounted radio provides high quality FM reception using re-designed electronics that are lower cost and lower power than our competitors' products. In addition, our radio offers the customer a unique level of customisation by allowing them to specify graphics, shape and colour. This means the device can be tailored to match their company image.

Team: Matthew Salisbury, Carl Morland, Kyung Park, Mikhail Turkin

Rhythmijig

An aid for deaf musicians and young children that transmits a live beat as a tactile stimulus to the performer.

The beat is input using a foot pedal by one of the musicians and transmitted via a series of wearable receivers to each member of the group. The four students involved in the project came up with the idea after a visit to the Mary Hare School, the national grammar school for deaf children. Meeting some of the pupils they discovered that some struggled to keep time while performing in groups. While they could use an able hearing conductor, this limited the band's ability to practice on their own.

Team: Michael Ansbro, Maria Katunina, Linda Kemp and Glen Walker.

Intelli-bin

An 'intelligent' high street litter bin that automatically separates aluminium and steel cans and discards wrongly inserted items into the general waste compartment. This allows cans to be transported directly to metal recycling plants, avoiding the need to send them to a special recovery plant and thus reducing transport costs and environmental impact.

Team: James Colgate, Rachael Mell, Ben Richardson, Ken Zhang.

The Ergopip

A redesign of the precision pipette, one of the most commonly used laboratory instruments, to address ergonomic issues. While current models satisfy the need for precision and reliability, their design falls a long way short in terms of ease of use. They are entirely thumb-operated and are known to cause cases of repetitive strain injury. The students have designed a comfortable, easy-to-use pipette, the Ergopip, which distributes workload to the user's fingers and is just as precise and reliable as existing versions.
Team: Jonathan Fraser, Mark Evans, Shu Sun and Rehana Khanam.

Mosquito trap

A passive mosquito trap designed for use in rural southern India, requiring no external power.
This mosquito trap is designed for use in the developing world, using locally available materials to minimise cost. Made of discarded plastic bottles filled with pebbles and a mixture of yeast and sugar, the trap attracts human-biting mosquitoes. The geometry of the trap is such that once inside the mosquitoes cannot escape. The students have also designed an injection moulded model for the Western market, sales from which could subsidise the trap for the developing world. The prototype has been successfully trialled in Bangalore.
Team: Andrew Boyce, Man Kit (Alvin) Lam, Rachel Milford and Stephanie Sgoda.

HeatSave Shower Tray

A novel shower tray for saving energy and money.
HeatSave Shower Tray has an integrated heat exchanger that facilitates energy recovery from waste water. Warm water leaving the shower tray is used to pre-heat cold water entering the system so that less energy is required by the electric shower unit for heating. A typical shower with two regular users will save around £30 per year in electricity, equating to a reduction of approximately 150kg in CO^2 emissions. The product is a self-contained unit that takes the place of a standard shower tray.
Team: Helen Cavill, David Clough, Li Dong, Matthew Leung.

French plaiting

A device to simplify the difficult task of French plaiting.
The French plait is a simple method of holding hair back from the face, making it particularly suitable for playing sports, swimming, horse riding and general day-to-day wear. The problem is that it is very difficult to do a French plait in your own hair. The project shows that a hand-held plaiting product is feasible, and with some more development can be sold as a consumer good. French plaiting requires methodical adding of hair into parts of the mechanism, and is the logical next step in the product's design and development.
Team: Sally Clemo, Karina Ali-Noor, Gopal Rao

Portable Clean Air

A transportable device producing a column of clean air for use in field surgery.
This design aims to provide a localised area of sterile air, via a portable, minimal-installation and easy maintenance system. The air will be filtered using a 'high efficiency particulate air' (HEPA) filter which has an efficiency of 99.97% at 0.3µm particle diameter. The potential markets for such a technology are many but we are concentrating on providing clean air sources to operating theatres in rural India, many of which currently have no provision for providing sterile air.
Team: Theerasak Mingarcha, Charlotte Kershaw, Abhishek Mandawewala.

For further information contact:
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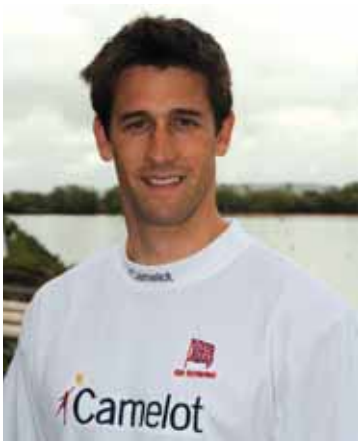
FACT BOX

A Higher Education Funding Council for England survey rated Cambridge first in the country for free-of-charge public lectures, with a 42% higher attendance than anywhere else in the country.

Engineering alumni shine at Beijing Olympics

Emma Pooley (left) photo courtesy of Tim Williams



Tom James

Tom Stallard (second left)

Four Engineering alumni represented Great Britain at the Olympic Games in Beijing, three have returned home with medals.

Tom James won a Gold as part of the Men's Coxless Fours. Tom along with Steve Williams, Pete Reed and Andrew Hodge rallied in the last 250m of the men's coxless four final to overcome rivals Australia. In doing so they took the top podium spot, but the six minutes that it took to secure victory were the product of years of sacrifice.

Tom said: "I think we were about one and a half seconds down on the Australians, but there was no sense of panic. We had this crescendo feeling in the last 500 when we just stepped on and on, and suddenly the Australians were manageable.

"It was very clinical how we did the last 300-400 metres. To be honest, I'm not quite sure where it came from, but we had a lot more power than I thought we had, even though we had been gunning it for the whole race."

Tom (2002 Matriculation, Trinity Hall) has been selected for the world renowned Men's Four. Tom made his GB Senior team debut as a 19 year old in 2003, winning his place in the men's eight and to a bronze medal at the World Championships in Milan. Recently he has had some injury problems and missed the last Olympics.

Emma Pooley won a Silver medal in Road Cycling in the women's time trials. Emma (2001 Matriculation, Trinity Hall) was selected for the Road Cycling team. Emma was a runner as a schoolgirl and made the transition from triathlon to road racing purely by chance while a student at Cambridge, after going out training with the local cycling club. She now combines full-time racing with a PhD in soil engineering at Zurich under the tutelage of Sarah Springman who was a lecturer here at the Department. Most elite British cyclists are full-time athletes, many of them having come through the system from junior level. Emma is a throwback to the days when bike riders worked or studied alongside their racing.

Tom Stallard claimed rowing Silver as part of the Men's Eight. Tom (1998 Matriculation, Jesus College) is a former World Champion who represented Team GB in the 2004 Olympic Games. A four time Cambridge Blue, he won a bronze medal in the eight at the 2007 World Rowing Championships. Tom is studying Motorsports engineering at Brunel.

Despite not making the winners' podium, the Department was also proudly represented by Andrew Baddeley who made it to the final of the 1500m.

Andrew (2000 Matriculation, Gonville and Caius) won the 'Dream Mile' in Oslo recently.

Before the 'Dream Mile' in Oslo, a Briton had not won the mile since Peter Elliott in 1991. When Andrew crossed the finish line first, his performance signalled what athletics fans will hope is the end of a very long lean spell for British middle-distance runners. So lean has it been, that many fans would not even have known about Andrew despite his status as the top Briton over 1500 metres. His progress has been steady and mainly low profile since embarking on an athletics career after graduating from Cambridge. Andrew earned a double first in Aeronautical Engineering.

Sport, Ethics and Engineering of the Olympic Games

A lecture for school children, age 12 to 15 years old, entitled 'Sport, Ethics and Engineering of the Olympic Games' took place here at the Department of Engineering. The two visiting speakers were Adam Whitehead, a former European and Commonwealth Champion and an Olympian at the Sydney Olympics 2000, and Dr Gilly Mara, a Sports Engineer.

The lecture began with Adam Whitehead, who showed off his array of swimming medals, including a Commonwealth gold medal and European Championships gold medal. The speakers gave an exciting insight into the world of engineering and sport and the ethical issues this raises. Engineering is not always seen by students

as an important factor in sport in general nor the Olympic Games in particular. However, the very core of all sports focusses on engineering and modern technology. Athletic tracks have changed from grass, to cinders, to the synthetic all weather surfaces that are used today and basic markings for a pitch or arena have transformed these surfaces to become the great stadiums of our age. Even the humble football has changed from a pig's bladder inside a laced leather cover – which doubled in weight in the rain! – to the footballs of today, which are made from modern waterproof materials and retain their size, shape and weight in all conditions. Technological advances such as the modern swimsuits worn by elite swimmers, through to the prosthetic limbs and equipment designed to aid athletes who have a disability, were also highlighted. Students had the opportunity to meet and engage in a lecture and debate with a sports engineer and an Olympic athlete, opening their eyes to the world of engineering and how it has helped change the theatre of sport.

The 'Sport, Ethics and Engineering of the Olympic Games' lecture, offered an exciting insight into the world of engineering and sport. It was funded by the Royal Academy of Engineering and supported by the British Olympic Foundation. The lecture was organised in collaboration with SETPoint Cambridgeshire and was very well received by the 180 school children who attended.

University of Cambridge, Department of Engineering Educational Outreach website: www.eng.cam.ac.uk/outreach/

Medical jargon 'may harm patients'

Tabassum Jafri, PhD student and Dr Melinda Lyons

Much of the Latin and Greek medical jargon that makes up the exclusive language of doctors should be abandoned because it could be harming patients.

Dr Melinda Lyons of the Department's Engineering Design Centre (EDC) said the "dead language" terminology, dating as far back as the 5th century BC, spreads confusion and could potentially put patients at risk. She wants to see the language of medicine brought up to date and simplified by removing "archaic risk-prone terms".

Writing in The Lancet medical journal, Melinda listed a wide range of prefixes commonly used by doctors which look or sound alike but have completely different meanings. Examples included "inter" (between) versus "intra" (within), "super" or "supra" (above) versus "sub" or "sur" (below), and "hypo" (low) versus "hyper" (high).

Melinda's paper in The Lancet demonstrates the broad scope of the EDC's focus. The paper highlighted the risks to patient safety due to the confusion over lookalike and soundalike terms that are generated through the sector's reliance on Greek and Latin terms. Unlike previous research, this paper identified the prefixes that pose the greatest risk. The field of healthcare typically manages problems of lookalike / soundalike terms through "quick fixes" such as coloured packaging and handwriting assessments, as well as encouraging "readback" of terms. Radical reforms of the language would rarely be seen as a solution.

In many ways, the challenge arising from the lookalike / soundalike terms is similar to that addressed by the EDC's inclusive design team, which seeks to educate designers to consider those with impairments or disabilities in order to ensure products are manufactured with their needs in mind. The definition of an "inclusive language of healthcare" would ensure that the safety of staff and patients alike is not compromised through misreading or mishearing terms.

Effective design is not just about the work of engineers or designers. By advocating a systems approach, in order to capture the many facets of the design process, the EDC requires the skills of many other professions. For example, in the EDC's healthcare design group, it is necessary to have a good understanding of the needs of the sector. As a result a number of the PhD students have backgrounds in pharmacy, radiography and counselling, whilst Melinda brings expertise in human factors and safety along with extensive experience in the offshore and aviation industries.

Engineering Design Centre (EDC) website: www-edc.eng.cam.ac.uk/

Professor Malcolm Smith's inerter raced in Formula One

Kimi Raikkonen's McLaren at the Spanish Grand Prix 2005. Photo courtesy of LAT Photographic.

It has been reported recently in the motorsport press that Professor Malcolm Smith's "inerter" device and concept has been deployed in Formula One racing (e.g. Autosport, May 29, 2008, page 33, "Mark Hughes on... A genius idea, and why McLaren hasn't tried to stop others using it"). McLaren signed an agreement with the University for rights to exploit the technology in Formula One. After a rapid and confidential development process the inerter was raced for the first time by Kimi Raikkonen at the 2005 Spanish Grand Prix, who achieved a victory for McLaren. The inerter had been used for the first time in practice by McLaren at the previous race at Imola.

During development McLaren invented a decoy name for the inerter (the "J-damper") to keep the technology secret from its competitors for as long as possible. The inerter featured in the 2007 Formula One "spy scandal" when it was reported that the Renault engineering team failed to understand the purpose of the device from a McLaren J-damper drawing they had acquired – see the FIA World Motor Sport Council Decision, 7 December 2007. The fact that the J-damper is an inerter was revealed in the Autosport article. Cambridge Enterprise, the commercialisation office of the University of Cambridge, has now entered into a licence agreement with Penske Racing Shocks enabling Penske to supply inerters to any team in Formula One.

The inerter is a device which provides a force proportional to the relative acceleration between its attachment points ("terminals") which must be freely and independently movable in space. A typical realisation incorporates a flywheel which rotates in proportion to the relative displacement between the terminals. The first publication on the subject, in which the word "inerter" was coined, was: "Synthesis of Mechanical Networks: The Inerter" (M.C. Smith, IEEE Transactions on Automatic Control, Volume 47, Number 10, Pages 1648-1662, October 2002). A patent on the device had previously been filed by the University.

The motivation for the inerter lies in the fields of electrical circuit synthesis and control systems. Classical circuit theory describes how to build circuits with the most general passive electrical impedances. Only three component types are needed: inductor, resistor and capacitor. There is an unexpected problem in translating this theory over to mechanical networks. Both the spring and damper have two terminals, but in contrast, the mass element has only one independently movable terminal. To achieve the greatest freedom to synthesize passive mechanical impedances a new element is needed which has two attachment points and where there is a proportionality between force and relative acceleration.

In a Formula One car the inerter can be used to improve "mechanical grip", i.e. to reduce tyre load fluctuations in dynamic situations. In conventional suspension design it is common to explain the role of individual components such as springs and dampers in achieving the overall goal. It is then natural to ask the question: what does the inerter do? Since the inerter is an energy storage element (like the spring) and not a dissipator (like the damper), an explanation in conventional terms is not immediately obvious. It is the fact that the inerter acts in combination with other elements (springs, dampers and masses) that the overall goal is achieved. To exploit the inerter the suspension designer is led to new methods which have their origin in electrical circuit synthesis.

It is pleasing that an idea which began with fundamental theoretical work in the Cambridge control group has led to this high profile exploitation in motor sport. Work is ongoing in the group to bring other applications of the inerter to fruition, e.g. in (1) vehicle suspensions for conventional road vehicles, (2) the control of motorcycle steering oscillations.

Malcolm Smith is Professor of Control Engineering and Fellow of Gonville and Caius College. For further information please contact: mcs@eng.cam.ac.uk.

Relevant links:
'Penske Racing Shocks to supply Cambridge inerter technology in F1' article:
www.enterprise.cam.ac.uk/news.php?key=76
'Secrets of the inerter revealed' article:
www.admin.cam.ac.uk/news/dp/2008081906

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