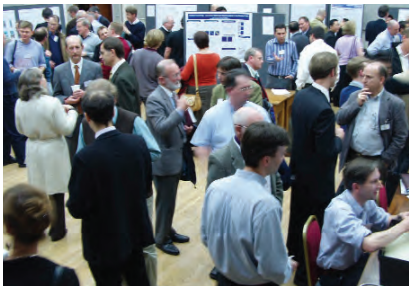
Issue 4 • January/February 2007

Newsletter

UNIVERSITY OF CAMBRIDGE
Department of Engineering

In this issue...

Executive Introduction



The picture above shows the buzz achieved at the first event in the Department's new Engineering Connections series, which aims to put businesses in and around Cambridge in touch with our latest research. The first event focussed on Information Engineering and attracted over 100 delegates to the talks and exhibition. The idea and sponsorship for the event came from Hermann Hauser of Amadeus Capital and was organised in partnership with Cambridge Network. Following this success, more events are planned. Please let us know if you would like to receive an invitation.

The implementation of the Department's strategy continues apace with plans to redevelop the Trumpington Street Site to a standard commensurate with its world class research and teaching activities. The plans will include space to welcome visitors, including school children, and showcase the Department's significant achievements. This major project will be designed so we can achieve our vision in a sequence of manageable steps which do not disrupt the Department's work. Once the plans are in place, we will pursue public and private grants, donations and sponsorship to make it a reality. More news will be available later this year.

Other aspects of the Department's fundraising campaign are proceeding well with several recent donations towards the Ashby Ph.D. Studentships in Mechanics and Materials. It is planned to begin the first of these endorsed Studentships on 1 April 2007. The Institute for Manufacturing (IfM) is very near to closing the funding gap for its new building.

There are also plans for an entirely new lectureship to form a bridge between Clinical Medicine and Engineering under our Engineering for Life Sciences theme. We are actively seeking funding for this exciting new post.

This year CUEA's Annual Conference will be part of the Alumni weekend that will take place from Friday 21st September to Sunday 23rd September. Engineering will run a series of three lectures on Saturday, a lunch for engineering alumni and their partners, and an exhibition on Sunday. For more detailed information visit http//:www.foundation.cam.ac.uk/weekend.php If you would like to be added to the mailing list, please contact the Alumni Office on 01223 332288 or email alumni@foundation.cam.ac.uk

Meanwhile, an alumnus has travelled into space, Professor Ann Dowling has been made a Dame in the New Year Honours list, and one of our recent graduates has received the Sword of Honour prize at Sandhurst. It has been a busy six months in the Department, which has generated more stories than we can share in this newsletter.

Please go the Department website at www.eng.cam.ac.uk for all of the news and contact Philip Guildford, the Director of Research, if you want to follow up any these stories (+44 (0)1223 332671 pg28@cam.ac.uk).

Department of engineering photography competition 2007 – Alumni category

As you may well be aware the Department of Engineering have been running a very successful photography competition for the past 3 years, the winning photos have received both national and international press coverage, and the numerous photo entries have allowed us to build up an excellent photo library.

The 2007 Department of Engineering photography competition will be open to all staff and students of the Department as always but we would like to add a separate category for our alumni.

We are searching for photos that capture all aspects of engineering for the alumni competition. We are particularly interested in images which show the alumni themselves in action 'out in the field'. The photos may be beautiful, fascinating, intriguing, amusing, and possibly all of these things.

The prize for the winning photograph of the alumni category is a choice of:

- a bottle of port of the year the winning alumni graduated sourced from a Cambridge college cellar
- a year's supply of Fitzbillies Chelsea Buns – Fitzbillies Bakery will send four Chelsea Buns each month for a year to any address in the UK.

The winning photograph will feature on the Department's website, newsletter, plasma screen, posters and more. We will use a very high proportion of the entries in a web gallery and throughout the Department's website, and an exhibition in the Baker building foyer, giving acknowledgements whenever they are used.

Previous years' competition entries can be seen on the Department's website http://www.eng.cam.ac.uk/

The rules are as follows:
The photograph must be submitted by email to photo-competition2007@eng.cam.ac.uk or sent to Jacqueline Saggers, Room 27, Baker Building, Trumpington Street, by 1st June 2007.

If photographs are sent by post please state whether you would like them returned and enclose an sae.

All entrants must include the following statement with their photos:
I give the Department of Engineering the right to publish the photograph(s) on its website and elsewhere.

The entrant must also provide:

- Name, address, telephone number and email address.
- Year of graduation.
- A brief summary of career since graduation.
- Title of the photo.
- Description of the photograph, noting whether the photograph is a composite of several images or has been enhanced in any way.
- Any due acknowledgements.

The judging panel will shortlist the entries and announce the winner by 15th June 2007.

The following guidelines should be followed:
Ideally the photograph should be of good print quality, but if it is available only as a web quality image then please still enter.

There is no limit to the number of photographs that you may enter. If you are not certain whether your photograph will win or you are trying to choose between several possible entries, then please just enter them all and let the judges decide.

We hope that our very first entry shown below will inspire you to enter.

Title: Advanced Communication Theory. This photo is of Richard Ford, who completed his PhD at the Department in 2002 with Professors Glover and Collings, hard at work at the McLaren F1 car test in Jerez, Spain. He's working on the laptop in the garage analysing live data from the cars as they circulate the track (this data is transmitted back to the pits in real time). He uses this data to spot problems in car operation, and help set up the car's various control systems (for which he is responsible at the track), including gearshift, differential locking, traction control, and many more systems besides.

He has two sets of headphones in order to monitor two separate radio channels (referring to the two cars we are running) as at the time all of our double-channel units were in use by other people. And at the same time he has come up with a novel solution to speak to the factory in Woking on his mobile phone.

Photographer Richard Hopkirk (Graduated from the Department of Engineering MEng 2001)

Engineering graduate receives the Sword of Honour prize at Sandhurst

The Queen presents the Sword of Honour to Angela Laycock

Engineering graduate, Junior Under Officer Angela Laycock received the Sword of Honour prize at Sandhurst, an award which is given to the most outstanding student of each course at the military academy.

She is the third woman to win the honour and was presented with the sword by the Queen at the Sovereign's Parade when the cadets passed out at the end of their gruelling 44-week course.

The prestigious award is given to the officer cadet considered by the academy's commandant, to be the best of the intake.

Angela, originally from Bedford, has no military family background. Her father is a printer and her mother a teaching assistant. She has dreamed of joining the Army since she was a child, and joined cycling, rowing and running clubs whilst at Cambridge. She said "It was all quite overwhelming. I didn't expect to win this. I'm so pleased to have received this honour, especially as we have to compete equally with the boys.

"It's been a lifelong goal of mine to join the Army. Ever since I was 15 or 16 at school I decided Sandhurst was for me. I love putting into practice all that they teach."

She added: "The commandant started to call out the winners of the 'big three' – the Overseas Sword of Honour, The Queen's Medal and finally the Sword of Honour. I was so nervous I instinctively sprang to attention."

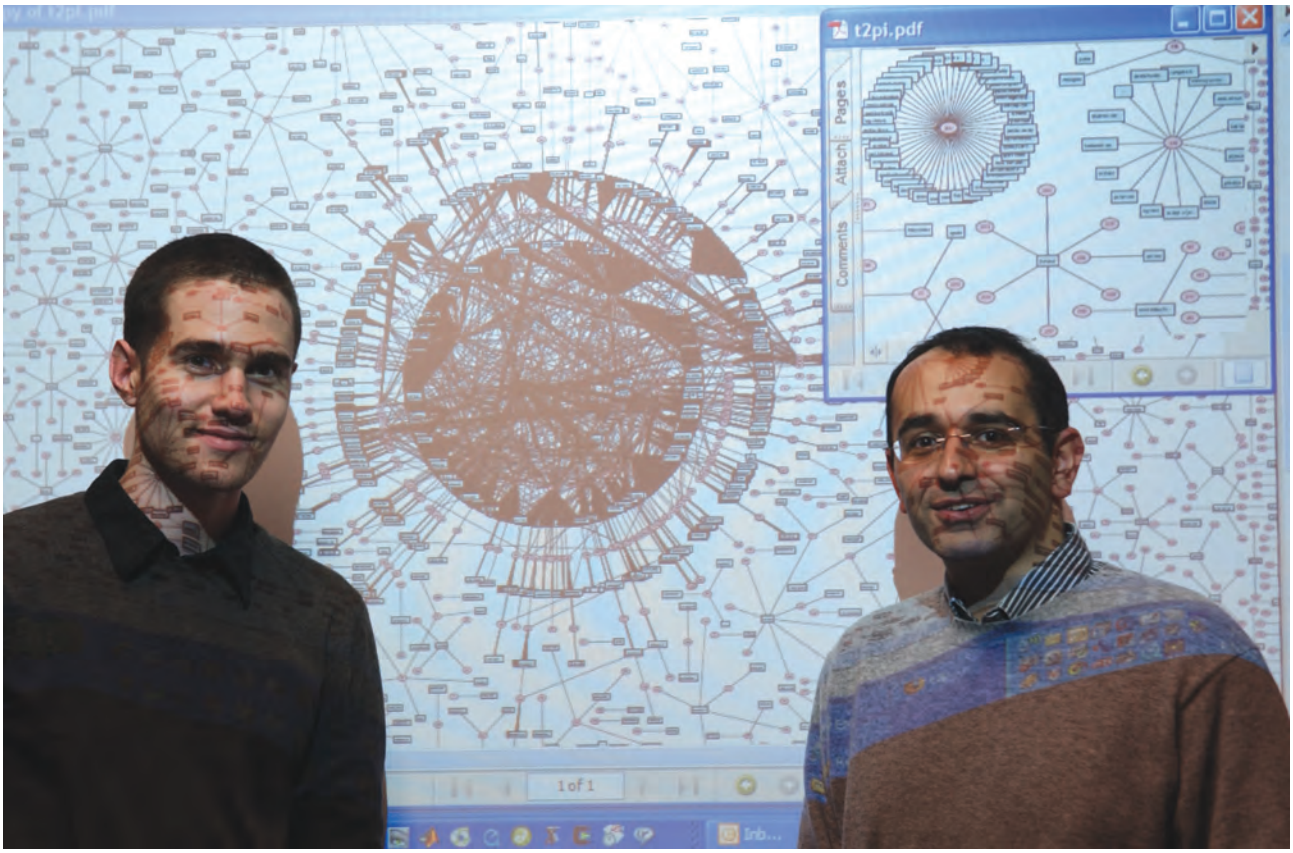
Angela attended Hastingsbury Upper School in Bedford before joining Welbeck College, the military's sixth-form college in Leicestershire which specialises in engineering subjects. Angela achieved five A grade A levels including one of the top five marks in maths in the country, then went on to study engineering here at the Department. She was a rowing finalist at Henley and represented England in the home counties rowing championship in 2003.

A Sandhurst spokesman said: "Female officer cadets at Sandhurst do exactly the same course as their male counterparts and compete on the same terms. Angela, with no Service family background, has proved to be a truly exceptional officer cadet."

As 2nd Lieutenant Laycock, she will now start her specialist training with the Royal Engineers.

More information can be found on the http://www.sandhurst.mod.uk/

Pushing the boundaries of search



Zoubin Ghahramani (right) and PhD student Frederik Eaton in front of a graph visualising how people search for information on MSN. This graph displays one thousandth of the data provided by Microsoft.

Zoubin Ghahramani, Professor of Information Engineering is one of 12 winners of a Microsoft Live Labs research award that aims to identify bold and innovative approaches to information retrieval, data mining, machine learning and human/computer interactions that can dramatically change the way we interact with the Web and its vast array of resources.

Recipients of the Live Labs grants are posing some of the most compelling questions in search technology today. Zoubin's grant has been awarded for 'Statistical Machine Learning for User Modelling'. His work aims at developing more intelligent adaptive search engines using methods from machine learning. Machine learning is the field of research concerned with how to get computers to learn from data, and to improve their performance. The web is the world's greatest database, and the combination of this data with search methods and machine learning offers many exciting opportunities.

In particular, Zoubin's group will look at ways to help improve personalised searches by learning from the results of searches by other users. They will also work on methods for predicting queries and identifying trends and trend-setters, and trying to discover the network structure of users and queries.

Designing good search methods involves solving an inference problem: "What is the probability that the user is interested in this web page given that she typed in this query?" Zoubin hopes that by making use of ideas that are coming out of cognitive science and statistical machine learning, we can create more intelligent, learning search engines.

Microsoft will help Zoubin's research with not only a cash award, but also with access to a wealth of real-world user query and click-through data from MSN. The data is completely anonymous so as to protect the privacy of the users.

Microsoft Live Labs is a partnership between MSN and Microsoft Research that brings together people with a variety of skills and perspectives to foster research programs, incubate entirely new inventions, and improve and accelerate new web-based technologies.

For further information please contact
Zoubin Ghahramani
http://learning.eng.cam.ac.uk/zoubin/

A move towards understanding

A move towards understanding
Image: Nature magazine

The Department's Professor Daniel Wolpert has been awarded a Wellcome Trust Programme Grant to study the computations the brain performs when controlling our movements. Movement is the only way we have of interacting with the world, whether foraging for food or attracting a waiter's attention. Indeed, all communication, including speech, sign language, gestures and writing, is mediated via the motor system. Taking this viewpoint, the purpose of the human brain is to use sensory signals to determine future actions.

However, the effortless ease with which we move our arms, our eyes, even our lips when we speak masks the true complexity of the control processes involved. This is evident when we try to build machines to perform human control tasks. While computers can now beat grandmasters at chess, no computer can yet control a robot to manipulate a chess piece with the dexterity of a six-year-old child. Therefore understanding brain processing could lead to dramatic improvements in technology.

A major area of Wolpert's research programme is to understand how the brain deals with uncertainty inherent in the world and in our own sensory and motor systems. For example, our only access to knowledge about the world is through our senses which provide information that is usually corrupted by random fluctuations, termed noise, which lead to variability in our perception; try localising your hand when it is hidden under a table. In addition, sensory inputs may provide ambiguous information about the possible states of the environment – you can't tell if a teapot is full or empty just by looking at it. Moreover, when we act on the world through our motor system, the commands we send to our muscles are also corrupted by variability or noise which leads to inaccuracy in our movements.

This combined sensory and motor variability limits the precision with which we can perceive and act on the world. Society places a premium on those of us who can reduce the overall variability of our sensory processing and motor outputs – financial rewards accrue to those who can reliably hit a small white ball into a hole several hundred yards away using a long metal stick.

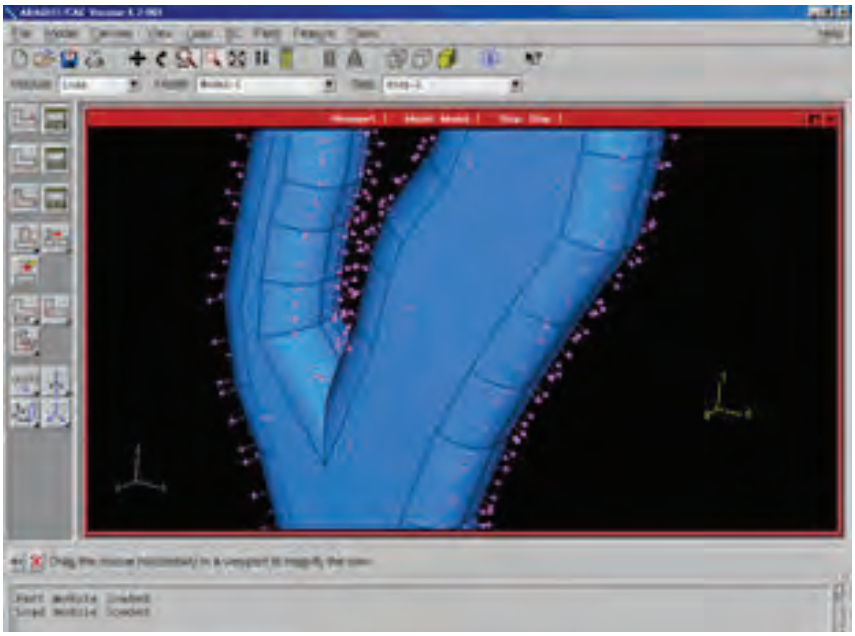
Wolpert's group have shown that not only does society care about reducing variability but that the brain dedicates its resources to reducing the uncertainty and variability in sensory and motor processing.

To investigate how the brain reduces uncertainty they have developed state-of-the-art robotic interfaces and virtual reality systems that allow researchers to control the environment as well as the visual feedback that volunteers experience during skill learning tasks. Using this apparatus they have recently shown that when we learn a new task, although we are not aware of it, our brains combine our prior experience with our current sensory input in an optimal fashion.

The precise way in which these two sources of information are combined is given by a formula known as Bayes rule after Thomas Bayes who was an 18th century English Presbyterian minister. The fundamental idea of Bayes Rule is that probabilities can be used to represent the degree of belief in different propositions about ourselves and the world – such as the probability that one is looking at an apple or tennis ball or that one's hand is at different possible locations when hidden under a table-top. Bayes Rule specifies the optimal way that these probabilities should be updated as new information is received. Bayesian methods are currently a major component of statistics and Wolpert's group is investigating to what extent they may provide a unifying mechanism by which the brain makes estimates about our own body and the world and chooses optimal actions.

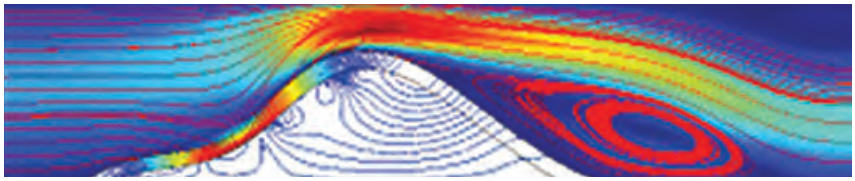
For further information please contact
Daniel Wolpert
http://learning.eng.cam.ac.uk/wolpert/

Biomechanics of the carotid artery



Computer generated image of the carotid artery.

Artery rupture



Simulation of the blood flow through a carotid artery, showing how the flow is disturbed at the constriction formed due to atherosclerosis. There is a higher speed region at the constriction and a recirculating flow pattern downstream. (Li et al, 2006, Stroke)

Atherosclerosis is commonly referred to as a "hardening" or "furring" of the arteries. When this occurs in the carotid artery, blood flow to the brain can be restricted resulting in a stroke. Dr Michael Sutcliffe and colleagues are studying the material, known as plaque, which is deposited on the walls of arteries that causes atherosclerosis. They are working to understand the interactions between the geometry and the material behaviour of the plaque, and the fluid mechanics of the blood flow through the artery.

The overall aim of the project is to use a combination of imaging and modelling of the carotid artery to develop better ways of estimating risk and so improve patient selection for different therapies. This includes a study of the stiffness and rupture of the plaque. Dr Jonathan Gillard at the Department of Radiology based in Cambridge's Addenbrooke's hospital, has developed world-leading techniques to produce high resolution images of the carotid artery, using high-resolution Magnetic Resonance Imaging (MRI) and Computed Tomography (CT). Michael and colleague Dr Yong Li are working with these imaging techniques.

The research team have recently received a donation by Instron of a universal testing machine, which will be used to assist with these tests. This machine will also be used for similar work on the mechanics of brain tissue being undertaken by a PhD student, Mr Dongjoo Kim, with Prof. John Pickard and Dr Marek Czosnyka at the Department of Neurosurgery.

For further information please contact:
Dr Michael Sutcliffe
email: mpfs@eng.cam.ac.uk

Extending active living through more effective design

The Department's Engineering Design Centre (EDC) has recently been awarded a major grant for a project on inclusive design titled "Extending active living through more effective design". The £1.9 million project is being lead by the EDC. Collaborators include Department of Psychiatry at Cambridge, Loughborough University and the Royal College of Art (RCA).

Rapid and unprecedented population ageing poses a serious social and economic challenge across the developed world. Escalating welfare and pensions costs require radical and imaginative responses from Government and industry. Key to this is maintaining a healthy population that is able and willing to work longer before retirement and can remain independent for as long as possible afterwards. A further requirement is to bring disabled people into mainstream life and employment. This challenge is recognised increasingly, resulting in new legislation impacting on the major world economies. Addressing it requires an understanding of wellbeing and its relationship to independence along with the redesign of workplaces and jobs to suit the changed profile of the working population.

There is a global market for products and services designed with older and less able people in mind, and industry is responding to this opportunity, both in the UK and internationally. A recent survey (commissioned by the UK Department of Trade and Industry and undertaken by Centre for Inclusive Technology and Design (CITD) with Professors Clarkson (Cambridge) and Coleman (RCA) of UK companies on the awareness and skills gap with regard to inclusive design concluded that the majority of companies are aware of inclusive design and its benefits. However, barriers remain to industry uptake due to, the lack of a perceived justifiable business case to support inclusive design, the lack of knowledge and tools to practice inclusive design,

Many consumer products require a capability level that exceeds that of a large proportion of the population. In many cases requiring such a high capability demand is unnecessary, and results in many people being excluded from using the product, and many more being extremely frustrated. The photos show a user attempting to open plastic welded security packaging, which requires extremely high strength and dexterity over a sustained period to cut with scissors, so the user tried more drastic measures (image below).

the need for a better understanding of the difficulties experienced by the majority of users of new technology products, and access to appropriate user sets. Importantly, the end-user data derived from earlier Office of National Statistics surveys on disability needs to be updated with data describing users from a product/user perspective, enabling designers to estimate better reasons for, and levels of, user exclusion and to provide greater insight in the search for better design solutions.

Inclusion is an important topic within government, as witnessed by a number of recent reports from the House of Lords and offices of the lower house. All see the need for change in government and industry to reduce exclusion in society, but few solutions are put forward that will encourage such change. It is also clear that descriptions of 'end-users', i.e. those that we wish to include, are vague and lacking in the detail required to encourage positive action. However, despite these shortcomings there is a mood for change and the proposed research team have good links with many of the government offices responsible for these reports.

EDC is supported by an £8 million grant from the Engineering and Physical

Sciences Research Council (EPSRC) as an Innovative Manufacturing Research Centre, (IMRC) which has recently been reviewed with an increase in budget. The EDC work to improve the effectiveness and efficiency of engineering designers and design teams by undertaking research into the theories that will underpin the design methods of the future and by promoting the importance of effective engineering design. These design methods are embodied in software tools, workbooks and publications that support the creation of reliable, high-quality, cost-effective products.

For further information please contact
Professor P John Clarkson
email: pjc10@eng.cam.ac.uk
The EDC website:
http://www-edc.eng.cam.ac.uk/

Silent aircraft one step closer to reality

Silent aircraft design

The vision of quieter and more environmentally friendly flying came a step closer as researchers from the University of Cambridge and the Massachusetts Institute of Technology (MIT) unveiled their revolutionary concept for a silent aircraft.

Originally conceived as making a huge reduction in the noise experienced by people in the vicinity of airports, this highly-efficient design also offers improvements of around 25% in the fuel consumed in a typical flight compared to current aircraft.

The design is intended for the generation after next of aircraft for entry into service in 2030. The design looked at improving the airframe as well as the engines, as half of the noise from a landing plane comes from the airframe. Some of the key design features employed include:

the overall shape of the aircraft which is a single flying wing – this allows the body to provide lift as well as the wings allowing a slower approach which reduces noise and the shape improves fuel efficiency as cruise flaps and slats have been eliminated – these are a major source of airframe noise when a plane is landing.

The undercarriage has been simplified and its aerodynamics improved when the engines are mounted on the top of the aircraft which screens much of the noise from the ground, novel ultra-high bypass engines, which have variable size jet nozzles allow slower jet propulsion during takeoff and climb for low noise. These can be optimized for maximum efficiency during cruise which requires higher jet speeds.

The research which led to the design was sponsored by the Cambridge-MIT Institute which has funded a wide range of research and educational collaborations between the two universities. The researchers formed a Knowledge Integration Community (KIC) which included staff and students from both institutions and participants from a wide range of aerospace collaborators which include regulators, airport and airline operators, aerospace manufacturers, other universities and representatives of a community group.

The KIC approach has been developed by the Cambridge-MIT-Institute and has been successfully applied in a number of research areas. It is an exciting way to address big problems and underpins the vital nature of collaboration in achieving the potential for step-change improvements.

Colin Smith, Rolls-Royce Director of Engineering and Technology said: "The Silent Aircraft Initiative (SAI) has been a great success in bringing many stakeholders together to study what an aircraft of the future might look like if very low noise was the primary requirement". Describing one of the clear lessons from the project he added: "The teams at Cambridge and MIT have energetically pursued their task and have considered some highly innovative ideas. The study has confirmed that the solution for extremely low noise must be a highly integrated combination of engine and aircraft design and operation".

This team has not only focused on the design itself but their work has had impacts on education, outreach and engagement with industry. The Department's Professor Ann Dowling, who led the UK research team said: "This project has brought industry, academia and other stakeholders together around a 'grand challenge' that has captured the enthusiasm and imagination of all partners: there has been effective collaboration, knowledge exchange, and development of a real team approach. The students involved have learnt a lot as members of this integrated product team."

For further information please visit http://silentaircraft.org/

Engineering for Sustainable Development

The Department's MPhil in Sustainable Development has a bumper crop of 36 students this year from almost as many countries: the UK, the USA, Malaysia, India, Canada, Australia, Uganda, Argentina, Vietnam, China, Eire, Germany, Trinidad, Kenya, Sudan and Jamaica. The course has been specially designed to attract top-flight engineers early in their careers to spend a year learning how to become more effective in delivering engineering for sustainable development, through enhanced technical skills, through better understanding of the issues surrounding Sustainable Development, and through an improved awareness of the commercial and management techniques to deliver more sustainable practices in their own working environments.

Chris Roe

Kyrea Njuguna

The course is now in its fifth year of operation, and has grown to its present size from an initial cohort of 14 students in 2002. Last year over 130 formal applications for places on the course were received, so competition is very strong. Graduates from the course are now working for a diverse range of organistions including the World Bank, the United Nations, UK Civil Service, US Navy and Dow Chemicals Ltd, NGOs such as Save the Children, the Intermediate Technology Development Group (ITDG), as well as engineering consultancies such as Mott MacDonald, Black and Veatch, Burro Happold, and Scott Wilson. Other graduates have gone on successfully to complete PhDs and are now holding academic posts. Several more have left to work for City Governments in places such as Vancouver, Trieste and San Luis Obispo, California.

Chris Roe, one of this year's MPhil students from the USA, describes himself as "A Seattle native". Chris says "I studied Mechanical Engineering at the University of Washington with an emphasis on energy and the environment. After graduation, I entered an engineering rotation program at The Boeing Company. Starting as an aircraft structures engineer, I soon decided to pursue my environmental interests and began working with energy conservation in Boeing's commercial buildings. Through the MPhil program in engineering for sustainable development, I hope to evolve my understanding of the complex environmental, social, and economic challenges that face engineers in industry. When I return to Boeing, I look forward to implementing sustainable practices into the company's energy use, and seek to be an agent of change."

Another of this year's students, Kyrea Njuguna, is from Kenya. Kyrea also plans to use this year of study to prepare for making a real difference. Kyrea says "I have 5 years of experience in the Oil & Gas industry working for major multinational contractors. The MPhil in Engineering for Sustainable Development should enable me to broaden the scope of my expertise as a Mechanical Engineer. I considered how my skills can be applied in a sustainable manner and especially instil this in future work in nation building in Africa and around the world. In terms of the future I hope to be in involved in project implementation, consultancy and policy making in the Energy industries, with emphasis on field work responsibilities. The renewable energy sectors are one of my interests, as they can be feasible in Kenya, for example. I hope to help create a self-sustainable energy network in developing nations where energy is readily available locally and its regional trade enhances the economic, social and ecological environments."

Kirsten Henson who finished the course last year had the following message for the Centre for Sustainable Development team "You are not simply educating the minds of the future but educating the minds that will ensure there is a future."

For further information on the Centre for Sustainable Development visit their website at: http://www-g.eng.cam.ac.uk/sustdev/.

What price alternative power sources?

Dr William (Bill) Nuttall, who holds a shared post between the University of Cambridge Judge Business School and the Department of Engineering, joined a broadcast discussion on the dividend from alternative electricity generation sources on the BBC Radio 4 programme 'The World Tonight' in September 2006.

The plans for the creation of a British billion pound energy research institute, the Energy Technologies Institute, promised in this year's budget by Gordon Brown to tackle global warming, have recently been unveiled by the government.

The aim of the Institute, to be jointly funded over a decade by the taxpayer and private companies, will be to develop new sources of energy that reduce the output of greenhouse gases. Energy companies will be asked by the government to contribute to this £500m scheme to research new low-carbon forms of energy.

In light of this announcement by the government, Nuttall was joined by a scientist from the Tyndall Centre. Together they gave an overview and commented on the viabilities of the various renewable energy technologies that are currently available.

Bill Nuttall is co-Editor of a new book, Future Electricity Technologies and Systems, published by Cambridge University Press, in which experts across the UK discuss renewable generation technologies.

Dr Bill Nuttall

For further information please contact:
Dr Bill Nuttall email: wjn21@cam.ac.uk

Department spin off company awarded £70K DTI grant

Christos Markides demonstrates the NIFTE heat pump with no moving parts

Thermofluidics Ltd, a recent spin-off company from the Department of Engineering at Cambridge, have just been awarded a £70,000 DTI funded research grant by the East of England Development Agency (EEDA). The company are developing 'Non-Inertive Feedback Thermofluidic Engine' (NIFTE) devices that do not require electricity to run and have no dynamic seals or bearings, giving them clear advantages over mechanical heat engines. Apart from unprecedented reliability and low maintenance, NIFTE devices can be manufactured from very low cost materials, using cheap and well established production techniques. This makes NIFTE pumps economically feasible in application areas where heat pumps are not currently viable.

Thermofluidics Ltd was co-founded by Dr Tom Smith and Dr Christos Markides, two recent graduates of the Department. Tom Smith said: "We are delighted with this grant, as it will help us to develop our NIFTE pumping technology to a stage where we can demonstrate required levels of performance in our two first stage applications: solar-thermally powered water pumping and domestic hot water circulation using waste heat. We will aim to demonstrate flow rates of up to 1000L/hr and pumping heads of up to 40m of water. We plan to demonstrate prototype units embedded into these applications over the next 18 months."

For further information please contact:
Dr Tom Smith
email: t.smith@thermofluidics.com
Dr Christos Markides
email: c.markides@thermofluidics.com

Dr Kenichi Soga wins the George Stephenson Medal

Dr Kenichi Soga

Dr Kenichi Soga, Dr Sang Ratnam (a former PhD student of the Department, currently working for Total) and Robert Whittle of Cambridge Insitu Ltd. were awarded this year's George Stephenson Medal from the Institution of Civil Engineers, for their paper entitled "A field permeability measurement technique using a conventional self-boring pressuremeter" published in Geotechnique in September 2005.

Long-term assessment of underground infrastructure requires not only the mechanical properties of the surrounding ground but also its groundwater flow properties. The prize- winning paper describes the development of a new *insitu* permeability measurement instrument. This instrument utilises a self-boring mechanism, which allows minimum disturbance to the ground during installation. A more accurate estimation of its insitu value, both vertically and horizontally, can be made.

The instrument was developed in collaboration with Cambridge Insitu Ltd, the world leading company in self-boring pressuremeters. The new instrument was tested at various sites in the UK including London and Scotland and is now a commercial tool used by Cambridge Insitu Ltd. The technical innovation of the work is that the instrument measures the scale dependency of insitu permeability and the paper describes comparisons between the measured scale effect and the theoretical values.

The new insitu permeability measurement instrument

New Year Honours

Professor Ann Dowling has been recognised in the New Year Honours list and is to become a Dame for services to science.

Ann Dowling is Professor of Mechanical Engineering, Head of the Division of Energy, Fluid Mechanics and Turbomachinery, Director of the University Gas Turbine Partnership with Rolls-Royce, and a Fellow of Sidney Sussex College. She has held visiting posts at Massachusetts Institute of Technology (MIT) (Jerome C Hunsaker Visiting Professor, 1999) and at Caltech (Moore Distinguished Scholar 2001).

Professor Dowling works primarily in the fields of combustion, acoustics and vibration and her research is aimed, in particular, at low-emission combustion and quiet vehicles. She is the UK lead of the Silent Aircraft Initiative, a collaboration between researchers at Cambridge and MIT who have recently released the conceptual design of an ultra-low noise and fuel efficient aircraft, SAX40.

Professor Dowling is a Fellow of the Royal Society, Royal Academy of Engineering (Vice-President 1999-2002) and is a Foreign Associate Member of the French Academy of Sciences. She serves on a number of industry and government advisory committees, and chaired the EPSRC's Technical Opportunities Panel (2003-06) and the Royal Society/Royal Academy of Engineering study on nanotechnology. She was appointed CBE for services to Mechanical Engineering in 2002.

Astronaut takes Department memento into space

Engineering graduate Nicholas Patrick

Cambridge engineering graduate Nicholas Patrick (Trinity, 1982) took his first flight as a NASA astronaut on the shuttle Discovery, having made it through the rigorous selection process to become one of the 321 astronauts selected by NASA. He is only the fourth Briton to go into space. NASA launched the space shuttle Discovery at 2047 (0147 GMT) on Sunday 10th December 2006, two days after poor weather forced a lift-off to be cancelled. Rocket flares from the shuttle were visible in the night sky across much of the south-eastern United States.

The shuttle landed at the International Space Station (ISS), which Nasa is racing to complete before the shuttle fleet is retired in 2010.

This is the third shuttle mission in six months and first night launch since the Columbia disaster in 2003.

While in orbit with the space station, Discovery astronauts carried out three spacewalks and rewired electrical systems inside the ISS.

After graduating Patrick worked as an engineer, a flight instructor, a programmer for a robotic company and a human-factors engineer. He has logged over 1,900 hours as a pilot in more than 20 types of craft, and trained as an astronaut since 1998.

Before the mission was underway The Times newspaper wrote, "Dr Patrick, 42, from Saltburn, North Yorkshire, and his crewmates are spending their final week in quarantine to avoid illnesses. It is an opportunity, he says, for some rest after the arrival two months ago of his third child and second son, Cameron. "I'm going into quarantine to catch up on some sleep," he joked. His wife, Rossana, a doctor, and their two other children, aged 4 and 3, were at the space centre at Cape Canaveral to watch the launch, with his parents Stewart and Gillian."

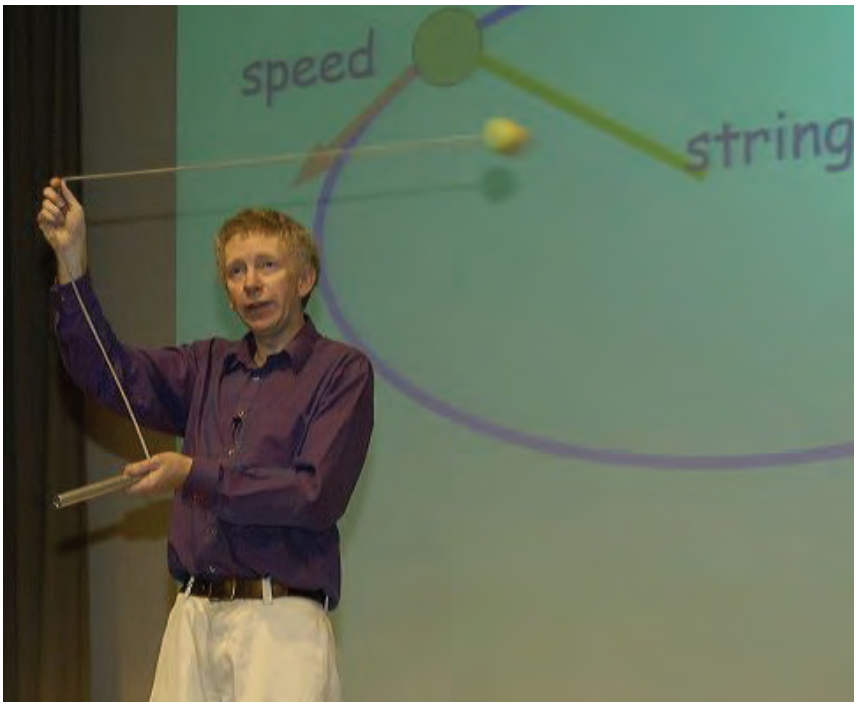
The mission, STS-116, was a construction and logistics mission to the ISS, the manned research space facility currently being assembled in 'low' orbit at about 220 miles above Earth. The ISS means there is now a permanent human presence in space, as there have always been at least two people on board since the first permanent crew entered in 2000. The ISS was also the destination of the first four space tourists.

Patrick took with him a memento of the Department of Engineering where he was a student: a medal bearing on one side an image of himself with the shields for the University and Trinity College. The other side has inscribed, "Nicholas Patrick became the first alumnus from the Department of Engineering at the University of Cambridge to journey into space during the flight of the space shuttle Discovery December 2006". The medal designed and made by Ali Khan and Alastair Ross, was specially etched in the Department on surgical grade stainless steel using high power laser. Alastair Ross, the Department of Engineering's Workshop Manager, led the work and came up with the design concept. Ali Khan worked with Alastair on the design and used a computer controlled laser at the Department of Engineering's Centre for Industrial Photonics to etch the images and words onto the medal.

For further information about the mission visit the NASA website http://www.nasa.gov/mission_pages/shuttle/main/index.html

The medal etched in the Department by high power laser

Communicating the Magic of Maths



Hugh Hunt giving his inspirational show

Dr Hugh Hunt a Senior Lecturer at the Department, is helping to make maths and physics more accessible and fun by giving inspirational lectures to audiences of all ages.

Hugh wants to help school pupils in particular to understand why maths is useful and to attract more young people to think about applying for courses in engineering.

By the end of this year, he will have given lectures to more than 4,000 GCSE and A level students at events that aim to bring maths alive for teenage audiences, encouraging more young people to study the subject beyond GCSE.

Topics for Hugh's lectures range from Boomerangs, Bouncing Balls and Other Spinning Things to The Secret Science of Music, and reflect his research interests in dynamics and vibration.

He carries a big suitcase of props to venues around the country, travelling by train. It contains bouncy balls, gyroscopes, boomerangs, bicycle wheels, mobile phones, hair dryers and angle grinders.

"Everyday objects are the best things to use. Then people can go away and experiment for themselves. It's great to see students throwing their mobile phones in the air after the lecture to test the law of conservation of angular momentum," he says.

During 2006 Hugh was a guest speaker at three Mathematics in Action events in London organised by the Training Partnership, and two shows staged by Maths Inspiration in Birmingham.

Mathematics in Action events, which attract audiences of up to 900 pupils, are organised by Radka Newby of the Training Partnership. Maths Inspiration is run by Rob Eastaway, a Cambridge graduate (Christ's College) and author whose books on everyday maths include 'Why do buses come in threes?' and 'How to take a Penalty'.

"We call our events "shows" rather than lectures and we are really choosy about whom we invite as speakers. They have to be both entertaining and able to put across complex ideas in a straightforward way," says Mr Eastaway.

"Our events are not about passing exams. We want pupils to leave feeling "Wow! That was fun and it's really got me thinking." Other Cambridge academics to have taken part in events run by the two organisations include Dr Robert Hunt, Deputy Director of the Isaac Newton Institute for Mathematical Sciences, and Dr Joan Lasenby, University Lecturer in the Signal Processing Group in the Department of Engineering. The schools events also regularly feature science writers Simon Singh (who did his PhD at Cambridge), David Acheson and the broadcaster Kate Bellingham.

In 2001 both Dr Hugh Hunt and Dr Robert Hunt (who are unrelated) were among winners of the University's annual Pilkington Prizes, awarded in recognition of excellence in teaching at the University. Dr Hugh Hunt has also twice been voted best lecturer by students in the Department of Engineering.

Article courtesy of Alexandra Buxton, University of Cambridge, Office of Communications and Community Affairs

Holographic projection – the partnership with ALPS

Dr Tim Wilkinson, Professor Bill Crossland, Dr Neil Collings

The University's recent press release announced that we have granted an exclusive licence to ALPS Electric Company Limited for a core holographic projection patent. This is an important milestone in the relationship between the Department of Engineering and ALPS, which started when ALPS became a founding strategic partner in the Centre for Advanced Photonics and Electronics (CAPE).

The experienced academic team of Professor Bill Crossland, Dr Neil Collings and Dr Tim Wilkinson is working very closely with ALPS to bring this technology to market through the ViHPS (Video Holographic Projection Display Systems) project. Jamieson Christmas, ALPS' Chief Engineer in the UK, is fully integrated with this academic team and is based in our labs in Cambridge.

Their impressive prototype was demonstrated earlier this year in Tokyo at the ALPS Show, which was attended by more than 6000 people from technical companies and the press. This device had a footprint about the same size as a credit card. It showed real-time images from a video camera as guests approached the exhibit using no more processing power than an ordinary laptop computer.

Example of a hologram as displayed on an LCoS microdisplay from the CAPE ViHPS Project. The pixels are coloured black and white to represent different phase values. The microdisplay is actually totally transparent. Photo courtesy of Jamie Christmas.

This is the replay of the hologram shown left to produce this picture in the far field. Photo courtesy of Jamie Christmas.

For further information please contact:
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Pandia Raj Ramar wins Hangai Prize Award

Pandia Raj Ramar receiving the Hangai prize

Pandia Raj Ramar, a PhD research student in the Structures Group of the Department of Engineering, has won one of the Hangai Prizes awarded at this year's International Association for Shell and Spatial Structures (IASS) Symposium in Beijing. The Hangai Prize is given by the IASS for the most innovative paper submitted by a young researcher. Raj's paper is entitled 'Using Symmetry for Tensegrity Form-finding'.

Raj is working with the Department's Dr Simon Guest on the development of novel symmetric tensegrity structures. Tensegrity structures were first explored by the artist Kenneth Snelson, to produce structures such as the 18 metre high Needle Tower, seen in the photograph. They are a remarkable structural form, where disconnected compression members are supported by a continuous cable network that is in tension. Raj has applied the tools of symmetry analysis and group representation theory to simplify the key step of 'form-finding' for tensegrity structures. The paper presented at the IASS 2006 symposium shows examples of his method where a simple analytical solution gives all possible symmetric configurations of certain tensegrity structures.

Raj is supported by the Gates Cambridge Trust, and received additional support from the Department of Engineering and Jesus College to attend the IASS symposium.

For further information please contact Pandia Raj Ramar email: rp317@cam.ac.uk

The needle tower sculpture built in Washington by the artist Kenneth Snelson. Raj's work is developing methods to find all possible examples of similar structures.

Alumna wins 'Individual of the Year' award for her post Tsunami shelter programme

Jo da Silva, a graduate of the Department, now an Associate Director of Arup and a frequent guest lecturer on the MPhil Sustainable Development course, has been named 'Individual of the Year 2006' for her role in a United Nations High Commissioner for Refugees (UNHCR) project. The project was to provide appropriate transitional shelter for people made homeless by the Boxing Day tsunami two years ago.

In an interview with The Times newspaper she said "About 120,000 homes were lost in Sri Lanka and my role was to co-ordinate the shelter sector where more than 100 non-government organisations were proposing to build shelters. We set standards for the shelters to be 200sq ft and 6ft high at the eaves, so people could stand up and sit down, with secure lockable doors and an internal partition for privacy. We wanted to bridge the gap between emergency shelter-like tents and newly reconstructed homes. It was a huge challenge which demonstrated that no matter how much money there is, you still need knowledge, leadership and expertise. The award recognised my contribution but also the partnership between the private sector, the UNHCR and the Sri Lankan Government." In six months 60,000 shelters were put up.

Jo is a trustee of Engineers Without Borders, an organisation that encourages young engineers to participate in overseas development.

For more information on the British Expertise awards visit their website: www.britishexpertise.org/

Project Nova takes to the skies

A group of ambitious students from the Department have set themselves a sky-high goal – to launch a rocket into space for under £1000. The first component of the system has just been tested, producing spectacular images of the curvature of the Earth from the upper atmosphere.

The team used a high altitude helium balloon to launch their tiny payload, no bigger than a lunchbox. Packed with instrumentation, it flew to nearly four times the height of Everest before descending by parachute, taking photographs throughout the flight.

"This marks the first step in a series of flights to prove our tracking and telemetry systems. Once we can take a larger payload stably up to 30km, we will be in a position to launch a rocket from the balloon that will reach the 100 kilometre boundary of space for a tiny fraction of the present cost," says Carl Morland, founder of the project. "By using a balloon to go as high as possible, a considerably smaller rocket can be used as there is much less drag due to the thinner air."

Project Nova is part of Cambridge University Spaceflight, a student-run organisation dedicated to space flight development. The balloon carried a camera, a data transmission system and two tracking systems, as well as the parachute. "We can track its position to within ten metres", says Henry Hallam, responsible for developing the tracking system. Robert Fryers, whose work on miniaturising the electronics was vital in making the flight possible, is excited about the future possibilities. "By reducing the size and weight of our control systems like this, we can go higher and carry more experiments."

The flight lasted about three hours, producing over 800 images. "After a tense night of checks, we took the balloon and payload to the launch site at Churchill College, Cambridge," says Hallam. The balloon was filled with enough helium to lift the payload at a steady rate of ascent of about 11mph. As the balloon rises it expands and it will keep on rising until it bursts, which it did exactly two hours after lift-off at an altitude of 32.2km or 105,600 ft above sea level. The descent was initially rapid in the thin air, reaching a peak descent rate of 100mph. Once the parachute had fully opened, the balloon landed safely at 12mph."

Cambridge University Spaceflight's Nova project is supported by the Cambridge-MIT Institute.

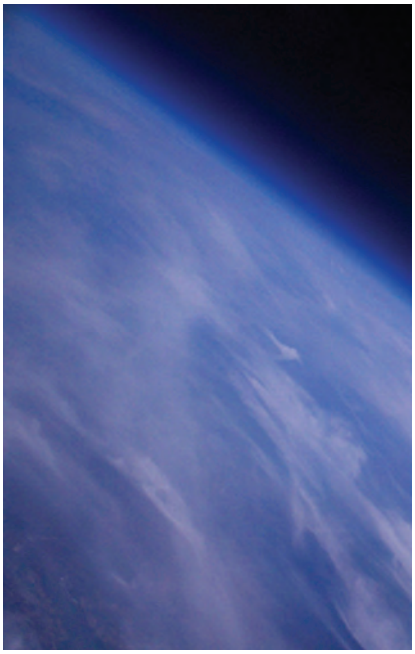
A video of the launch and a gallery of some of the photos can be found at www.cuspaceflight.co.uk. Further launches are planned for the coming weeks.

Please note, readers should not attempt similar experiments without the support of professional engineers, a thorough safety assessment, and the consent of the Civil Aviation Authority.

The team responsible for the launch can be contacted for further information.

Carl Morland email: cm471@cam.ac.uk
Henry Hallam email: hmh33@cam.ac.uk
Robert Fryers email: rjf44@cam.ac.uk

Launching Nova 1



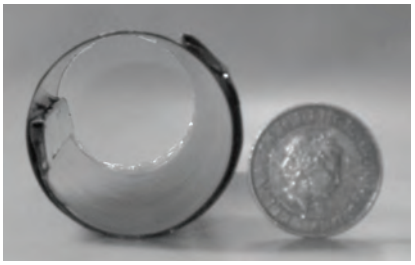
View from Nova 1 at 32km (105,000 feet)

Nova 1 Payload

Roll-up laptop screens for truly portable computing

A mocked-up flexible display supported on one of Keith's morphing structures

The display coiled up into a self-locking tube



View showing the overall thinness and compactness of structure

Dr Keith Seffen, a lecturer in the Structures Group, has developed a range of unique solid structures that can change shape. Known as "morphing" structures they can be used to produce many different configurations but without the need of complex parts or sophisticated manufacture. Along with his co-workers, Dr Simon Guest and graduate student, Alex Norman, they are working on a range of applications, including re-usable packing, roll-up keyboards, and thin flexible displays for truly portable computing: a "mock-up" and its operation are shown in the photos, where an A5-sized flat screen snaps into a tube for compact carriage in a briefcase or pocket.

Keith considers the performance of structures from multiple viewpoints, in particular how to retain strength and stiffness while permitting large changes in shape. Typically, civil engineering structures are designed to be strong (safe) and stiff (immovable); when they are not, the consequences can be disastrous. Writing in 'Proceedings of the Royal Society of London, Series A' (DOI: 10.1098/rspa.2006.1750), he describes a class of structures that behave normally under the usual operating conditions, but when the demands upon them increase, their response softens in a prescribed manner, permitting large yet safe departures from the original shape before becoming stiff and self-locking in a new configuration. Such behaviour is governed by the choice of material and initial shape of structure, and Keith combines these influences in a systematic manner for the first time, yielding the conditions required for morphing behaviour in a wide range of structures.

Assisted by Cambridge Enterprise, Keith and his team have filed a patent on the manufacture and operation of their morphing devices, and are actively seeking industrial collaboration for future development.

Please contact Dr Seffen (kas14@cam.ac.uk) for further information or visit his website http://www2.eng.cam.ac.uk/~kas14

What is engineering all about? An undergraduate's view of her first year at Cambridge

Charlotte Kershaw

One of our first year students, Charlotte Kershaw, is a runner-up in this year's Engineering Subject Centre Student Award for her essay on 'How does your experience of your course compare with any expectations you may have had?' Charlotte's essay beat off stiff competition and made it to the final against fifteen other entries.

You can find out more about the awards at www.engsc.ac.uk and read Charlotte's essay below.

Before I started my engineering course in October last year I had very few expectations or ideas about what it would be like. Indeed, I had only the vaguest grasp of what engineering was. I had my spiel which I dutifully trotted out at every interview about engineering being about helping people, being about innovation, being about the application of knowledge to the real world, but how did one go about teaching engineering? I had no idea.

Of course I knew that there would be these exotic sounding things called lectures, but what would they be like? I imagined old men with interesting facial hair talking in monotones for hours on end whilst I scribbled furiously in an attempt not to miss the crucial point that would come up in exams. I pictured myself spending hours in the library, being given a topic and then sent away to learn it. I wasn't even sure what I would learn as an engineer, let alone how it would be taught. A lot of maths and electronics and structures, I supposed, but what was it that was going to make my engineering degree different from a maths or a physics degree?

As I told numerous interviewers, engineering is about applying theoretical knowledge to solve real problems, and the link between the theoretical and the practical has been a major theme in my course so far. At A level I often questioned how what I was learning could be applied to the world. For example, how could the existence of j, the square root of minus one, which didn't actually exist, ever be of any real benefit to anyone? I imagined joining the working world able to sit and solve differential equations and work out the reaction forces in pictures of ladders but with no abilities that were of any use. It has been a major relief to come to university and suddenly be showered with examples of how I will be able to apply my knowledge. Both lectures and practical work demonstrate how useful my degree is going to be, with many lecturers giving examples of disasters in the past involving, for example, a bridge collapsing, and showing how the situations which led to these disasters could have been foreseen and averted using only first year engineering knowledge.

Lectures are not the dull monologues that I expected but are littered with practical demonstrations which are interesting diversions, especially when they fail to act as they're supposed to, as well as being very effective ways to remember a particular principle. At Cambridge each lecturer provides a handout, so there is no frantic scribbling and you are free to listen. As well as academic lectures there are also lectures from outside speakers with topics such as the role an engineer must play environmentally, the importance of renewable energy, and new advances and breakthroughs in various different fields. The hours and hours I imagined spending in the library have also never come to pass. Although the library is a very useful resource when you have trouble grasping a particular topic, the lecture handouts contain ample information and papers of questions are issued every week to back up what is being learnt in lectures.

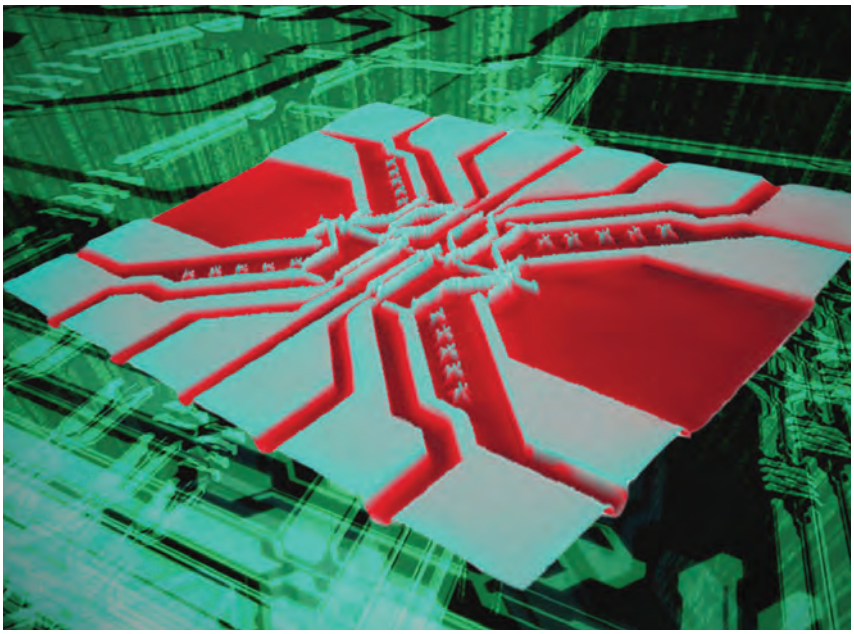
Something I did not expect was the abundance of practical work and experiments. At A level practical work was scarce and usually repetitive. I expected university to be no different, but now I have laboratory experiments 3-5 times a week and the subjects have been as diverse as programming a microprocessor to control a heater to loading a sample of steel until it fails, first at room temperature and then at minus 196 with the aid of liquid nitrogen. Each lab session is accompanied by a handout, and I very much like the way that, following an introduction, one is left to follow the instructions and figure things out for oneself, so that, though there is always help if needed, one is free to experiment, get things wrong, and fix the problems independently. I have found this to be a much more effective way to learn than the more controlled and constrained practicals I experienced at secondary school.

It is very true that, in general, learning at university is very independent. Though one is not left to sink or swim totally unaided every student is very much in control of their own learning. Though I was told this many times before I came to university I never really believed it, since surely it would be in the university's best interests to actively ensure that each student is working hard and is going to pass their exams. But, even if this is the case, every lecturer is also conducting

research or consulting for a project, and none have the time or the inclination to continuously check up on students.

On the whole I have found my course to be very different to the few expectations I had before coming to university. The scope of the course has been far greater than I imagined and all of the doubts and worries I had about starting my university life, such as not being able to keep up with the work and failing to take enough notes to revise for exams, have been cancelled out. I am enjoying a greater degree of independence in my studies and, above all (an expectation that I never had, and one which has been to me the most important change between secondary school and university), I finally understand how what I am learning can be applied to the real world. Which is, of course, what engineering is all about.

New method of growing carbon nanotubes to revolutionise electronics



A new method of growing carbon nanotubes is predicted to revolutionise the implementation of nanotechnology and the future of electronics.

Researchers at the University of Cambridge have successfully grown nanotubes at a temperature which permits their full integration into present complementary metal-oxide semiconductor (CMOS) technology (350 °C).

Carbon nanotubes are the driving force for current advances in nanotechnology; they have excellent mechanical and electronic properties, the latter making them extremely attractive for new-generation electronics.

Increasing efficiency through smaller components is the key towards miniaturisation of technology. The use of carbon nanotubes could find successful use from sophisticated, niche applications to everyday electronics (mobile phones, computers).

Thus far the growth of nanotubes has been carried out at very high temperatures, and growth below 500 °C was believed impossible. This made the direct implementation of nanotubes into electronic devices unthinkable. Trying to integrate nanotubes above 400–450 °C would in fact damage the inter-metal dielectrics commonly employed in CMOS device fabrication.

A group of researchers at the Department of Engineering, led by Mirco Cantoro, Stephan Hofmann, Andrea Ferrari and John Robertson, in collaboration with colleagues at the Cambridge Hitachi Laboratory and the Department of Materials Science, University of Cambridge, succeeded in growing single-wall carbon nanotubes at temperatures as low as 350 °C.

These nanotubes, grown by thermal Chemical Vapour Deposition (a chemical process often used in the semiconductor industry), are promising candidates for integration into existing nanoelectronic devices.

This result also sheds new light on the possible mechanisms that occur during carbon nanotube growth. Previously, the assumption that the catalyst has to be liquid often dominated carbon nanotube growth model considerations, but at these lower temperatures evidence has been found of a solid catalyst. These findings extend to the catalytic growth of other nanostructures in general.

For further information please contact:
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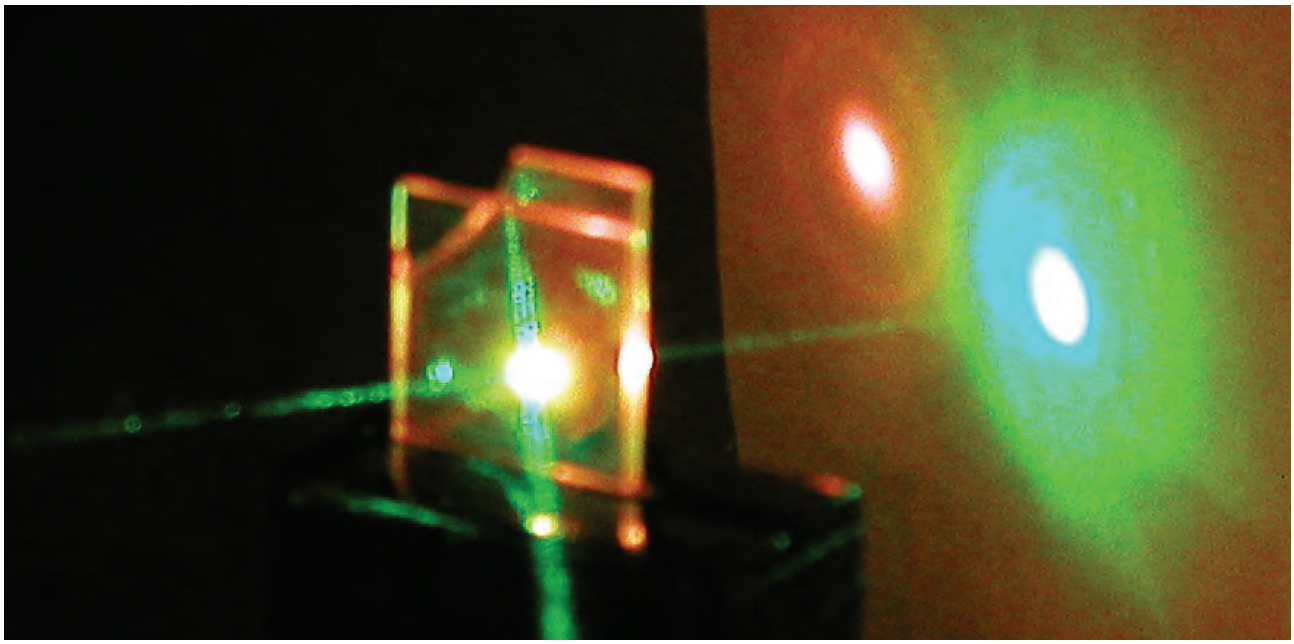
Photonics and lasing in liquid crystals



A lasing liquid crystal cell

Lasers were invented some 40 years ago and are now used in so many different applications. Stable liquid crystals were discovered at about the same time, and are now the basis of a large display industry. Both technologies involve photonics, the former in the creation and use of light and the latter in the control and manipulation of light. However, it is only recently that these two mature technologies have been combined to form liquid crystal lasers, heralding a new era for these photonic materials and the potential for new applications such as:

- **Medical applications.**
  Lasers are widely used for medical procedures such as the removal of skin blemishes. However, currently different coloured lasers are used for different procedures. Each individual laser is very expensive and they can be quite large in size, approximately the size of a small fridge. The microscopic size of these liquid crystal lasers (the size of a human hair) and the ability to easily vary the laser wavelength (from ultra-violet wavelengths, through the visible spectrum to infra-red wavelengths) make these lasers an extremely attractive alternative laser. A single liquid crystal laser could be used for a range of different surgical procedures thus eliminating the need to use a different laser for each individual different procedure. Liquid crystal lasers will save time, money and space.

- **Lab-on-a-chip technology.**
  Lab-on-a-chip technology is already being exploited (Nature, 442, 27th July 2006 P351) for chemistry procedures. Through reducing the size of scientific lab components to fit onto a chip, the operating time and costs of multiple scientific experiments are also significantly reduced. The microscopic size and wide wavelength tuning range of the liquid crystal laser makes it an ideal candidate for lab-on-a-chip applications such as optical spectroscopy (studying matter by investigating light that is emitted, absorbed or scattered by it).

- **Pixel arrays in liquid crystal displays (LCDs).**
  The microscopic dimensions of a liquid crystal laser are comparable to that of an LCD pixel. This in addition to the ability individually to address and tune each laser (pixel) will enable brighter LCDs with higher contrast ratios to be developed.

Professor Harry Coles, Dr Alison Ford and Dr Stephen Morris from the Department's Centre of Molecular Materials for Photonics and Electronics present an overview of the topic of liquid crystal lasers in an article published in the July/August 2006 'Materials Today' journal http://www.materialstoday.com. The article summarises the characteristics of liquid crystals that lead to laser devices, the wide diversity of possible laser systems, and the properties of the light produced.

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