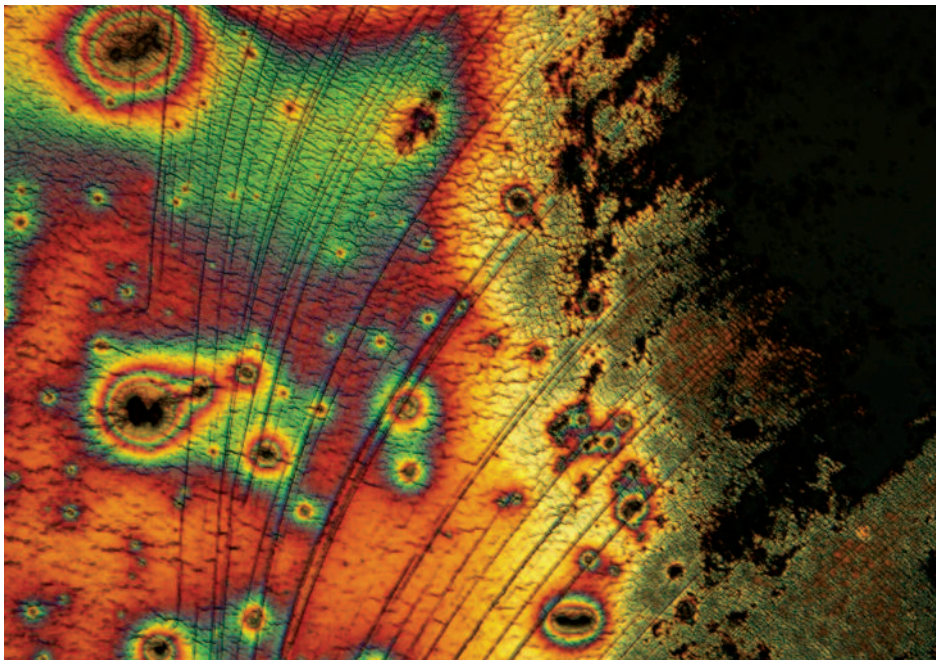
Newsletter

Issue 8 | Summer 2009

UNIVERSITY OF CAMBRIDGE
Department of Engineering



Picture entitled 'Moth' by Dr Ingrid Graz, won second prize in last year's Photography competition and has been used extensively in the University 800th Anniversary celebrations

Best Engineering Research in UK

The Department of Engineering has come top of the rankings for General Engineering according to the national Research Assessment Exercise.

The results were published in December 2008 and show a superb outcome placing Cambridge far ahead of other institutions in its class. 90% of the research submission by the Department was judged to be either internationally excellent or world-leading in terms of originality, significance and rigour. Remarkably, the breakdown shows that 45% of the submission achieved the world-leading status; this far exceeds the result for any other submission in General Engineering and is not surpassed by any institution in any other engineering or scientific discipline.

The result represents not only the excellence of individuals comprising the Department's 132-strong faculty, but also shows the power of uniting these academics in a single integrated department. They span a remarkably wide range of engineering disciplines and, within this one department, can easily team up to address the world's most pressing challenges. Their expertise and capacity for research is augmented by 195 contract research staff and research fellows. 573 research students also play a key role in undertaking research, transferring research skills to industry and, for some of them, becoming the next generation of engineering academics. The scale and quality of the Department enables it to secure the best support staff and facilities. Scale and quality also make it easier for the Department to build long-term relationships with other academic disciplines, other institutions, companies and the entrepreneurial community. These connections for undertaking collaborative research are also vital for transferring outputs to have material benefits for society. All of these factors reinforce each other in a virtuous circle by attracting the best academics, students and collaborators.

The result of the Research Assessment Exercise is a tremendous endorsement of the Department's staff and strategy, but ambitious plans and continual change are essential if the Department is to keep its world-leading position.

For more information on research collaborations please contact Philip Guildford: www.eng.cam.ac.uk/~pg28/

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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

Student numbers up

Another success for the Department is the number of students starting the undergraduate Engineering course which has seen a substantial increase on previous years. 324 first year students started their Engineering degree this academic year compared to 301 the year before.

Two hugely successful projects that without doubt have helped the Department to achieve such an increase are the Headstart summer schools and our Engineering Outreach programme.

Dr Geoff Parks is involved in organising Headstart courses open to students in Year 12 (or equivalent) who are interested in knowing more about working in the world of science, engineering and technology.

Dr Parks said: "Headstart provides a fantastic opportunity to discover what it is like to be an undergraduate at Cambridge and to learn more about the scope and importance of Engineering in the modern world. It is very gratifying to see many students whom I first met on our Headstart course going on to great things as undergraduates, and indeed postgraduates, at Cambridge."

The Headstart Engineering summer school at Cambridge gives participants a taste of the Cambridge style of teaching and the broad scope of the Engineering course.

Participants live in Jesus College to give them a taste of collegiate life. The four-day programme incorporates lectures, practicals, supervisions and a team design-build-test project plus social activities. Through these, they have the chance to meet and talk with current Cambridge undergraduates, graduates and teaching staff.

Dr Joy Warde is the Department's Outreach Officer who runs the Department's Engineering Outreach programme. Staff and students from the Department are involved with many activities to promote Engineering in both the local Cambridge area and nationally.

The outreach undertaken by the Department engages children, families and young people in the challenge of hands-on activities – such as building rockets and planes, skyscrapers and bridges.Working with more than 120 undergraduate and graduate volunteers, Joy stages a busy programme of outreach activities. Each year these attract participation by around 2,000 people.

Some activities are staged for schools and groups; others are open to the general public.

Engineers develop their Entrepreneurial skills

Six students from the Department have been awarded the "Certificate in Enterprise" after attending the highly successful Enterprise Tuesday series.

Shakir Mohamed, awarded the Certificate in Enterprise with distinction

To receive the prestigious certificate candidates had to prepare a portfolio which addressed eight of the twelve themes discussed at the Enterprise Tuesday lectures.

In total, fifty-nine people were awarded the Certificate in Enterprise and of the eleven gaining distinctions for the quality of their assignments, two were from the Department: PhD students Shakir Mohamed and Mash-Hud Iqbal.

Shakir's portfolio addresses issues in entrepreneurship such as how to recognise business opportunities, the ways in which resources can be gathered, and how to avoid mistakes in setting up a new business.

Shakir said, "I thought the programme was well structured and included a wide range of speakers whose knowledge, experience and passion for each of their businesses came through in their presentations. I find that entrepreneurial skills are particularly useful for an engineer whether one chooses to engage in a new business venture or not. These skills allow you to think about the impact of engineering work in the context of generating profit and usefulness to the consumer, and also gives an additional viewpoint from which to be objective about an engineering product, whether it be hardware, software or a design. The Enterprise Tuesday series is a great way for anyone to gain additional skills outside of their field of study. It is also useful to test or even develop your networking skills in the networking sessions held after the talks. In many cases the speakers are at these networking sessions and it is interesting to speak to them and quiz them about their experiences."

Mash-Hud has also benefited from the series. He explained, "From attending most of the Enterprise Tuesday lectures I learned a great deal about how to develop my entrepreneurial skills. All of the key-note speakers demonstrated a huge amount of motivation and provided valuable suggestions that could be helpful to young entrepreneurs. Being motivated, believing in yourself, being determined and persistent are the key issues to start with. After that comes understanding the business structure, knowing the market and customer needs, and seeking help from experienced key-players. Finally, in order to actualise an idea one needs to raise funds, convince investors, hire experienced people, and understand how boards of directors and business partners work. Learning these exciting aspects of entrepreneurship has enabled me to think constructively about the way to materialise my research ideas into a commercial product."

The Enterprise Tuesday programme, managed and delivered by the Centre for Entrepreneurial Learning, is a free evening programme open to the local business community and all the staff and students of the University of Cambridge. It is proving ever more popular with the number of candidates submitting portfolios doubling, a 38% increase in registered attendance on the 06/07 series and an average of around 300 people attending each of the twelve lectures. During the last year, people have travelled from Cranfield, London, Manchester, Wales and even from Finland to attend lectures. The quality and expertise of speakers such as Karren Brady of Birmingham FC, Lord Karan Bilimoria of Cobra Beer and Duncan Goose of One Water, is clearly a draw and kept people engaged throughout the entire programme.

Over a quarter of the registered attendees are from the local business community which is around a five per cent increase on last year. One of the main benefits of the programme is that it brings the academic and business communities together adding to the chemistry in the networking sessions which follow on from each lecture.

Further information about the programme can be found on the Enterprise Tuesday pages of the Centre for Entrepreneurial Learning website at: www.cfel.jbs.cam.ac.uk.

Dr Julian Allwood awarded EPSRC* Leadership Fellowship

Dr Julian Allwood has been awarded an EPSRC Leadership Fellowship for his work to reduce global carbon emissions that arises in the production of steel and aluminium parts.

Julian is a Senior Lecturer in the Department and as well as leading research activity on novel metal forming processes and the environmental impact of production, has initiated the departmental seminar series on 'Engineering for a Low Carbon Future.'

Julian summarises the research that he will be undertaking: "8% of global carbon emissions from energy use arise in the production of steel and aluminium parts. Demand for the two materials is currently growing at 6% per year, and is set to double within 25 years, yet in response to concerns about climate change we are aiming at a 60% cut in carbon emissions by 2050. How can this occur?

Industry efforts to improve energy efficiency and increase recycling rates have both been effective, but the most optimistic forecasts suggest only a further 30% reduction in emissions per unit output – which isn't enough to meet the target. The fellowship aims to find out how we could meet the carbon target for steel and aluminium.

Working with academic partners in several countries, future scenarios of metal flows and associated economic forecasts will be developed to anticipate what must be achieved. These will then be explored with a consortium of 20 major global companies spanning the metals supply chain, to identify the barriers to achieving them and find technical, economic and policy measures required to overcome the barriers.

Although all plausible scenarios will be examined, it is likely that a key element of a low carbon metal economy would be extensive re-use of metal without melting. Accordingly the fellowship includes exploration of several technological changes that would be required to support such re-use. The fellowship has attracted £1.5m of government support through the EPSRC and £2m of industrial commitment from companies including Boeing, Ford, Jaguar Land Rover, Corus, Alcoa, Novelis, Siemens, Arups and many others."

*Engineering and Physical Sciences Research Council

Control your TV simply by waving your arm

Consumers will soon be able to control their TV screens or home entertainment systems simply by waving their hand, thanks to technology developed by Toshiba's Cambridge Research Laboratory in collaboration with the Department of Engineering.

The new gesture-based interface for flat panel displays was recently shown at a major consumer electronics show in Berlin.

Using the Toshiba experimental TV viewers are able to interact with the display system simply by gesturing with their hand. Once the viewer is in front of the display screen, the system will 'see' them and invite them to take control of the display simply by raising their hand. As the system can robustly track their hand even under different lighting conditions, the visitor can enjoy controlling the on-screen cursor.

"The gesture-control research is extremely exciting and is opening an array of possibilities for consumers, such as new interfaces for TVs and interactive displays in shop windows and information kiosks," explains Professor Roberto Cipolla , who with Dr Bjorn Stenger at Toshiba and Tom Woodley at the Department of Engineering, has been pioneering the use of computer vision in human-machine interaction since 1992. Tom is a PhD student here at the Department and Roberto and Bjorn are both Department of Engineering alumni.

"The gesture interface may not replace a remote controller, but can provide an alternative way to interact with a PC or display. Imagine never having to search for the remote controller to turn the TV volume down when receiving a phone call.

"Having developed the system, we are now working on expanding its capabilities to ensure an easy-to-use and reliable system for the consumer which will work in real word scenarios, such as shops or peoples' living rooms."

Another vision-based interface has also been developed, viewers will be able to switch the display's language or contents simply by showing different picture cards. Identification interfaces like this offer the user the ability to personalise either the interface or the contents.

The system uses a single camera mounted on the top of the display and is started by the user raising their hand to initiate the interaction. The software then tracks the person's hand using multiple cues including colour, motion and appearance. It can reliably recognise and track the user's gestures even under rapid motion or changing light conditions. Since different cues are less reliable in different situations this multiple-cue approach is key to making a human computer interface work robustly.

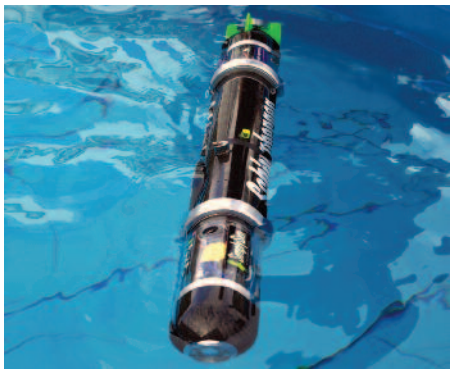
A hand signal pauses the new TV

The team's current research focuses on how to deal with multiple users (in a living room setting for example), how to track with finer control and how to deal with difficult lighting systems.

For more information please visit Professor Roberto Cipolla's webpages: http://mi.eng.cam.ac.uk/~cipolla/index.htm

Students win the Award for Innovation in Systems Engineering at Autonomous Underwater Vehicle competition

The University of Cambridge Autonomous Underwater Vehicles (CAUV) team competed in the third Student Autonomous Underwater Challenge-European (SAUC-E) competition and won the Award for Innovation in Systems Engineering.



The AUV in the water

The competition challenges university students from across Europe to design and build their own underwater robots and then perform realistic missions in the underwater environment, and by doing so advance Autonomous Underwater Vehicle (AUV) technology.

The competition encourages young engineers and scientists to think about underwater technology and its future possibilities, as well as fostering ties between the students and the organisations involved in AUV technologies.

The robots that the students build must be able to travel through an underwater assault course consisting of validation gates, submerged buoys, marker dropping targets and surface zones. However, the most impressive aspect of this competition is that the Autonomous Underwater Vehicles, as the robots are known, must complete the task on their own. This means no remote controls and no communication from equipment on the surface. Once the AUV is placed in the water it is on its own and must navigate its way based purely on its own sensors.

The Cambridge AUV team have a much improved robot from their 2007 model, with large thanks to sponsors Schlumberger, Composite Engineering and SimplySim. The entire hull was brand new and custom built including the carbon fibre shell.

The CAUV is 1.1m long and has a 90mm diameter with 4 internal vectored thrusters to provide manoeuvrability and a 100W rear propeller for a maximum speed of around 4.2m/s and a maximum range of 40km at a cruising speed of 2.4m/s. It makes use of the world's smallest full-featured x86 mainboard, the PICO-ITX, to power the autonomy software which guides it through the underwater assault course.

Paul Esparon, team captain said "The best part of the competition is meeting the people from the other teams. There is a fantastic amount of camaraderie between all the teams. Every team was quick to help the other teams by lending the various nuts or bolts that they were missing."

CAUV is a student-run Society of the University of Cambridge and relies on new recruits to keep the project a success. Preparations for the 2009 competition are underway.

Cambridge AUV would like to thank everyone who is involved with the project in one way or another. Particular thanks go to Dr T. Nickels, Alistair Ross, Steve, Professor Peter Wadhams, all the staff at the Department of Engineering, and the teams and organisers of SAUC-E.

For more information, please visit the Cambridge AUV website: www.cambridgeAUV.co.uk

Project Pebble

Project Pebble aims to design and build a small, deep-sea photographic vessel.

"Pebble" will be deployed onto the ocean floor, to document some of the exotic, undiscovered species that live more than a kilometre underwater.

Whilst deep-sea photography has been done before, Pebble differs in one key respect. Cost. Pebble is being built for under £1000, making her tens of times less expensive than comparable deep-sea craft. This is achieved by using off-the-shelf components, almost no moving parts, and a pressure-balanced design.

The Pebble Team comprises four members from the Engineering Department. Ben Sheppard, who founded the project in April 2008, is concentrating on Pebble's structure and mechanics. Robbie Howshall, a fourth year signals processing student, is focussing on Pebble's electronics and information systems. They are being supervised by Dr. Digby Symons, a lecturer from the Engineering Design Centre, and Dr. Joan Lasenby, a lecturer from the Signals Processing Group.

Pebble has progressed quickly since the design was finalised in November 2008. The build is nearing completion and the testing phase is about to begin. If Pebble successfully passes testing, then she will be deployed on her first deep dive.

Project Pebble would like to express its gratitude to its many contributors, without whose time and effort the project would not be possible. Project Pebble are sponsored by BAE Systems Submarine Solutions, which is currently building the planned seven-strong class of Astute submarines at its base in Barrow-in-Furness, Cumbria. Project Pebble

is supported by Tritech International, EADS, and Pentax.

More information on the project along with a gallery of photos can be found at: www.projectpebble.co.uk

New international nanomaterials research programme launched

As part of a unique collaborative agreement, the Japanese government has located a new research satellite at the Department of Engineering's Nanoscience Centre.

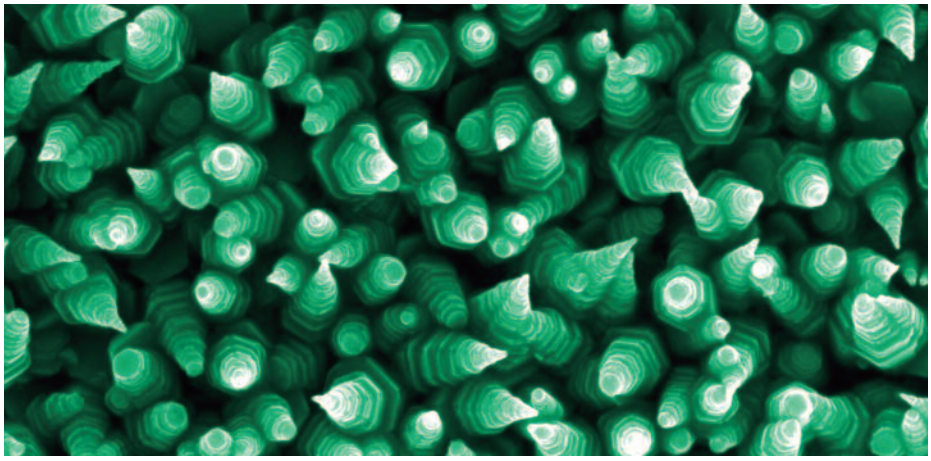


Photo by Dr James Bendall.

Cambridge is one of four institutes located outside of Japan which will host a satellite of the 'International Center for Materials Nanoarchitectonics' (MANA). (The University of California, Los Angeles, the Georgia Institute of Technology and CNRS, France will host the other three satellites.) Two branches will be located in Japan at Tsukuba University, Tokyo and Hokkaido University, Sapporo.

MANA is expected to create world-class research centres with global visibility and will be implemented under the supervision of a number of top scientists from Japan's National Institute for Materials Science (NIMS). The 10 year, $150M programme is aimed at developing innovative materials that contribute to sustainable development – realising a major shift in materials research.

The Cambridge University satellite will be led jointly by Professor Mark Welland, who heads the Nanoscience Group in the Electrical Engineering Division of Cambridge's Engineering Department, and Dr David Bowler from the London Centre for Nanotechnology and Department of Physics & Astronomy, University College London (UCL). It builds directly upon the strong international links developed as part of the Research Council funded Interdisciplinary Research Collaboration (IRC) in Nanotechnology and provides for a long term platform to substantiate and enhance scientific exchanges with the premier materials laboratory in Japan.

MANA provides priority support for projects aimed at creating top level research centres staffed at their core with the world's leading researchers. NIMS is one among five participants selected from Japan to participate in the World Premier International (WPI) Research Centre Initiative.

Professor Masakazu Aono, Director-General, MANA, NIMS, Tsukuba, recently said, "It is critical to the success of this 10 year project that we have leading international partners. Professor Welland's group at Cambridge and Dr Bowler's group at UCL will significantly enhance our work in the area of nanomaterials for a sustainable environment."

Professor Welland, the Principal Investigator of MANA & Co-Director of MANA Satellites said, "It is a huge honour to be part of one of the world premier institutions funded through the Japanese Government. The resources this will bring both directly to Cambridge in collaboration with facilities in Japan will have long term and substantial benefits to our research."

Dr David Bowler added, "Both groups involved in the satellite have long-standing links with NIMS and this project will considerably strengthen them. It also builds on the strong links between UCL and Cambridge which were established by the IRC in Nanotechnology. The close collaborations between experiment and theory, between UCL and Cambridge and between the UK and Japan promise to offer exciting opportunities for new research."

The Nanoscience Centre website: www.nanoscience.cam.ac.uk

New research collaboration for health announced

A new partnership between Cambridge University and the National Health Service will aim to improve everyday hospital care for people with major conditions including depression, dementia, stroke and childhood mental illness.

The University has been awarded a Collaboration for Leadership in Applied Health Research and Care, (or CLAHRC) following the decision of an independent international panel.

The collaboration is funded by the National Institute for Health Research (NIHR). Cambridge is one of nine Universities which will test new treatments and ways of working in specific clinical areas to see if they are effective and appropriate for everyday use. The hope is that over time this will improve standards of health care for NHS patients.

"This new Partnership will undertake high-quality applied research and develop new ways of translating research findings into improved outcomes for patients," said Professor Sally Davies, Director General for Research and Development in the NHS.

"They will be conducting work at the front line of the NHS, so that the benefits and findings from research can be swiftly incorporated into routine clinical practice."

Many departments of the University of Cambridge will be involved in the partnership, including the Department's Engineering Design Centre (EDC), the Department of Pyschiatry, Institute of Public Health and the General Practice and Primary Care Unit.

Alongside the research and high level of patient care, education and training carried out in the NIHR aims to "support outstanding individuals, working in world-class facilities, conducting leading edge research, focused on the needs of patients."

For further information about the EDC please visit their website: www-edc.eng.cam.ac.uk

A paper about pile jacking has netted Engineering PhD student Andrew Jackson more than £2000

Andrew Jackson (left) receiving his prize certificate from ICE Director General Tom Foulkes

Andrew beat off competition to win the UK final of the Institution of Civil Engineers (ICE) Graduate and Student Papers Competition. In March he won £250 for coming top in the regional heat.
He presented his paper 'Pile jacking in sand and silt' to a panel of senior civil engineers and an audience of students and graduates in London. The paper explores the problems associated with traditional pile-jacking and was the result of a collaboration between the Department's geotechnical group and Giken a Japanese piling company.

Pile jacking is a relatively new process for pushing foundation piles into the ground. Benefits over alternative methods include reduced noise and vibration during installation and improved performance of the pile in use. A pile jacking machine can be used to grip previously installed piles and use hydraulic rams to press (or 'jack') a new pile into the ground. This project aimed to improve understanding of the behaviour of the piles during jacking. This understanding can then help the designers and operators of the pile jacking machinery in specifying and controlling the machines. It can also assist engineers in checking that the piles will continue to be able to support the weight of the building above. All the findings then assist engineers in ensuring that the piles can continue to support the weight of the building above. As part of the ongoing Department of Engineering/ Giken collaboration Andrew spent a total of two months in Kochi in Japan, working with Japanese engineers and other Cambridge students to install and test full-size piles on site.

Said Andrew: "I am delighted to have won because the standard of entries was extremely high this year and it is an honour to have been chosen by the judges. I will certainly encourage others to enter in future."

In addition to the prize money Andrew also receives his choice of three days of professional training courses, £150 of civil engineering book vouchers and a commemorative medal.

Presenting the prize ICE Director General Tom Foulkes said: "I congratulate Andrew and indeed all the finalists for the innovative content of their work and for delivering such impressive performances."

Andrew's paper 'Pile jacking in sand and silt' can be downloaded as a 763KB PDF at: www.eng.cam.ac.uk/news/stories/2008/ICE_Student_Papers_Competition

Oliver racing towards a bright future after gaining first motor sport Blue

Oliver Turvey, a 21-year-old from Penrith, who is in his fourth year as an undergraduate, has managed to juggle a successful international motor sport career with his engineering degree.

In recognition of his achievements Cambridge recently awarded him an extraordinary Blue. He made history at Silverstone as it is the first time that a Full Blue has been awarded for motor sport. A Full Blue is the highest honour that may be bestowed on a Cambridge sportsman or woman, and is a much-coveted and prestigious prize. In general, the Full Blue standard is approximately that of being successful at a national level of student competition, and the Half Blue standard is that of being successful at county or regional level.

The award was presented to Oliver by the secretary of the University Men's Blues Committee, Dr John Little, who said: "We judged Oliver's outstanding achievements on the race track to be wholly worthy of this, the first ever Full Blue for motorsport."

Oliver started racing karts at the age of eight and won two national titles. He moved up to cars in the Formula BMW series, but lack of funds threatened to end his career prematurely. He finished second in the championship, despite missing six of the races, and was awarded the McLaren Autosport Young Driver of the Year Award. This brought him to the attention of The Racing Steps Foundation who have picked up the £500,000 bill that enabled him to compete in F3 this year. He has also received the Dunhill Future Champion prize from The Racing Steps Foundation ambassador John Surtees, an award which aims to highlight the most promising British driver.

"It has been an extraordinary year for me in more ways than one," says Oliver. "The Racing Steps Foundation UK, a group which identifies and funds Britain's best drivers, stepped in and saved my racing career with a fully funded drive with Carlin Motorsport. I've come through my third year at university successfully. And now I have been awarded a Full Blue."

He said: "It's been tough fitting in motor racing and course work over the last three years. I've had to be very determined and focused, and be prepared to make a lot of sacrifices.

"If I have three or four days away racing, I would have to fit in course work around that. There was a lot of burning of the midnight oil. Sometimes I worked all night to meet a deadline.

"Cambridge is one of the top universities in the world and very successful academically so I wouldn't have missed that experience for the world. It's rare for a driver to be studying at university but I'm hoping that will be my trademark that sets me apart from other drivers.

"Most racing drivers and people I race against haven't continued with their education and all they do is race.

"It has been hard work but having an engineering degree is a big advantage. F1 is becoming more and more technical and the relationship between a driver and engineer is very important.

"Top F1 drivers know about cars. Michael Schumacher was a good example of that as he knew everything about his car, and Lewis Hamilton puts a lot of work in on all aspects of his career.

"I can communicate much better with the engineers and help to develop the car and get more out of it."

Happold Brilliant Award

Congratulations go to the team of lecturers at the Department who have been awarded the Happold Brilliant Award for Excellence in the Teaching of Building Physics in the context of a Low Carbon Economy.

Professor Randall Thomas (left) and Allan McRobie (right) receiving the Happold Brilliant Award from Lady Happold

On behalf of the Department, Allan McRobie and Randall Thomas collected the prize of a beautiful crystal column with hand engraving, along with a cheque for £1,000, at The Chartered Institution of Building Services Engineers (CIBSE) President's Award Dinner last month. The money will be used to support and reward student work and interest in the subject.

Buildings contribute almost half of the UK's carbon emissions, and Building Physics has thus risen rapidly up the political agenda in the past few years. The award recognises the work of many people in the Department who, in close collaboration with colleagues in the Department of Architecture, have been working to raise the profile of this increasingly important subject. Along with Allan and Randall, the team includes Mauro Overend, Ruchi Choudhary and Chris Morley at the Department and Michael Ramage, Torwong Chenvidyakarn, Ben Foo, Alan Short and Koen Steemers at the Department of Architecture.

Much of the teaching innovation has been stimulated by the arrival of Randall as the Royal Academy of Engineering Visiting Professor in Building Engineering Physics. One of Randall's suggestions is that final year engineering and architecture students should work together on this subject, and this has been taken up by the Architectural Engineering course. Around 100 students from the two Departments work together in multidisciplinary groups on a low carbon building design project. This year the students have been challenged to design a solar powered house for entry into the European Solar Decathlon. A student-led Cambridge team has entered the competition, which will involve building such a house and transporting it to Madrid for the competition in 2010.

sd europe
SOLAR DECATHLON

For more information on the Cambridge interdisciplinary team's participation in the 2010 Solar Decathlon please visit: www.research-horizons.cam.ac.uk/researchnews/solar-decathlon-europe-2010.aspx

Teds in space – One small step for bears, a giant leap for Cambridge outreach

A team of students from the University of Cambridge sent four teddy-bears into space this week as part of an initiative to engage local schoolchildren in science and engineering.

Earth from 30km

Bravely going where few of their kind have gone before, the Teddy-nauts were dressed in special space-suits designed and made by 11 and 12 year-old pupils from Parkside and Coleridge Community Colleges as part of a project with Cambridge University Spaceflight to help them learn more about science, engineering and space.

After a nail-biting wait for optimal weather conditions, the children were scrambled by their schools to the mission launch site at Churchill College, Cambridge. From there the four intrepid space pioneers, dressed in their special suits, were launched on a foam-padded box containing instrumentation and cameras attached to a helium balloon.

The Teddy-nauts spent two hours and nine minutes in flight from the launch site in Cambridge reaching heights of more than 30 thousand metres – known as Near Space or the Edge of Space. In spite of enduring temperatures of between minus 40 degrees and minus 53 degrees, depending on the effectiveness of their spacesuits, all four landed safely just north of Ipswich to be retrieved by the team of student scientists who had travelled from Cambridge by car, following the Teddy-nauts' progress via an onboard GPS system.

The enthusiasm of the pupils for the project was evident:

"This was a really fun thing to do. The best bit was when we set the balloon off with the bears. The CU Spaceflight team made us really involved and we helped assemble all the equipment." Aiyana Stead age 12.

"It was really fun when the balloon was blowing up. We had to hold it in the freezing winds. It felt like we were being smothered by a giant dumpling." Megan Makinson age 12.

"I really enjoyed launching the teddy-bear into space and I also enjoyed designing and building the teddy-bear suit. The balloon was enormous compared to the normal balloons, and it was really hard to keep hold of, but it was great fun letting go of it." Kane Robbins age 12.

Ed Moore – one of the CU Spaceflight team involved in the project said:

"Space is inspiring, and getting there brings together science, engineering, imagination, and lots of fun. As a team, we all have stories of the spark that lit the fire and motivated us to choose science and aim for Cambridge. There can be few more worthwhile things for us to do than to try and provide that spark for the current generation of school kids. We had a fantastic time working with the kids and their teacher, Dr Hinshelwood, and as a team we're delighted that there could, with luck, be some hugely talented people joining CU Spaceflight in a few years time!"

Teacher, Steve Hinshelwood, who runs Science clubs at Parkside and Coleridge said:

"This was a super activity for the students to be involved in. They had great fun problem-solving as they tried to turn their original space suit designs into something that they could actually build. Suddenly scientific ideas such as insulation, convection, conduction and radiation became important. Thinking about weight made ideas of buoyancy, pressure and the composition of the atmosphere relevant. The need to get the teddies back gave the students a chance to think about computer control and radio communications. I don't think that the students realized how much science they were learning – they were just having fun. CU Spaceflight is a super team to work with. They were able to engage with the students at just the right level, stretching their understanding and always encouraging. They're superb ambassadors for the fun that can be had following science."

No treasured possessions were endangered in this experiment. The four teddy-bears used were purchased specifically for the mission by Mr Hinshelwood.

Engineering students involved in this project were: Rob Anderson, Jeremy Appleyard, Sal Drummond, Robert Fryers, Henry Hallam, Ed Moore, Daniel Strange and Iain Waugh.

Video of some of the launches and a gallery of many of the photos can be found at: www.cuspaceflight.co.uk

Design of a timber framed multi-storey car park

Benjamin Torrance has won 1st prize in the TRADA (Timber Research and Development Association) Timber in Construction Student Prize for his 4th Year MEng project.

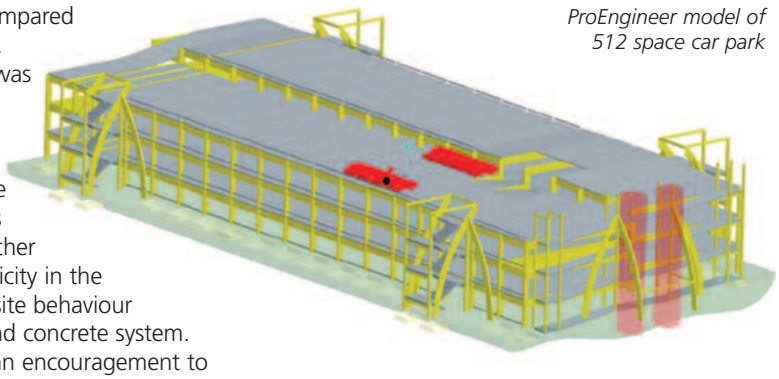
Benjamin received prize money of £1000. The project grew out of research in the Department into timber-concrete composite flooring. It was a chance to put the findings of this research into a design, investigating the commercial and structural viability of timber in construction by following a brief to design a 500 space multi-storey car park.

The structure is primarily glue-laminated timber columns and beams, based around a 15.5m x 4.8m column grid. A composite floor system consisting of a concrete deck slab secured onto the timber beams with coach screws provides an efficient flooring system. The concrete helps to stiffen the structure, whilst the use of timber for the bulk of the structural elements within the building provides a lower embodied carbon structure.

The use of this composite flooring enabled long span column free parking space to be achieved in a structure type usually dominated by steel and reinforced concrete. Furthermore, using timber reduced the structure's embodied carbon by around 80% compared to a steel frame.

The design was based on the Eurocode 5 design code for timber, but finite element analysis was used to further investigate plasticity in the partially composite behaviour of the timber and concrete system. The results are an encouragement to engineers to embrace timber design with the new codes. Benjamin says; 'Timber has been used to build fantastic structures for thousands of years, and I hope we shall continue to see exciting new ways of incorporating it into structural and architectural design.'

Benjamin would like to thank Richard Persaud for access to his PhD work on timber-concrete composite flooring systems, his supervisor Digby Symons and Ramboll Whitbybird for their support and advice.



ProEngineer model of 512 space car park

The abstract from the project report, which provides a brief but more technical discussion of the work can be downloaded as a 63KB PDF document at: www.eng.cam.ac.uk/news/stories/2009/timber_framed_car-park/

For further information please contact Dr Digby Symons at: dds11@eng.cam.ac.uk

Yak Yak

Yak down (fine hair) is set to contribute to the revitalization of the economy of one of the world's most remote regions thanks to efforts from a Cambridge University engineering graduate.

The 'Yak Yak' Project has been set up by Operation Mercy, a non-governmental organisation (NGO), with the help of Sarah Ong, who recently completed a degree in manufacturing engineering. The project is intended to generate income from fine yak hair for the inhabitants of the Pamir mountain range in Tajikistan. Little industry exists in the area, which covers almost half of Tajikistan, but the mountain range is home to a sizeable yak population. Although the animals have been herded there for centuries, their down has generally been discarded.

Its potential as a source of income was first identified by Operation Mercy Tajikistan and Sarah worked throughout the spring with their team to decide how best to put it to use. The end product is yet to be finalised, but progress has been made on trialling hand tufting of the down, collecting spun samples, and knitting prototype hats and scarves. The fineness of the down lends itself to knitwear and Yak Yak is planning to target high street consumers. "We decided on producing finished goods to maximise the employment potential for the locals," Sarah said. "The biggest problem is to separate the down from the hair - along with improving quality, we also need to establish reliable production if we want to export garments overseas."

Sarah now plans to return for another two years, to follow up on her initial work by testing the reliability and quality of production and beginning the search for partner organisations. She said: "I didn't want to work at a regular factory in the UK and central Asia gave me the chance to use my skills where they will make a big difference. It was wonderful to be able to apply university knowledge in somewhere so completely different. My stay there has changed my perspective on life. From these people, I have learnt the difference between a luxury and necessity. Earlier I would think that taking a shower is a necessity, now I think it's a luxury. I also believe that the West can learn a lot from them because eventually we are all going to face a resource crunch. They know how to live with fewer resources, and not out of choice but because they are forced to."

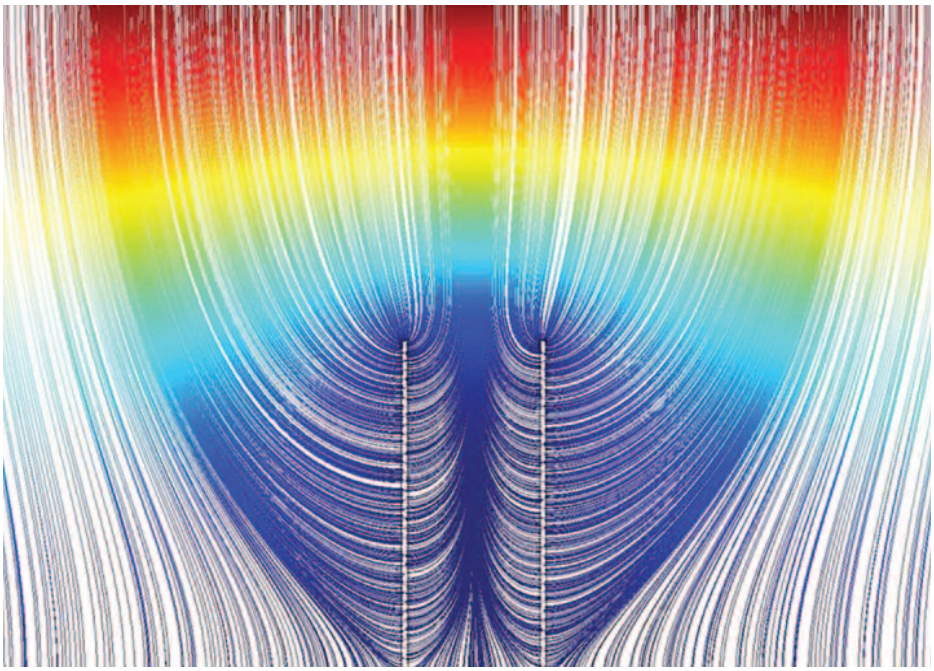
Funding for Sarah's initial project was provided by a bursary from Engineers Without Borders UK, an NGO dedicated to funding projects that help human development through engineering, and the Royal Academy of Engineering. The early stages and ongoing work have been funded by other sources.

Sarah Ong

For further information about the project visit www.yakyakstory.com or contact Sarah at: sarah.ong@cantab.net

The Future Is 3D Liquid Crystals

Dr. Tim Wilkinson from the Department's Photonics Research Group has made an exciting breakthrough. He has combined liquid crystals with vertically grown carbon nanotubes to create a reconfigurable three-dimensional liquid crystal device structure.



Simulation of the electric field surrounding a single MWCNT in vacuum

This offers completely new ways to control molecules in liquid crystals, allowing the crystals to move in a variety of directions to create optical components such as lenslet arrays. The technology is still in the early phase of development, but recent trials indicate that potential applications exist in adaptive optical systems such as the wavefront sensors used in optometry, digital video cameras, optical diffusers and emerging head-up display devices.

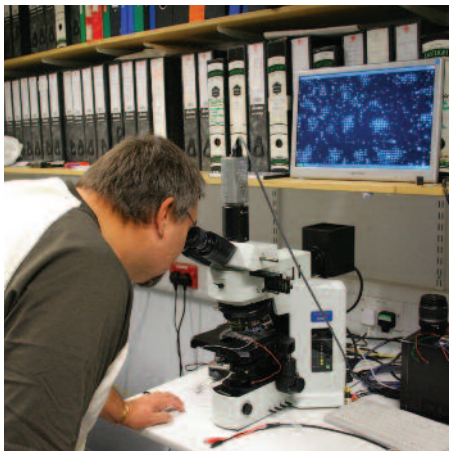
Liquid crystal (LC) molecules are shaped so that they naturally align with each other if put in a cell to form an optically active pixel. In a display device the liquid crystal pixel is used to change the polarisation of the light passing through it and the degree of change (seen as contrast) is done through an applied voltage onto electrodes at the top and bottom of the cell. The applied voltage makes the LC molecules rotate in the cell and changes their orientation with respect to the light passing through the cell. This cell geometry limits the ways in which the light can interact with the liquid crystal molecules to a 2D plane. If we add a 3D element to the lower electrode we can change the way in which the voltage interacts with the LC molecules to make a 3D optical structure. A simple example is shown above, where a thin conducting rod is added to the lower electrode to create a Gaussian electric field profile which forms a tiny microlens in the LC material. With many rods it is possible to create an array of micro lenses which can have a focal length that varies with the applied voltage. Such a reconfigurable array has many uses in adaptive optical systems and 3D holographic displays.

Talking about his work Tim says "My idea is to combine two well-established technologies – liquid crystals and nanotechnology – to make a new hybrid device. The LCs has the ability to create a reconfigurable optical modulator (such as would be seen as 2D pixels in a liquid crystal device (LCD)) with the vertically grown multiwall carbon nanotubes (MWCNT) which act as a 3D electrode structure. In a traditional LC device (such as a display screen) the pixel electrodes are above and below the LC and allow it to be switched in a simple way. In the hybrid device the lower electrode is the MWCNT grown on silicon which sticks out from the surface into the 3rd dimension. This is also a more complex electric field profile which in turn creates a more complicated 3D refractive index profile in the LC layer. Hence we can make very complicated optical elements using a very simple device structure and an applied voltage to switch it.

An example is when the MWCNTs on the lower electrode surface are all connected and switched with the same voltage. The resulting electric field profile surrounding each MWCNT electrode is Gaussian in shape which creates a Gaussian refractive index profile in the LC layer. This looks optically like a tiny lens which is centred on each MWCNT, hence for an array of CNTs spaced 10 m apart we end up with an array of microlenses 10 m apart. By changing the voltage applied to the CNTs we can switch the microlenses on and off and also vary their focal length. There are many applications for such a switchable microlens array such as in adaptive optical systems where the ability to self-focus a lens is important or as an active diffuser in a head-mounted display system.

More importantly this breakthrough changes the way in which we think about creating liquid crystal devices. It allows us to include a 3D element to the design of modulating characteristics. If we address each individual CNT with a separate voltage then we can build more complex 3D refractive index profiles similar to those you would see in a full 3D photographically recorded hologram. However the difference with the LC/CNT device is that the hologram can be changed dynamically as you would change an image on a LCD. This allows full 3D displays to be built using this sort of technology."

Articles on this research appeared in EuroPhotonics trade magazine (August 2008), in Advanced Materials and in Advanced Imaging Magazine (January 2009).

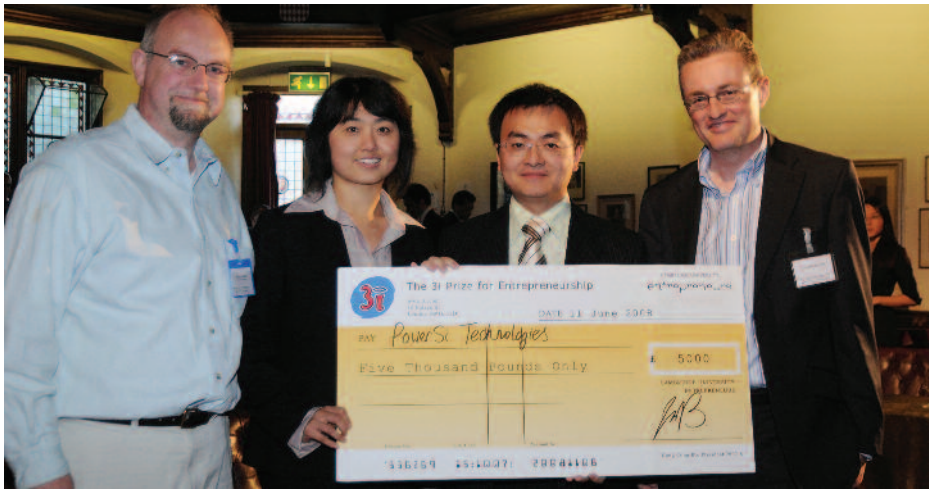


Tim Wilkinson uses an Olympus BR11 microscope to display the switching of a lenslet array in his laboratory. Picture credit: Phil Hands

More information can be found on the Centre of Molecular Materials for Photonics and Electronics (CMMPE) group website: www-g.eng.cam.ac.uk/CMMPE/nanolc. html

PowerSi Technologies wins prizes

PowerSi Technologies Limited, a spin-out from the Department of Engineering, have won prizes at both the 2008 Cambridge University Entrepreneurs (CUE) £5K Challenge and the 21st Century China UK Entrepreneurship Competition.



PowerSi Technologies founded by Dr Patrick Palmer, Reader in Electrical Engineering (left), and two of his former PhD students, Dr Zhihan Wang and Dr Yalan Wang (centre)

October 2008, 336 teams entered the serial CUE Challenge business plan competitions. The team of PowerSi Technologies won both Technology Prize and Cleantech Prize, pitching in front of a panel of Cambridge entrepreneurs, business angels and venture capitalists. The team also won the first place in the 21st Century China UK Entrepreneurship Competition out of more than 200 entries from both the UK and China. The team presented at the China UK Showcase held in London in June with prestigious delegates from both the UK and China. The two prizes include £12,000 cash, free IP services worth £5,500 and other free advisory services.

PowerSi Technologies was recently founded by Dr Patrick Palmer, Reader in Electrical Engineering, and two of his former PhD students, Dr Zhihan Wang and Dr Yalan Wang, from the Electronics, Power and Energy Conversion group of the Department. Their winning business plan is to promote the technologies for power semiconductors and controllers in renewable energy applications.

PowerSi Technologies has developed and patented a technology AVC (Active Voltage Controller) that will revolutionise energy conversion through the intelligent control of power semiconductor devices. By using AVC, electric energy can be more efficiently transformed from one form into the other form (e.g. from AC to DC). Zhihan says "Our Active Voltage Controller, the most intelligent controller today, will reduce the total cost of a conversion system by 40%, improve the efficiency by 10% and enhance reliability. Our entry market is industrial converters of renewable energy applications, including wind power, solar energy and hybrid vehicles. The total available market of controllers in these three sectors is worth $1.3bn in 2008, of which we will take 20% within 5 years."

Research on the control of power semiconductors has been led by Dr Palmer since the early 1990s. The AVC has been developed as an intelligent and cost-efficient method to drive and control power semiconductor devices, including Insulated-Gate Bipolar Transistors or IGBTs which are semiconductor devices, noted for high efficiency and fast switching, and Metal–Oxide–Semiconductor Field-Effect Transistors or MOSFETs which are devices used to amplify or switch electronic signals. The AVC exerts intelligent feedback control on conventional power devices for the first time that enables them to have user-defined and well-behaved switching performance. The team has been actively cooperating with Cambridge Enterprise on the patent filing and commercialisation.

The AVC demonstrator products are currently in production and expected to be adopted to control tens of IGBTs in series connection in a large-capacity Static Compensator in China which is a national project funded by the Ministry of Science and Technology of China. This will be a big challenge in the power electronics field.

For more information, please contact Dr Zhihan Wang at: zw220@cam.ac.uk
Website: www.powersitech.com

Strictly Come Cambridge

The University's ballroom dancers were the toast of the Empire Ballroom in Blackpool last month when they won the national universities competition there for an unprecedented fourth year in a row.

The Cambridge University Dancesport Team (CUDT) competes against other universities up and down the country at five competitions during the course of the year, culminating in the nationals in Blackpool. It consists of 16 couples, each dancing one of waltz, quickstep, cha cha or jive. The 16 couples are divided into four teams of four.

The team competed in the Empress Ballroom, the spiritual home of ballroom dancing, against 80 teams from 29 universities.

Of the 32 Cambridge dancers, two are from the Department of Engineering; Blaise Thomson and Krisada Chaiyasarn.

Blaise a PhD Student in the Dialogue Systems Group, Machine Intelligence Laboratory in the Information Engineering Division talks about how he got involved: "I got involved with the dance team four years ago, when I initially came to Cambridge to do an MPhil. I went along to the trials to see what it was all about, got selected for the team and couldn't stop competing ever since!

Krisada a PhD student in Computer vision for tunnel inspection, in the Geotechnical Research Group, says "I started dancesport with the Cambridge University Dancesport Team and competed in a beginner level during my 3rd year in the Department. Despite having to stop dancing in the 4th year, I began dancing again during my 1st year of the PhD study in the intermediate latin dance and became a finalist in most major competitions including the Inter-Varsity Dancesport Competition (IIVDC).

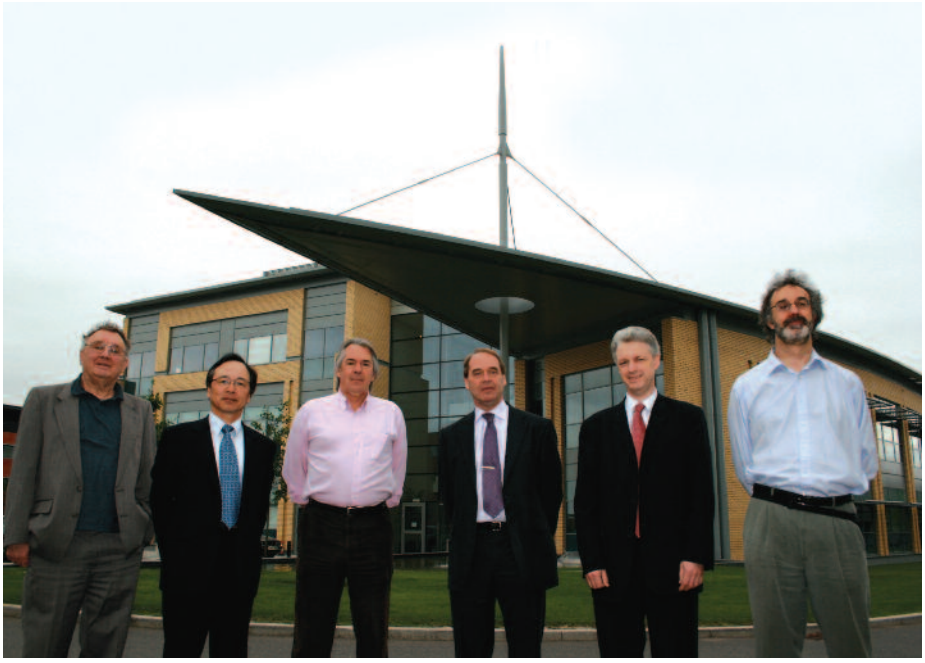
The 36th Varsity match was held on Saturday 2 May 2009. Cambridge won making it three wins in a row against their Oxford rivals.

Dancesport is a half blue sport for both men and women. Cambridge dancers have also won extraordinary full blues for 4 of our women whose performances demanded greater recognition by virtue of their outstanding success, both against university competition and on the open circuit.

The Cambridge University Dancesport Team website:
www.srcf.ucam.org/cudt/pages

Enhancing CAPE-abilities in photonics and electronics

A unique model of industrial-academic partnership is demonstrating how UK Research and Development can stay ahead of the game in a rapidly moving electronics market.



From left to right: Bill Crossland (CAPE), Shinichi Sasagawa (ALPS Electric), Bill Milne (CAPE), Peter Woodland (ALPS Electric), Ian White (CIKC) and Terry Clapp (Dow Corning and CIKC)

The fast-expanding advanced photonics and electronics field is dominated globally by large, often non-European, industrial operations capable of investing tens of billions of dollars in research and development. This creates certain challenges, as Professor Bill Milne, Head of the Electrical Engineering Division, explained: "The problem in Cambridge and the UK is how do you stay involved, engage with global players and maintain a competitive edge in an industry when the bulk of investment is being made elsewhere?" The Centre for Advanced Photonics and Electronics (CAPE), which Professor Milne directs, is Cambridge's answer: a unique way of working with industry involving an equal partnership between the University and a small group of key industrial companies.

Strategic Partners

CAPE, based in a purpose-built building at the West Cambridge Site and housed within the Department of Engineering's Electrical Engineering Division, is now four years into its five-year strategic agreement and has attracted international attention as a model of university–industry collaboration. The two current Strategic Partners are the Japanese company ALPS Electric Company Ltd and the US-based company Dow Corning, with Carl Zeiss SMT as an Associate Member.

An important remit was that the industrial partners be global players with a wide geographical spread and should represent non-overlapping areas of the supply chain (ALPS makes electronic components and Dow Corning is a materials supplier). "Without this we couldn't hope to have sufficient oversight of the market,' explained Professor Bill Crossland, CAPE Chairman, 'and the fact that Strategic Partners were not in competition enabled us to develop the degree of trust and readiness to share strategy and road-mapping that was needed."

An imperative from the outset was that CAPE would not be about contract research – instead, the partnership is focused on inventing and developing materials, processes, components and systems that will have a major, long-term impact in photonics and electronics through research effectively jointly commissioned within the partnership.

Uniquely, the governance of CAPE through its Steering Committee is shared between the academic and industrial partners with precisely equal votes. Through CAPE's Strategic Partnership Agreement (SPA), ownership of intellectual property is retained within the University and the industrial partners benefit from preferential licensing. This closed model of partnership is intended to provide the best and most rapid route of linking breakthrough research to market implementation.

Looking forwards

Getting CAPE off the ground required initial funding of £10 million, raised entirely from its industrial partners (which originally also included Marconi as a founding member), and CAPE remains self-funded. As the Steering Committee now looks forward to the next five years, it recognises the importance of building on this successful partnership, aiming to expand back to four, or perhaps five, Strategic Partners whose business interests retain the cross-supply-chain nature of CAPE. Provision is also made for CAPE Associate companies in special areas of technology; the involvement of Carl Zeiss SMT as CAPE Associate for Electron Beam Imaging has been particularly successful. The SPA already allows for 'Third-Party' projects with companies outside CAPE, which may become important in the recent CAPE initiative on the role of electronics and photonics in the sustainability of the built environment.

Innovation to commercialisation

CAPE's success has been instrumental in allowing Electrical Engineering to bid successfully to create the Cambridge Integrated Knowledge Centre (CIKC), funded by the Engineering and Physical Sciences Research Council (EPSRC). Dr Terry Clapp, one of the CAPE founders and CIKC Director, explained: "Although the CIKC works very differently to CAPE – it's an open partnership funded with government agency money – the two are highly complementary, with the CIKC providing an integral role in moving proof-of-principle research carried out in CAPE on to the prototyping stage." Professor Milne added: "CAPE and the CIKC effectively represent the two poles of how academia can interact with industry. Together, they enable cutting-edge research to be effectively and quickly transferred for the benefit of society."

This highly successful model is bringing results: two ground-breaking projects have reached important milestones in their development. Professor Ian White, CIKC's Principal Investigator and also Head of the

School of Technology and Head of Photonics Research in Electrical Engineering, explained: 'These projects are excellent examples of CAPE technologies that have been originated, researched and patented in the University, licensed to our partner companies, and are now being prototyped under the CIKC.'

Projecting the future

Imagine a projector the size of a credit card, capable of showing real-time images and expending the minimum of energy. This is the goal of a flagship project at CAPE in partnership with ALPS Electric.

Conventional projectors take a small brightly illuminated image of a scene and then make it larger by projecting it onto a screen. Because the small image absorbs most of the light that illuminates it, the process is extremely energy expensive.

The idea behind the Video Holographic Projection Display System (ViHPS) is to represent the image to be projected by a completely transparent, computer-generated, liquid crystal hologram – it blocks no light, instead representing the image by delaying the light as it passes through. The advantage of these projections is that they reduce the power consumption and the size of the projector, making micro-projectors possible.

Recent developments are creating a new market for highly portable micro-projectors that can be integrated into mobile phones, personal digital assistants and laptop computers.

The facilities for assembling prototype micro-display for holographic projectors have been built up in CAPE with the support of the CIKC. Early tests are now being carried out in ALPS UK on a miniature full-colour projector that will be demonstrated at the ALPS Show in Tokyo in September 2008.

'Within CAPE, our UK engineers engage with renowned academics in Group-funded research, creating new business opportunities for our UK operations.'
Peter Woodland
Managing Director, ALPS Electric (UK) Ltd

Displaying the future

Reflective colour displays that can open up the world of 'electronically controlled print' are a grand challenge for the display industry. A CAPE project in collaboration with Dow Corning has electronic posters within its sights.

Flat-panel liquid crystal display panels such as television screens have finally displaced the cathode ray tube, and the industry is now worth more than $100 billion per year. A large market sector for the display industry lies with street furniture – everything from advertising billboards to displays of public information. But, as yet, no current display technology can challenge good-quality print. To be able to deliver the size and the reflective viewing characteristics of printed media, current proposals are turning to electronic 'e'-ink.

At CAPE, the SiLC project is based on the use of smectic A liquid crystals and coloured dyes. This is a true e-ink technology; one electrical pulse colours the liquid crystal ink and a second pulse clears it. Pictures can remain for many years with no electrical power feeding them.

'Our partnership with CAPE helps Dow Corning accelerate our technology development efforts and provides access to other potential business opportunities.'
Dan Futter
Executive Director for Dow Corning's Business & Technology Incubator

For more information about CAPE, please visit www-cape.eng.cam.ac.uk
This article originally appeared in Research Horizons (Issue 7 September 2008), the University of Cambridge research magazine: www.research-horizons.cam.ac.uk

New home for Institute for Manufacturing

The newest building on the University of Cambridge's developing science and technology campus at West Cambridge has opened its doors.

The Department's Institute for Manufacturing (IfM) formally took possession of the keys to the building from developer Kier Marriott this week at a special event to celebrate the completion of the £15 million building.

Guest of Honour at the event was leading British industrialist Dr Alan Reece (pictured right), whose major donation to the Institute enabled the building to go ahead. It will be named the Alan Reece Building in his honour. He spoke at the event of how very pleased he was to be involved in such a successful, high quality and worthwhile project.

The striking two-storey split-level building to the south side of the West Cambridge site is based around an attractive central courtyard and will provide laboratory and office space for the Institute.

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.

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

It is the first University building to have achieved an excellent BREEAM rating in recognition of its environmental performance. Features contributing to the building's environmental impact rating include the widespread use of natural ventilation, good levels of natural light, and the installation of a biomass boiler.

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.

Substantial funding for the 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 Energy, Fluid Mechanics and Turbomachinery and the Centre for Advanced Photonics and Electronics.

Professor Mike Gregory and Dr Alan Reece

The Chancellor, His Royal Highness Prince Philip visits the Department of Engineering

The Chancellor, His Royal Highness Prince Philip, and the Vice-Chancellor, Professor Alison Richard, visited the Department on Thursday 12th February.

The Chancellor started his visit at the 'Heat Lab' where he met Anthony Law, a fourth-year Aerospace and Aerothermal Engineering student and team manager of the Cambridge University Eco Racing team, along with other members of the team. The Chancellor viewed the eco racing car and was shown how the design and technologies have evolved.

Professor Simone Hochgreb then showed the Chancellor the Cambridge High Pressure Combustion Facility (CHPCF), a state of the art test unit for the study of combustion and instabilities. Simone demonstrated the type of testing that can be carried out in areas such as combustion phenomena and pollutant formation in gas turbines and car engines.

Professor Nick Collings showed the Chancellor his engine test cells and explained how these are used in his research on internal combustion engines, in particular the measurement and control of pollution. Nick went on to demonstrate the gas engine in the student teaching lab.

The Chancellor's party accompanied by Professors Collings and Hochgreb, and Mr Law shared a buffet lunch with the following students:

Iain Waugh, a fourth year student who is member of the Cambridge University Spaceflight team, told the Chancellor about CU Spaceflight and their aim to launch a rocket into space for under £1,000. During various test flights to the edge of space a tiny camera, included as part of the payload, has been used to capture the dramatic curvature of the Earth. The CU Spaceflight team have also been involved with some exciting outreach work with schools in the community.

Sam Cocks, a second year student, spoke to the Chancellor about his three months working in Kenya where he developed a small-scale wind turbine capable of providing a practical solution for electrifying remote regions.

Barnaby Sleep is a member of Full Blue Racing, a team who take part in the international 'Formula Student' competition. Barnaby explained that 'Formula Student' challenges teams of students to design and build a small formula-style race car, with the design brief that the car is a prototype for a 1000 unit-per-year production run for a vehicle intended for amateur autocross racers.

Alex Ridge, a second year student, is a member of the Cambridge Autonomous Underwater Vehicles (CAUV) team. He spoke to the Chancellor about how the team design and build their own underwater robots and then perform realistic missions in the underwater environment at an annual European competition – see p4. This encourages young engineers and scientists to think about underwater technology and its future possibilities, as well as fostering ties between the students and the organisations involved in AUV technologies.

Helen Cavill spoke to the Chancellor about the excellent Engineering Outreach work that goes on here in the Department. 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. The events are a great opportunity for local families to visit the Engineering Department, meet some real engineers and complete a fun hands-on challenge. Working with more than 120 undergraduate and graduate volunteers, Joy Warde the Outreach Officer stages a busy programme of 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.

Sakthy Selvakumaran from Cambridge University Engineers Without Borders (EWB) spoke about the work of EWB a student-led charity that focuses on removing barriers to development using engineering. The programmes provide opportunities for young engineers in the UK to learn about technology's role in development. By taking part in the activities, and with the support of the EWB-UK community, EWB members

are making a difference to people's lives around the world. Sakthy herself is due to go to Peru to work on a micro hydro project.

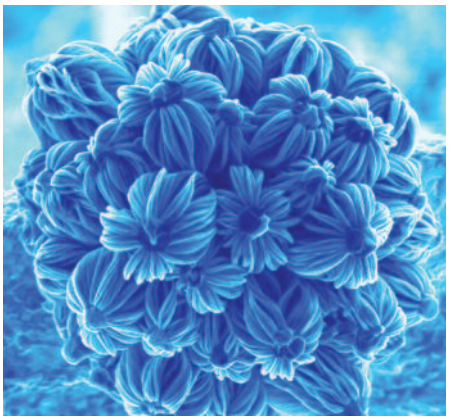
Karen Ball, a fourth year student, spoke about her final year project which is in collaboration with McLaren Racing and concerns the dynamics of vehicles at their performance limit.

Warren Rieutort-Louis, a fourth year student, won the Engineering Subject Centre Student Award 2008 for his essay 'What makes a good lecturer?', in which he has analysed the great teaching he has experienced as an undergraduate here at the Department, which he shared with the Chancellor.

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 opened her eyes to the possibility that engineering could be a "legitimate career choice". Helen spoke to the Chancellor about providing support, inspiration and information to women working in science, engineering and technology.

The Chancellor's successful visit was co-ordinated by Jane Hunter, enabling him to see a great deal of the work that goes on in the Department.

A new centre will generate the scientists needed for Britain's future



The University of Cambridge has won funding for a new centre that will help generate the scientists needed for Britain's future. This was announced by the Engineering and Physical Sciences Research Council (EPSRC), the UK funding body for science and engineering.

The new Doctoral Training Centre (DTC) in NanoScience will equip the next generation of researchers with the skills and experience to become nanoscience entrepreneurs by turning basic science research into future applications.

The DTC offers a unique opportunity to bring together research expertise and best training practice. The EPSRC funding, of over £6 million, will support over 50 PhD students over the next five years for a four year postgraduate training programme spanning a range of disciplines.

By integrating MPhil-level training, including highly-rated enterprise components, students will be stretched in new directions. The DTC will provide postgraduates with a broader experience than currently possible in either graduate research or technological innovation.

The training includes a first year of taught nanoscience courses across physics, engineering, chemistry and material science with mini-projects and nano-lab practicals. This is followed by an interdisciplinary PhD placement in one of the nanoscience research groups around the University.

An important element of the programme is exposure to innovation and business courses through the University's Judge Business School.

Drawing together a team from the Physics, Materials Science, Electrical Engineering, and Chemistry Departments it will be led by Professor Jeremy Baumberg and co-directed by Professor Mark Blamire.

Commenting on the announcement Professor Baumberg said: "This is a wonderful investment in young researchers, complementing the strong nano-fabrication infrastructure and world-class interdisciplinary groups across the University of Cambridge".

Professor Peter Littlewood, Head of the Department of Physics, said: "Cambridge University has a strong track record in taking innovations in Nanomaterials and converting them into commercial endeavours. Here we will expose PhD students at an early stage to innovation, and grow the next general of entrepreneurs to feed the Cambridge phenomenon."

Minister of State for Science and Innovation, Lord Drayson, announced the £250 million initiative which will create 44 training centres across the UK and generate over 2000 PhD students. The students will tackle some of the biggest problems currently facing Britain such as climate change, energy, our ageing population, and high-tech crime.

Lord Drayson said: "Britain faces many challenges in the 21st Century and needs scientists and engineers with the right skills to find answers to these challenges, build a strong economy and keep us globally competitive. EPSRC's doctoral training centres will provide a new wave of engineers and scientists to do the job."

He continued: "These new centres will help to develop clean renewable energy, fight high-tech crime, assist in reducing carbon emissions, and discover new healthcare solutions for an ageing population. This is an exciting, innovative approach to training young researchers and will help build a better future for Britain.

EPSRC Centres for Doctoral Training are a new approach to training PhD students, creating communities of researchers working on current and future challenges. 17 of the new centres will be industrial training centres that will equip their students with the business skills they need to turn pioneering ideas into products and services, boosting their impact on the UK's economy.

The multidisciplinary centres bring together diverse areas of expertise to train engineers and scientists with the skills, knowledge and confidence to tackle today's evolving issues. They also create new working cultures, build relationships between teams in universities and forge lasting links with industry.

Students in these centres will receive a formal programme of taught coursework to develop and enhance their technical interdisciplinary knowledge, and broaden their set of skills. Alongside this they will undertake a challenging and original research project at PhD level.

For further information please visit the Nano Science and Technology Doctoral Training Centre website: http://np.phy.cam.ac.uk/NanoDTC1.htm

EDC graduates participated in the 48-Hour Inclusive Design Challenge in Tokyo

Five research students and Lecturer Nathan Crilly from the Department's Engineering Design Centre (EDC) took part in the 48-Hour Inclusive Design Challenge in Tokyo.

From left to right: Nathan Eng, Ana Medeiros, Malia Kilpinen, Andrew Muir Wood, Anna Mieczakowski

The Challenge was collaboratively organised by the Royal College of Art Helen Hamlyn Centre, Nikkei Design and Tokyo University. The teams worked to a brief on the theme of disaster. "Design a product, service or system (communication or otherwise) that will be of fundamental assistance to a range of people, including older and disabled people, in the event of a natural disaster (earthquake, floods, typhoon or fire) within a high- density urban environment."

Challenge participants were divided into three design teams (A-C) consisting of, among others, in-house designers from leading Japanese companies, engineering graduates from the University of Cambridge and the University of Tokyo. Each team, led by an experienced UK designer, worked with a disabled design partner and had input from disaster professionals.

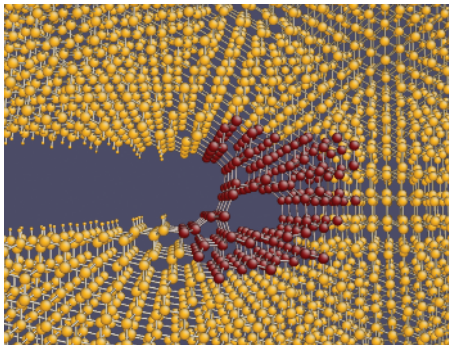
Team A, including Ana Medeiros and Nathan Eng, developed the 'Elixir' bag, which can be used for both hydration and sanitation during the times of disaster. This product won two awards, one for 'Best Design' and the other one for 'Most Innovative Product', making Team A the main winner of the Challenge.

Team B, including Malia Kilpinen and Andrew Muir Wood, developed the 'Crowdscape™', which is an LCD-based navigation system that can be mounted on floors and walls of such public areas as train, bus and underground stations, as well as airports. Team C won the 'Best Technology' award.

Team C, including Anna Mieczakowski, proposed the 'Know Your Way' campaign, which stressed the importance of preparing and establishing a mental image of where the exits in a building are and how to get to them before a disaster strikes. Team C won the 'Best Theme' award.

Why materials crack

Dr Gábor Csányi from the Mechanics, Materials and Design division and his team have recently had a research paper published in the journal Nature.



Special configuration of the tip of a crack in silicon

The research explores how and why materials crack with the hope that by understanding how cracks propagate, scientists and engineers will be better able to prevent cracks from occurring.

Using computer simulations, they studied the motion of atoms that takes place when cracks occur in brittle materials, such as those used in making electronic devices, solar cells, surface coatings and armour. Surprisingly, it turned out that they needed to resort to using Quantum Mechanics, the most fundamental theory that describes the physical world, to explain why the motion of cracks in silicon are unstable, and why these cracks exhibit jogs and kinks as the two halves of the material part at high speed.

Dr Gábor Csányi

Further information about Gábor's research can be found on his website: https://camtools.cam.ac.uk/access/wiki/site/5b59f819-0806-4a4d-0046-bcad6b9ac70f/lay_crack_blurb.html

Alumni Feature: From Cambridge to Kabul

Harry Wardill studied Engineering here at Cambridge from 2000-2004. He now lives in Kabul in Afghanistan working for an organisation called the Turquoise Mountain Foundation, working as a project engineer on the Murad Khane (Old City) regeneration project. His initial contract is for one year. Below, he tells his story from Cambridge to Kabul.

The House of Screens

Measuring up in the House of Screens

Harry (left) giving the design presentation to the team

Thinking back, this journey really began in my second summer at Cambridge, when a classicist friend of mine suggested travelling overland from Istanbul to Cairo to take in a few of the sites en route. Having never left Europe, I was keen to broaden my horizons, and jumped at the opportunity. The trip not only ignited my passion for the people, architecture, art and food this part of the world has to offer, but also confirmed through its rich built history that the switch I had made from mechanical to structural engineering was the right one. The following summer was spent working at Alan Baxter & Associates (ABA) in London, getting a taste for structural engineering with a conservation leaning. After graduating from Cambridge, with the memory of my first trip still at the forefront of my mind, I decided to head out to Iran and Pakistan for a few months of wandering before returning to ABA to embark on my career.

In contrast to now, 2004 was a great time to graduate, and the work at ABA was interesting and varied. During my four years there I worked on many different projects ranging from the restoration of a 1920's steel framed building on Regent Street for the Crown Estate, to the regeneration of a historic tin mine complex in the old industrial heartland of Cornwall. Having completed the process to become a chartered member of the IStructE, I started to look abroad for opportunities in the field of building conservation. One organisation that I came across that really stood out was the Turquoise Mountain Foundation (TMF) based in Kabul, Afghanistan. As luck would have it they were recruiting, so I applied, managed to secure a position, and flew out at the end of January 2009.

TMF is involved with the regeneration of Murad Khane, the historic commercial centre in the old city of Kabul, as well as running an educational institute for traditional Afghan arts, which will ultimately be housed in a number of the regenerated buildings. I have been employed as a designer and project manager for the restoration of two courtyard houses dating from the late 19th century, one noteworthy for its decretive woodwork screens (The House of Screens), and the other for its intricate plasterwork niches (The House of Niches). Both of these structures are currently in poor condition, primarily due to the rubbish that has been allowed to accumulate over the years, resulting in a much higher ground level than the buildings were originally designed for. This has led to the rotting of timber sole plates and column bases, erosion of earth brick walls, and settlement of foundations. Other problems have occurred due to timber elements being removed for use as firewood to help survive the harsh winters, general neglect, and in some cases direct rocket hits at the time when Kabul was a battle ground during the civil war. The two buildings, which will be completed by summer of next year, will be used as accommodation for visiting teachers to the institute, and as part of the woodwork school. The main thing that has struck me during my relatively short time here is the real buzz of activity down on site in Murad Khane. At the height of the building season there will be over 300 workmen, many learning new skills from highly trained craftsmen. It is the immediate effectiveness of this project that is most satisfying to witness, and I am very much looking forward to seeing my two buildings progress over the next year and a half.

You can find out more about the work of the Turquoise Mountain Foundation by visiting www.turquoisemountain.org

New British entry to the World Solar Challenge

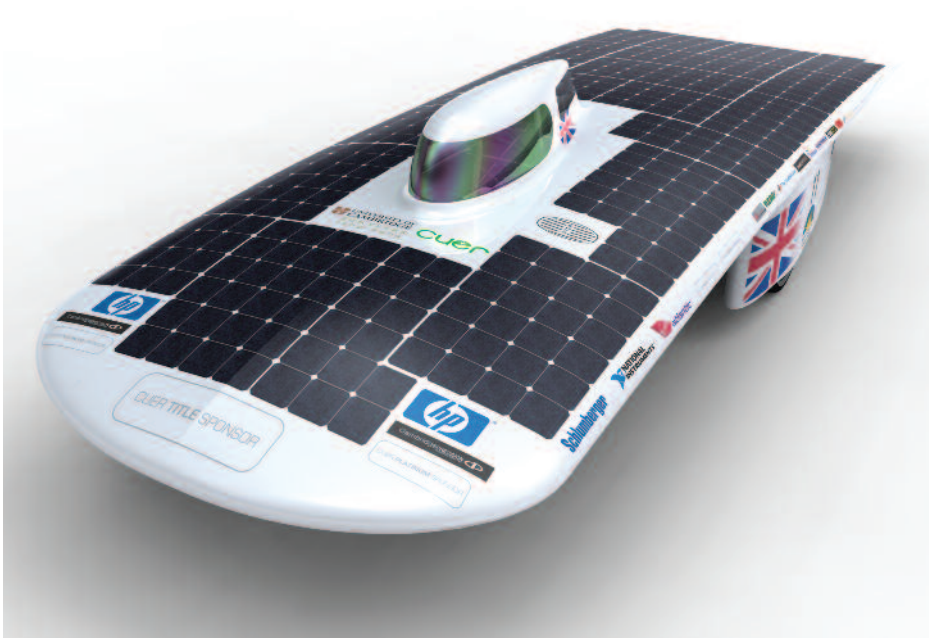
Cambridge University Eco Racing (CUER) has released images of the team's new solar-powered racing car design.

The vehicle, currently codenamed 'Bethany', will compete in the World Solar Challenge in Australia in October 2009. The independent student team, sponsored by Cambridge Precision and HP, hopes to provide the UK's best ever performance in the 3000km endurance race across the outback. They will compete against university and corporate teams from across the world, some with budgets of over £1 million.

By taking an uncompromising approach to efficiency and performance, CUER has developed a vehicle capable of cruising at 60mph using the same power as a hairdryer. The car will weigh just 160kg and sports 6m^2 of the world's highest efficiency silicon solar cells. In order to achieve the car's extraordinary performance, CUER's engineering team has systematically reduced energy usage for each part of the car. Aerodynamics, rolling resistance, weight and electrical efficiency have all been optimised to create a vehicle that uses up to 50 times less power than a normal petrol car and has potentially infinite range. Extensive computer modelling and simulation have been necessary to achieve this, using Dassault Systèmes' SolidWorks and Simulia packages for mechanical design, ANSYS's Fluent for aerodynamic simulation, as well as National Instrument's LabVIEW and The MathWorks' MatLab and Simulink for systems modelling.

Cambridge University Eco Racing's new solar racing car will undertake a 3000km journey through the Australian Outback during the World Solar Challenge 2009 and the team hopes will set a new British record for success in the race.

Under its solar skin, the racing car is simply an ultra-efficient electric vehicle. The technologies used are therefore applicable to the commercial electric cars that are beginning to appear on our roads. Technologies used include a 98% efficient electric hub motor, control systems providing battery management (supplied by REAPsystems) and regenerative braking, lightweight mechanical design, and carbon fibre composite bodywork. CUER's Team Manager, Anthony Law, commented: "At a time when the automotive industry is being forced to look at a low-carbon future, our vehicle demonstrates the enormous potential of electric vehicle technologies. Transportation currently accounts for around 35% of the UK's energy use so this is obviously an area in which we can have a big impact on climate change."



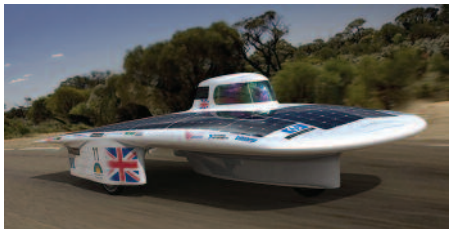
Capable of 60mph using the same power as a hairdryer, Cambridge University Eco Racing's new solar racing car showcases cutting-edge environmentally-friendly technology, applicable to the next generation of electric vehicles. (Image produced by Lovegrove Studio.)

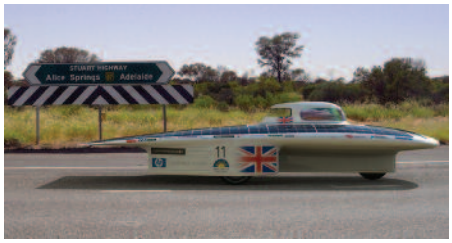
During the race across the Australian outback from Darwin to Adelaide, four drivers will rotate in four-hour driving shifts. The drivers will undergo months of training to cope with the intense heat of the Australian sun and their unusual seating position. During the race they will only be required to steer the car and stay alert, because the vehicle's advanced cruise control system (built using HP and National Instruments hardware) will automatically adjust its speed according to road conditions and weather forecasts.

The CUER team has used the experience gained from building the prototype vehicle, Affinity, in the new "Bethany" design. Affinity was the first solar-powered car to drive legally on UK roads and the team drove it from Lands End to John O'Groats in June 2008. The team is now part way into the manufacture of the new World Solar Challenge '09 car, with moulds currently being machined from material supplied by Huntsman Advanced Materials and the canopy being built by A V Engineering Services, whilst Cambridge Precision is machining hundreds of other components.

Technical Director Charlie Watt said: "Manufacture is progressing well and we hope to have a finished car by June, leaving us time for extensive testing in the run-up to the race." The official launch of the new car is expected to take place in July.

CUER sponsorship packages are still available at all levels for the World Solar Challenge. Interested parties please visit www.cuer.co.uk/sponsorship or email sponsorship@cuer.co.uk to find out more.





The Intelligent Airport

Airport terminals will increasingly require systems with high levels of computational power to provide the necessary intelligent automation; high quality services to passengers; stringent levels of safety and security that are as unobtrusive as possible; efficient processing of commercial goods and luggage; high quality information systems; airport transportation systems and appropriate support for in-house commercial ventures.

Researcher Michael Crisp demonstrating the TINA passenger location system whereby the passenger is tracked via monitoring of an RFID tag on the boarding card

The Intelligent Airport (TINA) project seeks to develop a next generation advanced wired and wireless network to meet the potential requirements for future "intelligent networks" within an airport environment. To address this major topic, a wide range of skills are required including those in computer architectures, protocols, fixed and wireless links and sensing units, in particular Radio Frequency Identification (RFID). The project involves four research groups: University College London, the University of Cambridge (in both Electrical Engineering and the Computer Laboratory) and the University of Leeds, who are working together to address different aspects of the network, collaborating with partner companies including Arup, BAA, Boeing, Laing O'Rourke, Motorola, Red-M, Tyco and Zinwave. Since the instigation of the project, other companies have expressed interest in becoming involved. The research groups have forged new links with Professor Henry Chan of Hong Kong Polytechnic University who has developed a sister project, involving Cisco and the Hong Kong International Airport Authority.

A Showcase Event in October 2008 provided an overview of the advances to date within the project, allowing participants to view first phase demonstrations by the Universities. There were also presentations from speakers representing Ofcom, the Hong Kong Airport Project and the Department's Institute for Manufacturing's RFID team.The following Projects were demonstrated:

Passenger and Data Flow Modelling by University of Leeds:

A computer-based design tool was demonstrated. The demonstration simulated passenger flow through a realistic departure lounge in the busy morning period. Passengers visit retail outlets and business lounges before departing on their flights. The simulation also predicts the time/space varying mobile bandwidth requirements for both current and future scenarios.

MOOSE – Highly Scalable Ethernet Infrastructure by University of Cambridge, Computer Laboratory:

As the number of networked devices used by passengers and airport staff increases, current Ethernet switch technology becomes unable to manage the number of MAC addresses involved. The MOOSE switch architecture has been developed to overcome this limitation by dynamically rewriting addresses. The demonstration showed this technology in use for live internet traffic.

Active Tag Location by University College London:

The ability to locate passengers within a terminal will provide the airport and airlines with valuable operational information. This demonstration showed how an active tag can be used to locate passengers with approximately 1m resolution.

Passive Tag Location and Data Overlay by University of Cambridge, Department of Engineering:

If it were possible to extend the read range of passive RFID tags to 10m, it would enable zonal location information, which is sufficient for many applications in the airport. This demonstration showed how the use of a Radio over Fibre Distributed Antenna System (RoF DAS) can improve the coverage of passive RFID and also how the service can be overlaid on a WiFi distribution network.

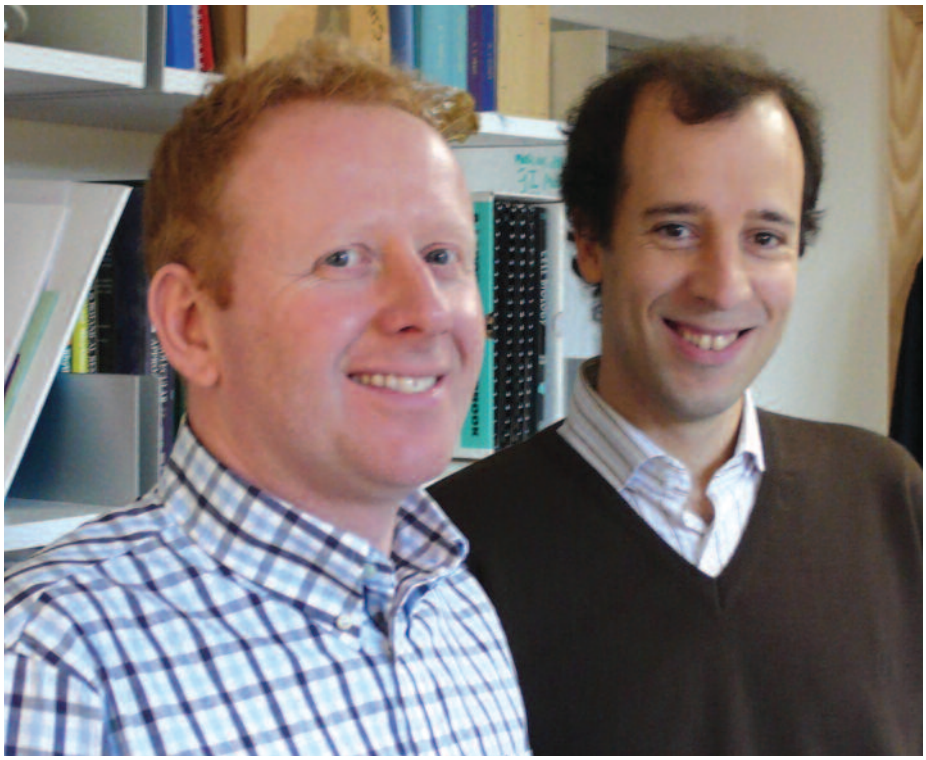
The project has also generated a prize winner; George Gordon, an engineering graduate from Auckland University has won a Rutherford scholarship to do his PhD working on TINA here in Cambridge. George has been studying ways to connect information from independent electronic sources in an "intelligent airport" using fibre optic and radio frequency technologies. The doctoral scholarship at Cambridge marks the 100th anniversary of Ernest Rutherford receiving the Nobel Prize. The Rutherford Foundation said the Auckland University student had shown exceptional academic ability.

For further information please contact Professor Richard Penty at: rvp11@cam.ac.uk

George Gordon an engineering graduate from Auckland University has won a Rutherford scholarship to do his PhD working on the Intelligent airport project here in Cambridge

Clockwork plants

How do plants tell the time and the passing of the seasons? Plant scientists are enlisting the help of engineers in their quest to uncover the rhythms of circadian clocks.



Dr Alex Webb (left) Dr Jorge Gonçalves

Ever since the French scientist Jean-Jacques d'Ortous de Marian discovered in the 1700s that patterns of leaf movement follow a 24-hour clock, our understanding has been growing of the in-built clocks that plants and animals live by. 'Circadian' clocks are important for living organisms to maintain the rhythms of life and have evolved independently at least four times: in blue-green algae, fungi, animals and plants. Desynchronisation of the clock with the environment has adverse effects - all too familiar for those who have experienced the unpleasant feelings of disorientation during 'jet lag', where the crossing of time zones disrupts the functioning of the circadian system.

Plants, which are literally rooted to the spot, use their circadian clocks to help them adapt to the night/day cycles of light and temperature caused by the rotation of the Earth, whether it is preparing for day-time photosynthesis or preventing night-time water loss. Seasonal events like fruiting and leaf drop are also governed by the clock. Increasing our understanding of the molecular mechanisms at work therefore has wide implications: from the possibility of selective crop breeding, through increasing ecosystem productivity, to control of atmospheric CO^2.

Dr Alex Webb and colleagues Drs Antony Dodd and Michael Gardner in the Department of Plant Sciences have been working to understand the intricate processes of the daily clocks of plants. Recent findings have taken a surprising turn, one that is benefiting from the application of engineering principles through a collaborative project with Dr Jorge Gonçalves in the Department of Engineering. The research, funded principally by the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC), is combining engineering control theory and plant cell biology, with the result that novel tools are being developed to understand oscillating biological systems.

Regulating rhythm

A circadian clock comprising 10-20 genes that form interconnecting feedback loops of gene expression is present in every cell of the plant. Initiated by changes in light and temperature, these linked loops of gene expression control a huge amount of plant biology; plants grow rhythmically, with rhythms of metabolism and even rhythms of photosynthesis, and a third of all plant genes are switched on and off within a 24-hour cycle.

How can the activity of so few genes have such a pervasive effect on the biology of plants? It seems that the level of calcium, a key regulator of cellular events in all organisms, is crucial. In plant cells, the concentration goes up and down with a 24-hour rhythm governed by the plant circadian clock.

Dr Webb and colleagues have discovered that what causes the rhythms of calcium to change is a molecule called cyclic ADP ribose (cADPR). By studying Thale Cress (Arabidopsis thaliana), the researchers found that the concentration of cADPR is regulated by the circadian clock genes and that fluctuations in calcium levels are caused by cADPR binding to protein channels in the internal membranes of plant cells, permitting calcium to enter the living part of the cell.

Loops within loops

The next discovery was a surprise: not only is cADPR regulated by the circadian genes but many circadian-regulated genes are themselves regulated by cADPR. This led to the intriguing hypothesis that the clock genes cause 24-hour oscillations of both cADPR and calcium, which in turn regulate the level of activity of the clock genes as part of a new loop in the plant circadian clock - a sort of loop within a loop. The problem was how to test this hypothesis.

This is where the skills of the engineers allowed an advance that could not be achieved using biological techniques alone. By creating mathematical simulations of how a plant's circadian system might behave, they were able to compare these simulations with the behaviours of genetically modified plants with altered cADPR levels. The results, published in December in Science magazine, demonstrate the existence of this feedback loop.

Running fast and slow

One intriguing feature of these findings is that by interfering with cADPR signalling the plant clock might be forced to run faster or slower. Dr Webb and Professor Andrew Millar at the University of Edinburgh found that mutant laboratory strains of plants with clocks that run fast or slow grow to half the size of neighbours with a correctly functioning clock. Remarkably, when put in artificial light/dark cycles that matched the 'expectations' of the mutant clocks, the mutant plants grew better than normal healthy plants. It seems therefore that matching a clock to the local day-length conditions could have beneficial effects on plant growth.

By making a plant clock run faster for short daylight hours or slower for long daylight hours, interesting opportunities

might arise in crop development for bioenergy and agricultural output. This might in fact have been the accidental outcome of the selective breeding of barley by farmers thousands of years ago, when they began moving the crop further northwards, where summer day-length is longer. Working with colleagues at the National Institute of Agricultural Botany in Cambridge, Dr Webb is investigating the circadian clock of different barley varieties to see if this might be true.

New mathematical tools

Meanwhile, the collaboration between the engineers and plant biologists is continuing. One spin-off has been the development of new types of mathematical tools to understand complex systems.

The tools used by control theory engineers have been very successful at designing a large number of technological systems, from the simple cruise control required to maintain the speed of a car, to more complex controls that allowinherently unstable aeroplanes to fly. When looking at biology, however, it's clear that new mathematical tools are needed to analyse biological systems. These systems are highly complex, dynamic in space and time, have many components that are often used to perform multiple tasks, often involve feedback with clear non-linear behaviours, and, perhaps most challenging of all, biological data are typically expensive, lengthy to obtain and noisy. To deal with the complexities of biological systems, engineers Dr Gonçalves and Dr Guy-Bart Stan are developing new theoretic mathematical approaches to study such complex non-linear systems. As collaborations between biologists, engineers and mathematicians become more common, it seems that the world of biology is changing. And Engineering Departments too are changing: increasingly, engineers are turning their expertise towards biological systems such as plant growth, gene expression, cancer, cognition and the beating of the heart.

For more information, please contact the authors Dr Alex Webb (aarw2@cam.ac.uk) at the Department of Plant Sciences or Dr Jorge Gonçalves (jmg77@cam.ac.uk) at the Department of Engineering. This research was published in Science (2007) 318, 1789-1792.

This article originally appeared in Research Horizons (Issue 6 Summer 2008), the University of Cambridge research magazine

To Centre Court: Paul McIlroy

Engineering graduate Paul McIlroy, has recently returned to the Department of Engineering to study for a PhD in real-time computer vision. In between graduating and starting his PhD, he has achieved a huge amount.

Paul explains how it all happened: "Hawk-Eye is a camera-based ball-tracking system that first made its name in cricket broadcasting, but is now most widely known as the system which allows tennis players to challenge line-calls at elite-level tournaments including Wimbledon. In my fourth year as an undergraduate I had the opportunity to pursue a research project based on this system thanks to links forged between the Machine Intelligence Laboratory and Hawk-Eye Innovations Limited.

"I was offered a full-time role with the company upon graduation and joined a team of three other full-time staff. Hawk-Eye had recently been spun out as separate company from Siemen's Roke Manor Research in Hampshire and in these early days was operating from a portable cabin at the Hampshire Rose Bowl cricket ground.

"I was initially responsible for improving the underlying computer vision algorithms the system is based on and I also enjoyed the opportunity to travel extensively to operate and develop the system at cricket and tennis events around the world.

"In 2004 the International Tennis Federation (ITF) announced that it wished to implement a electronic review system for line-calls. Extensive development and testing was carried out at venues from Hampshire to Los Angeles over the course of more than a year to enable the system to meet the ITF's stringent accuracy and reliability criteria. I took on the role of Technical Director in 2005 and was joined in my development team by fellow Engineering graduate James Leigh. The system achieved the required ITF accuracy standard in New York in October 2005 and has since been employed as an umpiring aid at most major tennis events world-wide. Hawk-Eye now employs over 50 full-time staff with an in-house development team of six.

"Following the success of the tennis system, Hawk-Eye was invited to work with the Premier League to develop a goal-line technology for football. Despite Hawk-Eye successfully demonstrating its goal-line system to football's IFAB committee in 2008, FIFA voted last March to freeze development for now in favour of a trial of extra linesmen. The system is on ice for now, but I expect the technology issue in football will be revisited in the near future.

"I am extremely fortunate to have had the opportunity to work for such an exciting and successful company and to have been involved in the introduction of technology into sport. I had originally hoped to work in industry for a year or two before returning to academia to pursue a PhD in real-time computer vision. I am now thoroughly enjoying my return to the Department and I feel my industry experience has enabled me to fully appreciate this valuable opportunity for learning and research."

Further information can be found on the Machine Intelligence Laboratory webpages: http://mi.eng.cam.ac.uk/milab.html

Cracking the code of a killer

More than one million people die from malaria every year – most of them in the world's poorest areas.

Electron micrograph shows a Malarial sporozoite migrating through the cytoplasm of midgut epithelia. Photo courtesy of Ute Frevert published in a Public Library of Science journal

While it is no surprise to find Cambridge scholars at the forefront of the battle against the disease, crucial research is underway not just in subjects like biochemistry and physiology, but in the unlikely setting of the Department of Engineering.

Malaria is one of the world's worst health problems and one of its biggest killers. We may not feel its impact very often here in the UK, but in South and Central America, Asia, the Middle East and - in particular - Africa, it can be devastating.

According to the World Health Organisation, more than one million people die from its effects every 12 months. Children in Africa can expect to have between one and five episodes of malaria fever in a year. And every 30 seconds, malaria kills another child.

The sheer scale of that impact has led to internationally-backed initiatives such as Roll Back Malaria, which aims to have significantly reduced global deaths from the disease by 2010. Treating it, however, and creating the as-yet-elusive malaria vaccine, is easier said than done. To cure it, you have to know how it works. To do that, you have to understand what makes malaria parasites similar to or different from one another. And to achieve that, you have to know where to look.

Which takes us from the world's worst malaria hotspots to the unlikely setting of the Department of Engineering. Strange as it may seem, researchers here are producing computer software which has already proven essential in the global fight against the disease.

The work is being undertaken in the Department's Machine Learning Group. This team of researchers, led by Professor Zoubin Ghahramani, focuses on understanding and devising computer algorithms - the sequences of operations which allow computer programmes to perform a given task. It was precisely one such set of algorithms developed by Dr Karsten Borgwardt which towards the end of last year helped scientists at the Sanger Institute near Cambridge to decode the genetic make-up of the malaria parasite Plasmodium knowlesi.

Until recently, only four species of malaria were known to affect humans. Plasmodium knowlesi was thought mainly to be a cause of malaria in monkeys, but in fact scientists had been grossly underestimating its effects. Today, it is emerging as the fifth human malaria parasite and is particularly dangerous in south-east Asia, where people often live close to the monkeys and mosquitos which carry it.

Although all malaria parasites are similar, each new species has a unique set of tricks and disguises which stop the host's immune system from fighting it off. This is all the more important because to treat malaria rapid recognition and an early response is vital. By decoding its genome - the complete set of genetic information controlling its behaviour - scientists were able to spot the "cloaking devices" used by Plasmodium knowlesi and move a step closer to developing drugs and vaccines to fight the disease.

But what does all this have to do with algorithms developed at the Engineering Department? To crack Plasmodium knowlesi's code, scientists used a technique called "comparative gene finding". This involves taking a similar species (another malaria parasite) whose genes have already been located and identified, and then looking for the same genes in the unmapped species.

"In any genome we have a very long string of sequence information," Karsten explains over the phone from the Max Planck Institute in Tübingen, Germany, where he now works. "To work out the position of the different genes within the genome we need to find parts of the sequence which are shared by the genome we already understand."

The problem is where to look. Any genome contains a baffling quantity of sequence information which makes spotting the similarities and differences rather like trying to find a needle in a haystack. Fortunately, this is precisely what computer algorithms are designed to do: The software developed by machine learners allows computers to extract useful patterns, rules and information from a huge jumble of data.

In this case, Karsten, working closely with Professor Irmtraud Meyer at the University of British Columbia in Canada as well as Dr Arnab Pain and other researchers at the Sanger Institute, developed software which enabled scientists to make predictions about where they might find certain genes in the sequence.

"Imagine it this way," Karsten says: "We want to be able to give a label to every part of the genome sequence as we move along it. We want to be able to say: 'This part of the sequence affects that gene, this part of the sequence belongs to this part of this gene."

"Finding the most likely label for each part of the sequence is basically a mathematical problem - it depends on probability. Machine learning and statistics can help scientists to label the sequence and establish how the parasite works. Because not every parasite is the same, they can then spot the genes which are only present in one particular malaria species."

Ultimately, it is this knowledge of the parasite's code that will lead scientists to creating a vaccine. In the meantime, Borgwardt and his colleagues are interested in how they might provide similar support to those mapping the genomes of entirely different species using the same comparative method.

"The probability of finding a gene that is similar to a gene of a related species depends on which species you are looking at," he adds. "This means that our algorithm has to be able to adapt to each genome you want to decipher. New mathematical questions are being generated all the time as more comparative gene finding gets underway. By answering them, we may ultimately be able to help to solve a whole range of biological problems."

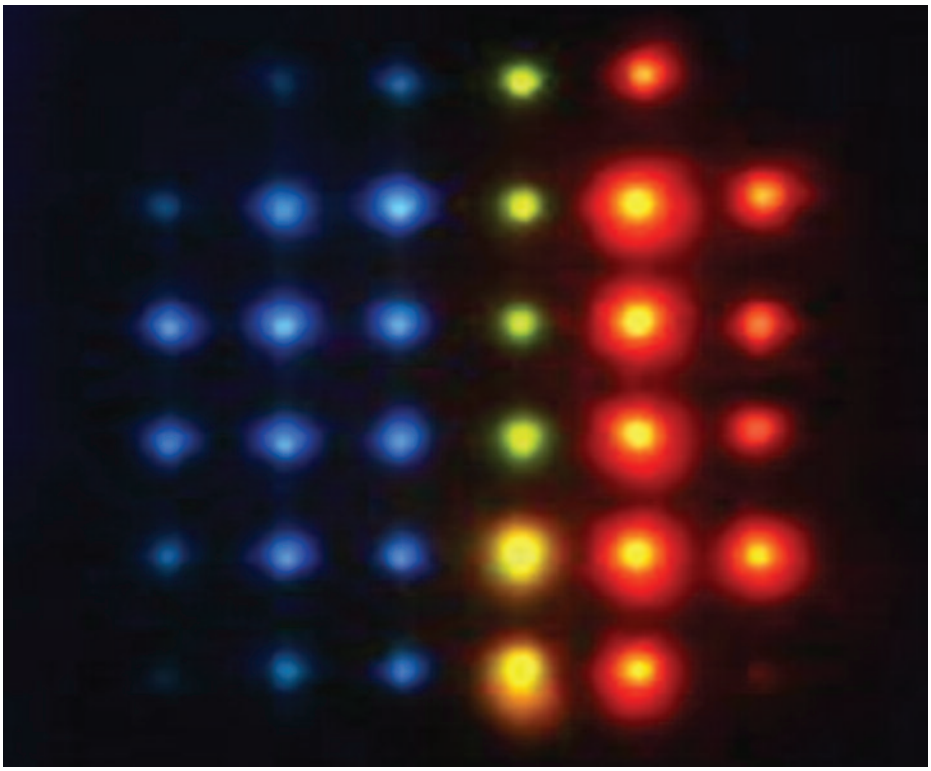
This research was reported in *Nature* journal last year: 'The genome of the simian and human malaria parasite Plasmodium knowlesi' in *Nature* 455, 799-803 (9 October 2008).

The Machine Learning Group, here at the Department, are working on a number of research projects at the intersection of machine learning and computational biology, ranging from new algorithms for predicting how proteins fold, models for learning the regulatory networks of genes, to methods for discovering biomarkers for diseases. http://mlg.eng.cam.ac.uk

This article originally appeared in Newsletter The Magazine for the Staff of the University of Cambridge, February/March 2009.

Liquid crystal lasers promise cheaper, high colour resolution laser television

Researchers at the Centre of Molecular Materials for Photonics and Electronics (CMMPE) are leading the way towards the development of extremely high colour resolution laser displays using liquid crystal laser technology.



Polychromatic laser emission from a gradient pitch liquid crystal cell, pumped from a single optical source

Laser displays are new to the market, and are currently being developed by a number of electronics manufacturers. In a laser display, pixels of light emission are generated from three separate red, green and blue (RGB) laser sources. They therefore have a much narrower spectral linewidth compared to the relatively broadband RGB sources from other display technologies, including CRT, plasma, LCD and even the latest organic light-emitting diode (OLED) displays. When these three narrow linewidth red, green and blue sources are combined in a laser display, they offer unprecedented depths of colour resolution over competing display technologies.

CMMPE has been performing extensive research into a new form of laser technology based on liquid crystals. In a recent article in Optics Express, they demonstrated a two-dimensional liquid crystal laser array, consisting of red, green and blue colours simultaneously being emitted from a single liquid crystal laser device, whilst being optically pumped with a single 430nm source. The article suggested that liquid crystal lasers could be used to replace the individual RGB lasers that are currently required in emerging laser displays. This would facilitate a reduction in the fabrication and materials cost of this currently fabrication-expensive technology. Furthermore, liquid crystal lasers are less likely to suffer from problems such as speckle, which are commonly associated with conventional laser display systems.

The liquid crystal laser itself is based on a similar device architecture as a conventional liquid crystal display. Liquid crystals are fast becoming an alternative medium for use as the feedback structure for a wide variety of miniature laser devices. Certain liquid crystal phases, in particular the chiral nematic phase, spontaneously self-organize to form a helical structure with a periodic refractive index. When combined with a gain medium, such as a fluorescent dye, the chiral liquid crystal provides sufficient feedback to generate lasing within a device of thicknesses less than a human hair. Unlike most conventional semiconductor lasers, the emission wavelength of a liquid crystal laser can be dynamically tuned using an applied voltage to alter the degree of periodicity of the macroscopic molecular structure. A further merit of this technology is that the emission can be chosen to be at any desired wavelength across the visible range through careful control, chemically, of the macroscopic material properties. A gradient in the periodicity of the liquid crystal structure can therefore be formed, which gives rise to simultaneous different emission wavelengths across the device. Such a feature is not readily achievable with existing laser technologies.

Liquid crystal lasers, however, are not merely restricted in their use to laser displays. Researchers at CMMPE are also developing applications for their use in infra-red medical diagnostic tools, telecommunication devices and holographic projection.

This research is on-going and is part of the four-year Basic Technology Research Grant 'COSMOS' funded by the EPSRC (Engineering and Physical Sciences Research Council) to develop a new generation of micron sized tunable coherent light sources based on ordered organic periodic structures. The research programme is a joint venture between research groups in the Department of Chemistry's Melville Laboratory, the Department of Engineering's Centre of Photonic Systems group and the Centre of Molecular Materials for Photonics and Electronics (CMMPE) group and the Department of Physics Optoelectronics group and Biological and Soft Systems group

More information can be found on the Centre of Molecular Materials for Photonics and Electronics (CMMPE) group website: www-g.eng.cam.ac.uk/CMMPE/index.html Or from Professor Harry Coles directly at: hjc37@cam.ac.uk

Articles on this research appeared in:
Optics Express (November, 2008)
Laser Focus World (January 2009)
Nature Photonics April 2009, Volume 3 No 4 pp177-236
Nature Photonics October 2008, Volume 2 No 10 pp581-638
Authors: Stephen Morris, Philip Hands, Sonja Findeisen-Tandel, Robert Cole, Timothy Wilkinson, Harry Coles.

"What's going on Underground? Tunnelling into the Future"

Professor Robert Mair recently gave a Public Lecture at the Royal Society in London.

The Royal Society hosts regular Public Lectures, designed to give a perspective of science in society from leading scientists, writers and broadcasters. The title of the lecture was "What's going on Underground? Tunnelling into the Future".

In Shanghai 140 km of tunnel were built in 2008 alone and there will be 400km of new tunnels completed by 2010. In Rome a new metro line beneath the Coliseum is about to be constructed. In London the exciting Crossrail project has got the green light. Urban congestion is a serious problem in many cities, so the creation of underground space and in particular the development of underground transport is environmentally essential. How can tunnels be built in ground sometimes as soft as toothpaste? What can go wrong? Will buildings above be affected by subsidence? What else is underground already that might get in the way? Geotechnical engineering, the application of the science of soil mechanics and engineering geology, plays a key role in answering these questions.

Professor Mair presented the latest methods of tunnelling that will ensure that London's Crossrail scheme can be safely constructed without damage to the buildings above ground. Work on the Crossrail scheme which will connect Maidenhead in Berkshire to Shenfield in Essex via Heathrow airport and London began in mid-January and the new line is due to open in 2018. The project will involve major new tunnels and stations constructed beneath many buildings in central London. The tunnels and stations will be considerably larger than a typical London Underground station and so extra care will need to be taken to protect existing buildings.

According to Professor Mair, engineers will use an innovative technique called compensation grouting to protect certain key buildings during construction of the tunnels. Before tunnelling, steel tubes known as 'tube a manchettes' (sleeved tubes) will be installed in the ground between the tunnel and the buildings above. During tunnelling, grout (liquid cement) will be injected from any one of a large number of holes in the steel tubes into the ground to compensate for the ground movements being caused by the tunnel excavation. The result is that the building experiences only a slight settlement, compared with what might have been a severe settlement if no compensation grouting had been undertaken.

Speaking about the technique, Professor Mair says: "The most famous example of the successful application of this technique was the protection of Big Ben from tilting during construction of Westminster Station for the Jubilee Line Extension. It has also recently been used to protect King's Cross Station during tunnelling works beneath it and is now being used to safeguard buildings from tunnelling settlements in many international projects, including metros in Amsterdam, Barcelona and Rome."

Other advances in tunnelling include the development of sophisticated closed face tunnelling machines which provide continuous support to the tunnel face while the ground is being excavated. An 8m diameter tunnelling machine was used for the recent Channel Tunnel Rail Link project that built the tunnels connecting Folkestone with St Pancras Station for the Eurostar. "Tunnels as large as 15m in diameter – three times the size of a London double-decker bus – have recently been completed in the cities of Madrid and Shanghai. In Shanghai the ground was as soft as toothpaste."

Professor Mair describes the critical importance of geology and the development and application of the latest tunnelling techniques. Examples of current and future projects from all over the world demonstrate the size, technical challenges and complexity of modern underground construction. Protection from subsidence is critical and new ways to ensure buildings are unaffected during tunnelling are explained.

Your chance to hear the lecture for yourself

Professor Robert Mair will be giving his lecture for the Cambridge University Engineering Association on Thursday, October 29th at One Great George Street, Westminster, London, SW1P 3AA (the Institution of Civil Engineers).

Tickets cost £20 a head and the evening begins at 6.30pm with a wine reception. All graduates are welcome but space is limited so please book early.

Email: alumni@foundation.cam.ac.uk for a reply form, or send a cheque direct, made out to University of Cambridge, to:

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