

▶ *engineering* ◀

CAMBRIDGE UNIVERSITY ENGINEERING DEPARTMENT AND ENGINEERS ASSOCIATION

Whatever the weather

With tight TV schedules and ever increasing expectations from spectators, delayed starts and cancellations for sporting events have become a lot less acceptable. As a result, many stadia are now being constructed with retractable roofs, not only to cope with such demands but also to provide multipurpose facilities that have the versatility required to make them financially viable in the longer term.

Frank Jensen, a PhD student working with Professor Sergio Pellegrino and Professor Chris Calladine in the Deployable Structures Laboratory has come up with some rather stylish schemes for the next generation sporting venues and stadia:

“The ideas generated in the deployable structures laboratory have led to a couple of novel concepts. We first took an existing deployable structure and developed it into a flat roof structure consisting of two identical layers of plates interconnected using simple cylindrical joints. This unique looking roof is able to open and close in a manner similar to that of an iris of a camera lens but, importantly, friction is greatly reduced, as there is no contact

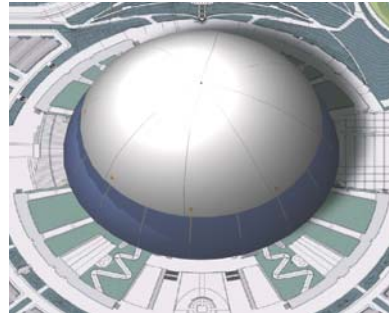
between the plates.”

“I am now working on a related solution for a sphere. The idea is to use the inherent structural strength and stiffness of the dome shape to help us to span the full width and length of a stadium effectively.”

There are a number of other possible applications for this type of structure, (as is often the case when a good idea is involved). For example, a micromechanics application would be for a tissue sampling machine – using sharp blades to form the rigid plates, the sphere could be closed to slice off a delicate sample of tissue, which could then be transferred directly to other equipment for testing, thus avoiding contamination. This concept is being pursued together with researchers at the Technical University of Delft, The Netherlands.

Meanwhile, there are those of us who would just like to see Wimbledon continue without rain stopping play!

For further details of this work and to view animations of the retractable roof concept, please visit the DSL web site on: www-civ.eng.cam.ac.uk/dsl/roof/



Spherical retractable roof as proposed by Frank Jensen.

In brief...

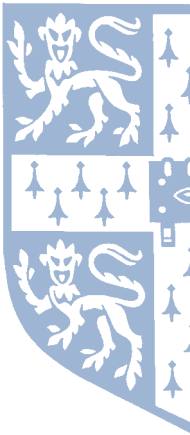
The Department continues to burst at the seams. To relieve this situation in the short term, a lease has been taken out on a Unit in the Science Park, which now houses the Centre for Molecular Materials for Photonics and Electronics (CMMPE) led by Professors Harry Coles and Bill Crossland within the Electrical Engineering Division and with collaboration from other departments. The centre was opened in February by the Minister for Science, Lord Sainsbury and the University Vice-Chancellor, Professor Sir Alec Broers.

A short term lease has also been taken out on offices in Keynes House on Trumpington Street, providing a home for the team working on the MPhil for Sustainable Development and some members of the Engineering Design Centre. The top floor of the new Gates Building, West Cambridge, has also been colonised by researchers in Communications Engineering, led by Professors Andy Hopper and Ian White.

Congratulations go to Professor Ann Dowling who has been elected a Fellow of the Royal Society, to Professor Andy Hopper on the award of the Royal Academy of Engineering's Silver Medal and to the ten undergraduates who were awarded the RAE's Leadership awards (a record number).

Professor Keith Glover, who became Head of Department last October, has set up a number of strategic working groups tasked with an extensive review of both research and teaching.

Dr David Holburn is the new Honorary Secretary of the CUEA, and the Annual Conference will be held in the Department on Saturday 27th September.



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August 2003

A Wonderful Thing is a Phillips Machine...

In the Meade Room in the Dept of Applied Economics of Cambridge University stands a Phillips Machine, a device so cunning and ingenious that it can predict the running of the national economy to within 4% accuracy. And

all by means of pipes and buckets, trickling with pink-coloured water, powered by a pump scavenged from the landing gear of a Lancaster bomber. It is a hydraulic computer, invented back in the 1950s by Bill Phillips.



The Phillips machine, launched in 1950 has been described as "a Heath Robinson device at its finest". It is shown here before renovation began, in the Departmental Workshop, being critically assessed by Allan McRobie and Alistair Ross.

Only fourteen Phillips Machines were ever made and the Cambridge machine is believed to be the only one still in a potentially-working condition. A conference to celebrate the 100th birthday of the Cambridge Economics Department is to be held in September this year, and invited alumni range from the Governor of the Bank of England to the Education Secretary. A team from the Engineering Department have undertaken to refurbish the Machine in time for this event.

Allan McRobie is coordinating the project at CUED "The machine is absolutely brilliant. We all know that engineers should have a knowledge of economics, but Phillips made an enormous contribution and showed that economists could learn much from engineering! Perhaps the Governor can be invited to work the monetary valves, and someone from Government the fiscal controls. Phillips was a genius and it is an honour to be involved with this project."

Those who would like to know more are recommended to read:

A.W.H. Phillips: *Collected Works in Contemporary Perspective*, Robert Leeson (ed), CUP 2002, £65.00.

No small achievement



Professor Mike Kelly, who was appointed to a new Chair as Prince Philip Professor of Technology last year, is now an Executive Director of the Cambridge MIT Institute (CMI) in partnership with Professor Ed Crawley from MIT.

"I took the decision to come back to Cambridge specifically to pursue my interest in the manufacturability of the small structures being proposed for advanced electronic and opto-electronic devices," he explains. "To manufacture such devices we are talking about precision at the atomic level. I aim to work at the interface of Physics and Engineering, to identify those devices, which will be in the minority, that lend themselves to manufacture in number, rather than just being produced as one-offs."

Although Professor Kelly has been diverted from his research interests to take CMI forward over the next three years, he intends that his research in this area should be maintained. Meanwhile, he is also playing a key organisational role as Deputy Head of the Department, leading a team to develop a new research strategy for the Department. This is part of Professor Keith Glover's programme for a sharper strategic plan for all CUED activities.

Prince Philip, Patron of CUEA for 50 years

A reception was held in the gardens of the Vice Chancellor's residence in Latham Road, on Monday 23rd June to celebrate the 50th year of Prince Philip as Patron of the Cambridge University Engineers' Association. The President of the Association, Viscount Montgomery of Alamein was present. A sundial based on the CUEA logo, fashioned in stainless steel and bronze, designed by Dr Peter Long was manufactured in the Department's Workshop to mark the occasion, and this was presented to His Royal Highness.

The reception followed a full day for Prince Philip, who had, in the morning, visited the new Nanoscience building on the West Cambridge site, as well as conferring Honorary Degrees at the Senate House. In his speech at the reception,

Prince Philip commented on the valuable role engineers play in society, and his appreciation at having access to some of the top experts in the field, through his association with Cambridge.

Membership of the CUEA which is free to all Cambridge graduates associated with the profession of engineering, now stands in the region of 6100. All members are entitled to receive free copies of "Enginuity".

Annual Conference

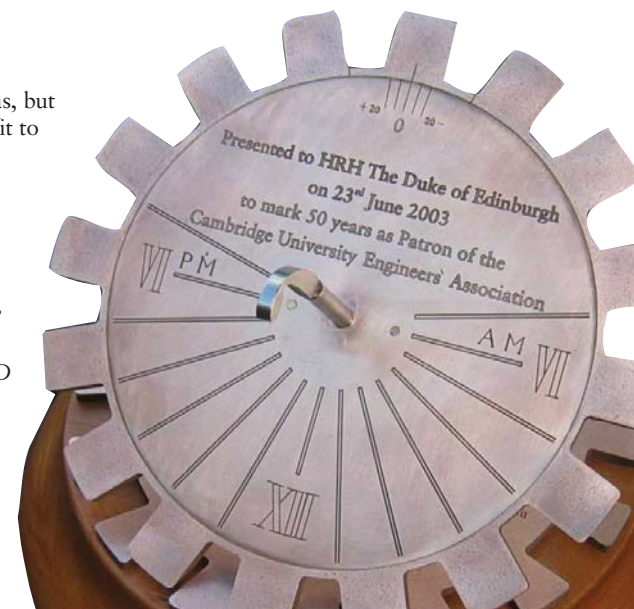
This year's CUEA conference will have a biomedical theme and will be held on Saturday 27th September to coincide with the University's alumni weekend. These conferences were instigated in 1965 in the belief that "they would

result not only in the production of new ideas, but also in action which will be of positive benefit to the national economy."

Speakers will include:

- **Dr Tom Bligh**
"Engineering the human genome"
- **Professor William Bonfield**
"What will your next hip be made from?"
- **Dr Richard Prager**
"Stradx: the highest definition freehand 3D ultrasound system in the world"

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Sign of the times

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Researchers in Roberto Cipolla's Computer Vision and Robotics group are tackling a new and interesting problem: how to teach a computer to recognize 3D sign language (as used by deaf people), and translate it into normal speech or written transcript.

"It may seem like an easy problem, getting a computer to recognize a human hand and determine its 3D shape – but to do this in front of an arbitrary background and in real-time is pretty difficult – the computer has to evaluate thousands of possible interpretations for each view it is shown." explains Cipolla. "In fact this can only be done because computing power is now available relatively cheaply. We are moving away from solving these problems using visual geometry alone, and are into the realms of Bayesian Statistics. The aim is to stabilize the visual interpretation. This uses the concept of 'prior' (i.e. expectations about the shape and movements of hands) and 'likelihood'

(measurements which take into account features such as colour, shading and edges in the images) to determine the most probable interpretations (position of hand, shape and movement) of the image being viewed. Each hand has 27 degrees of freedom which result in millions of possible states associated with a given view. Our algorithm quickly determines the most probable."

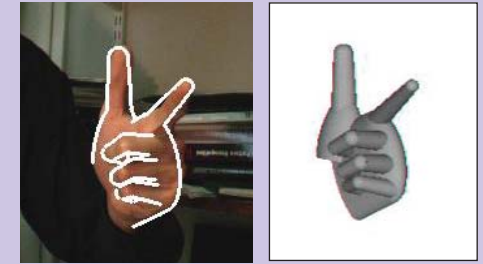
The Royal Mail are interested in this work, as they already provide an automated booth where typed words can be translated into sign language. They now want to close the loop so that deaf and dumb customers can 'sign' directly to a machine and have their needs recognized.

Other applications of the technique will include intelligent interfaces in cars which will recognise simple driver signals to turn on the radio, the lights, the windscreen wipers etc. An extension of this technique to recognise facial

features can also be used to monitor whether the driver is falling asleep or not watching the road when a pedestrian is in front of the car. "Cars are pretty lethal machines really" says Cipolla. "Legislation being introduced in Japan requires that far more use be made of automatic safety features." This work ties in with the interdisciplinary project on 'sentient vehicles' being led in the Department by Professor Nick Collings.

Help is also at hand for parents who worry about their kids slouching in front of screens – the next generation of computer games, using this type of technology requires participants to become actively involved – their movements, such as running, jumping and shooting, being tracked and used as input to the games...

For more details see the website at <http://mi.eng.cam.ac.uk/~bdrs2/hand/hand.html>



Philip Guildford – New Director of Research

Philip Guildford has recently joined CUED as Director of Research. A graduate in Natural Sciences from Cambridge (Jesus College) specialising in Materials Science, Philip has spent the last seventeen years in industry. Having begun his working life in R&D, working with building products, he soon moved into the aerospace sector, and then into industries taking a lead in 'green', environmentally-friendly projects related to energy efficiency and renewable energy.

A strong interest, and ability, in project management and technology strategy then led him into the realms of business consultancy, and back to Cambridge, working for PA Consulting Group. He was then lucky enough to move into telecoms, working as Principal

Consultant for Analysys, just when the market entered the greatest boom in history. "That was an exciting time" comments Philip. "We had companies queuing up for help in establishing new businesses and devising corporate strategies, as the industry went through dramatic transitions."

After over a decade of hectic international consulting work, he moved back into the University and joined the newly formed Corporate Liaison Office, which has been set up to act as an interface between the University and the business world. Having spent a year leading the development of the Office's strategy, implementing a project management system, building regional links and facilitating relationships with companies,

the move to CUED seemed a natural step.

"The job of Director of Research at CUED is very attractive to me – engineering is still the subject that excites me most and CUED has the most superb international reputation. I look forward to using all my skills, experience and energy, to help the academics to develop and express their research strategy; gather intelligence on funding opportunities that match their interests and aspirations; and ensure the provision of a professional service to support academics in winning and managing grants."

For further information, please contact Philip on pg28@cam.ac.uk



Biomedical engineering course launched

Over 100 students have taken the new course in biomedical engineering, offered as a second year elective this year, making it one of the most popular options.

The lectures on Oculomotor Control given by physiologist Dr Roger Carpenter were accompanied by a lab in which the students measured eye movements. Not only did this lab give the students a chance to do something a bit different, the fact that they had to go into the Downing Site to the top of the Physiology building was a new experience.



Roger Carpenter commented on the responsiveness of the engineering students: "It is interesting how they look at the equipment and investigate how it works – the medics we usually work with are not at all interested in that side of things." So the interdisciplinary nature of the course has provided useful experience all round, and good to know that our students are a credit to the Department off-site

The biomedical course, organized by Richard Prager in CUED, is very much a 'taster', designed to build on principles that the engineers are already familiar with, such as control systems, structures and fluids. These are related to Ocular motion (control), Flagellae of bacteria (structures), and the principles of flight and how fish swim (fluids). This approach which uses quantitative engineering techniques and applies them to biological systems is already leading to great advances in the field.

Silver Medal Awards

This year, Andy Hopper FREng, Professor of Communication Engineering, won a Silver Medal for his phenomenal record of developing and commercialising new computing technologies.

The award of the Royal Academy of Engineering Silver Medal to Professor Andy Hopper recognises "his outstanding research exploitation characterised by imaginative innovation followed through to practical realisation: this has led to industrial exploitation, including some ten successful start-up operations." He has founded or co-founded ten start-up companies, including Acorn Computers Ltd, where he was Research Director. After the success of its BBC Microcomputer, Acorn spawned the world-leading chip company ARM. Professor Hopper received his medal at the Academy Awards

Professor Howard Hodson received a Silver Medal from the Royal Academy of Engineering in 2001 in recognition of his 'outstanding and demonstrated personal contribution to British engineering, which has led to market exploitation.' His research has led to the development of a high-lift turbine which has up to 20 per cent fewer blades and higher efficiency than previously. How is this still possible after so many years of turbine research?

Howard Hodson explains:

"The efficiency of aircraft engines has risen steadily over the years, largely because of increases in the operating temperatures that can be used. However there is a trade-off between the life of components and the operating temperature so we had to look at other ways of reducing the whole life cost of the engine. One way is to increase the efficiency of each component but this is very difficult. Another is to reduce the number of blades (currently around 1000) used in the low pressure turbine that drives the fan. Because this turbine is large and heavy this reduces not only the cost of manufacture but also the weight of the engine

Dinner in London on Thursday 5 June.

Professor Hopper is currently excited about one of his newest spin-offs, RealVNC Ltd, formed last year to develop remote control software for desktop PCs. "This one is really going against the trend," he says, "we're going back to the old-fashioned idea of dumb terminals, which carry only graphics, linked to a central computer that does the hard work. It burns bandwidth passing all the instructions and graphics up and down the line but the trade-off is much simpler programming." Five million users have downloaded over 15 million licences for RealVNC from its open source on the web. "We're exporting British engineering to a huge number of people all over the world, in its own field this is revolutionary technology but we run it with three lads in an office in Cambridge."

and therefore the cost of ownership."

"This can only be done by making each turbine blade carry a greater aerodynamic force. We managed to do this by going back to examine the fundamentals of fluid flow around the turbine blades and discovering a method of increasing the lift and efficiency which involves seeding the laminar flow around each blade with bursts of turbulence. This actually increases the amount of laminar flow in a rather subtle way. Laminar flow is needed to increase the efficiency. The problem is that laminar flow tends to detach from the blades, which means that the lift cannot be sustained. By the way, we had actually spent the previous ten years 'proving' that this was not a good idea!"

"This project was conducted in conjunction with Neil Harvey, Senior Technologist at Rolls Royce. It was this close collaboration with industry that allowed a successful outcome to the project – that and the enthusiasm and talent of a large pool of graduate students working at the Whittle Laboratory."

"So what is the way forward now? Well, there are always trade-offs in this type of work,



Andy Hopper with his wife Dr Alison Smith...

The Academy's Silver Medals, instigated in 1995, are awarded annually to engineers aged 50 or under who have made outstanding contributions to British engineering. Only four awards may be made each year.

and one of the problems of reducing the number of aerofoils in each stage of the turbine is that the engines become noisier. So the next step forward is likely to address the possibility of reducing the number of stages in jet engines, and thus achieve a further reduction in the number of component parts."

For further information, please contact Professor Howard Hodson email: hph@eng.cam.ac.uk

