SOUE News

Issue 2 **Summer 2003**

Society of Oxford University Engineers

Welcome to the second issue of SOUE News

We are hoping to produce an issue roughly once a year (Issue 1 was in December 2001); the production of this issue has been regrettably delayed by some months due to work commitments. You will see that most of our articles describe activities in the Department, but one, by Jeremy Cooper, describes what one of our graduates has been up to in the world outside. We hope this will be the first of many such. If you have something to say that you think might be of interest to fellow members, please let us have it. It doesn't have to be about some bang-up-to-date activity. For instance, if you were involved in something rather fascinating back in 1940, why not write about it now, while you still can!

Please send articles for publication to SOUE at the address on the back page or via e-mail to souenews@soue.org.uk.

We draw attention to two other items:

1. The separate note re e-mail communication with members. Please respond.
2. The request (back cover) for graduates aged around 30, who would be willing to give advice to undergraduates about careers in their branch of engineering.

The editors, by the way, are:

Sarah Turner (Lincoln 1987)
Simon Turner (Lincoln 1987)
David Witt (Magdalen 1959)

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Head of Department's Report to SOUE 1 October 2001 – 30 September 2002

Rodney Eatock Taylor

Research

In the 2001 Research Assessment Exercise, the Department was once again awarded the top classification, 5*A. This corresponds to international excellence in the majority of our research and the highest band in terms of proportion of research active staff. The assessors noted in connection with this Department "the high level of inter-disciplinary work and the outstanding success in obtaining industrial funding and the formation of spin-out companies".

On the wider University level, Oxford can boast of having more researchers in world class (5 and 5*) departments than any other university, and the highest research income.

The Department has been successful in competing to participate in major new national initiatives, such as the Research Councils' Basic Technology Research Programme and the e-Science initiative which results from the government's spending review in 2001. We are also a major partner in the Doctoral Training Centre established in Oxford as part of the EPSRC's programme at the Life Sciences Interface. Engineering Science's involvement is primarily through the Interdisciplinary Research Centre ("From Medical Images and Signals to Clinical Information"), directed by Mike Brady.

The new Information Engineering Building project, on which I reported last year, is now moving forward. An additional £1.5 million has been contributed by the Wolfson Foundation, leaving us with £2.3 million to complete the funding of the vision. Construction is due to start in Spring 2003, on the site of the Victorian houses between the Jenkin and E & T buildings. When opened in summer of 2004 it will bring together research in robotics, medical imaging, signal processing and pattern analysis, communications and displays, control, and manufacturing systems analysis.

Significant Awards

- Professor Mike Brady has been selected for a Royal Society – Wolfson Research Merit Award. Thirteen were awarded nationally in the second round of this scheme.
- The University conferred the following titles on members of the Department in 2002:

Professor	Reader
Alistair Borthwick	Paul Buckley
Arthur Dexter	Janet Efstathiou
Alison Noble	Robert Field
Gilliane Sills	Steve Roberts
	Paul Smith

- Dr Joanna Ashbourne has been awarded an 1851 Research Fellowship, to support her work in Dr Paul Smith's group.
- Royal Academy of Engineering Leadership Awards:

  Fiona Howarth (St. Catherine's), Anthony Man (Wadham) and Alexander Quayle (Lincoln) are amongst the winners of the Academy's prestigious national competition for second year M.Eng. students. As well as receiving a financial award, they join the Academy's Engineering Leadership programme, which provides professional development advice and training designed to promote leadership qualities.
- Emmy Award:

  The Boujou Automated Camera Tracker, using software based on research into computer vision by Professor Andrew Zisserman and Dr Andrew Fitzgibbon in this Department, was awarded a Primetime Emmy at the 2002 Engineering and Interactive Television Awards ceremony, held in Hollywood on 21 August. "Lord of the Rings" and "Harry Potter and the Philosopher's Stone" are among the films to have benefited from this technology, which is marketed by the company 2d3.

- The IMechE 2001 George Stephenson Prize was awarded to David Hills, David Nowell and Ludwig Lummer (Rolls-Royce) for their paper "A combined testing and modelling approach to the prediction of fretting fatigue performance of splined shafts".

Academic Staff Movements

- Professor Roger Ainsworth has been elected as Master of St. Catherine's College.
- Professor Peter Dobson has been appointed to the post of Director of the University's Begbroke Business and Science Park.

  (Both Roger and Peter thereby relinquish their posts in the Department, but both intend to continue some research activities with us).
- Dr Mark Cannon has been appointed to a University Lecturership with a Fellowship at St. John's, as from 1 October 2002. He was previously employed on a Temporary Lecturership funded by Invensys plc, with a fellowship at St. Peter's.
- Dr Julia Stegemann was appointed to a Departmental lecturership as from 1 January 2002. The post is held in association with CEH Wallingford.
- Four Departmental Lecturers left during the course of the year: Dr Shengmin Guo, Dr Raja Ghosh, Dr Jannette Fransden and Dr Neil Townsend. Reappointments are being made.
- Mr Alan Knight and Mr Peter Rockett retired from their positions as Design Engineers, latterly as members of the Teaching and Design Support Group. Alan had been with the Department continuously since 1967.

Other News

- League tables. This is the year to take notice of these! In 2002 Oxford was for the first time ranked the top university in the Times *Good University Guide*. The Department was placed first in August 2002 in the Guardian University Guide's teaching rankings in the General Engineering category (which comprises 38 universities including Cambridge).
- The Royal Academy of Engineering Annual Soirée and Exhibition was hosted by the Department on June 26 2002. The Vice-Chancellors of both Oxford (Sir Colin Lucas) and Cambridge (Sir Alec Broers) attended, the latter in the role of President of the RAEng.
- Two of our 4th year undergraduates are spending the whole of the academic year 2002–2003 at Princeton University, under the new exchange scheme which we intend to expand in future years.

Retirement of the President

Rodney Eatock Taylor

Gordon Lewis (Pembroke 1944) became President of the Society in 1993, following a distinguished career in the Bristol Aeroplane Company and then Rolls-Royce (following the merger of the two companies in 1966). He shared in the prestigious MacRobert Award in 1970 for the rôle he played in the development of the Pegasus engine, was made CBE in 1977 and awarded the Royal Aeronautical Society British Gold Medal in 1978. From 1986 until his retirement in 1988 he was Technical Director of Rolls-Royce.

The Society has much benefited from the distinction that Gordon has brought to the office of President. He has assiduously presided over the business of our Annual Meetings, for many years, and chaired the Jenkin Lectures. In 1999 he went way beyond the call of duty for the President, in delivering one of the mini-lectures at the Open Day in May. Entitled "The Early Days", this provided an entertaining and enlightening insight into the fledgling aeronautical industry.

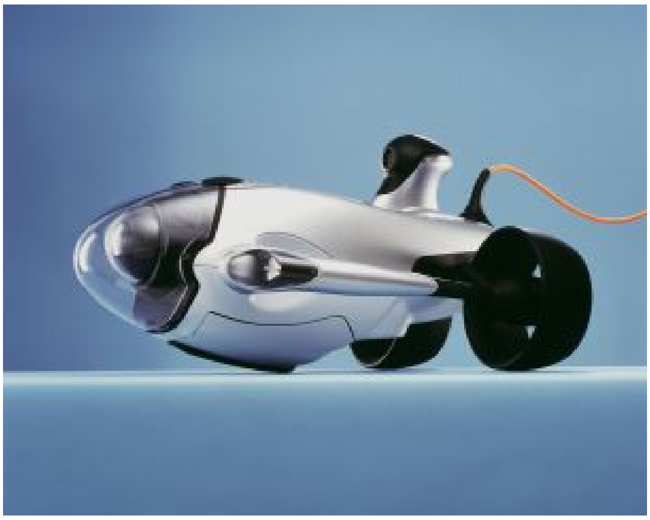
We are extremely grateful to Gordon Lewis for his Presidency of the Society, and wish him well in his retirement from this position (while hoping that we will continue to see him at the annual meetings of SOUE). The new President is Brian Cook (Brasenose 1953), who has taken a very active interest in the Society from its earliest days, and served on the committee for several years. In 1989 he gave the Second Jenkin Lecture, on Offshore Engineering. We are grateful to Brian for accepting this new rôle, and look forward to his Presidency of the Society.

Working on Spyfish®

Jeremy Cooper (Oriel 1990–4)

When I first received the advert for my current job from the recruitment agency I paid it little attention. I had been working in my previous job, in the electronics department of an industrial power tools manufacturer, for the 4 years since I had left Oxford, but a number of factors made me feel it was time to move on. This particular advert from the agency really did nothing to inspire me, but I was told that the MD of the company was keen to meet me and so I thought I might as well see what it was all about. What I found when I turned up for interview was diametrically opposed to the situation at the power tools company. Instead of the procedures, control and production focus of manufacturing industry, I found a small, creative and enthusiastic team of engineers all working on the research and development phase of a single project. The opportunities for expanding my engineering skills and creativity and for learning from the people and the project were clear to me and so it was that I ended up working for H2Eye Ltd — the creators of Spyfish®.

Spyfish® is described as a Submarine Telepresence Vehicle (STV), which translates as a remotely operated vessel (ROV) that relays live video of the underwater world to the user who is safe and dry in a boat on the surface. Spyfish® has been designed as a leisure product, initially something to complement the luxury boating market. The Spyfish® system comprises the ROV or Fish, cable, topside box and screen and wireless hand controller. The Fish has two horizontal and one vertical thruster that use sealed brushless dc motors. There are also two headlights to improve the illumination in poor light conditions and to enable night diving. The 150m cable is used only for video and communications and not for power so that it can be light and manageable. Navigation data in the form of compass heading and depth reading are sent to the topside and displayed along with the live video feed. And the hand controller gives the user intuitive control of Fish movement and graphical user interface. The entire system is Lithium Ion battery powered and portable, differentiating the Spyfish® system from other commercial types of ROV.



My work on Spyfish® began with the motors systems and soon included the power systems in general. During the course of the project I have developed skills in switching power supplies, which play an important part in the Spyfish® system, digital and analogue circuit design and become fluent in microcontroller firmware. Four years and a number of personnel changes later, I am today responsible for most of the electronics in the whole system.

Because the team is small, each member is almost solely responsible for large sections of the project. For my own part, this means taking various aspects of the electronic system right through from concept, circuit design and PCB layout to advanced pre-production prototype. Because each stage of this development is directly under my control I can make changes very quickly. And because I am sitting across a desk from the mechanical engineers, the integration of electronics and mechanics can be both complex and fluid. Indeed this high level of integration is the most important feature of the engineering of Spyfish®. Industrial design and hydrodynamics have dictated the exterior form of Spyfish® but have left some very odd shaped volumes in which to fit the various electronic and electro-mechanical systems. Without the dynamic nature of the engineering team, the level of integration required to realize Spyfish® would have been a great deal harder to achieve.

The different engineering disciplines inevitably retain some degree of separation, but working so closely with mechanical, software and other electronics engineers has given me a valuable appreciation of all areas.

We have had a great deal of success over the years of development. At present we have a number of fully working systems which we can use to test the robustness of our technology or to try out improvements. Initially we are able to run a system in our small test tank, but we have also put Spyfish® through its paces in more exotic locations around the world — locations where it will eventually be enjoyed by the user. Some of the video footage that we have recorded on these trips is truly stunning and helps to remind us of what we are aiming for. The images and video on the website are all genuine! (www.spyfish.com).

The project is currently moving from the design and development phase towards production and so the project focus, and consequently the work to be done, is changing. Whether the product turns out to be a commercial success remains to be seen, but one thing is certain, I have thoroughly enjoyed working on the design of Spyfish® in an environment such as H2Eye. I am aware that opportunities such as this do not come along often in the course of a career.

The 15th Jenkin Lecture: Engineering, Management and Aircraft

Martyn Hurst (Merton 1962–5, now Managing Director, Messier-Dowty, manufacturers of aircraft landing gear), 4th October 2002 — report by David Witt

Martyn Hurst told us how, when he went from Oxford into the Engineering Branch of the Royal Air Force, the forefront of our air defences was the Vulcan bomber fleet. So it seemed a bit of a let-down at first to find himself appointed as No.2 looking after a fleet of 25 propeller-driven Chipmunk training aircraft. However by sheer fluke he rapidly became the Senior Technical Officer in that unit, responsible not only for the aircraft, but also for the airmen who serviced them. Challenges and experience came quickly, and not only in engineering matters:

> *But the real benefit was to learn about people. Within the Royal Air Force the junior managers were held responsible for the people they managed — not just for their output but also for their well-being. To ensure they were housed, solvent, healthy and that any lack of sobriety did not adversely affect the local community.*
>
> *Now this may sound somewhat paternalistic in the brave new 21st century. But I passionately believe that if you are going to manage people you need to get to know them, care about them as individuals and to empathise with them in their success and difficulties.*

At that time the Royal Air Force was well ahead of its time in terms of management training, not just for administration skills but motivation and leadership too. He remembered visiting some contemporaries working in the steel industry and:

> *being shocked by the relationship — or rather the lack of it — between those who were trying to manage and the main body of employees. When I moved up to Doncaster and got to know junior managers in the coal industry and visited several mines the same picture was clear. No doubt someone will produce a comprehensive and objective analysis of the UK's post war industrial situation. I suspect it will make pretty sad reading — with misunderstandings of the real situation, wasteful conflict and squandered opportunities. There is always a tendency to blame this on trade unions. However I wonder whether things would have been different if managers had been better trained and supported.*

After various other postings, Martyn found himself looking after Harriers in the 1970s, when this remarkable aircraft was quite new to the RAF. Its VTOL capability meant that they were sometimes operated from tented camps in the woods in close support of the Army — quite a contrast from a well-endowed airbase.

From servicing Harriers in the field (almost literally), he moved to the Harrier Engineering Authority, a joint body between the Air Force as users and Hawker Siddeley as builders, concerned with the airworthiness and future development of the aircraft. This was a chance to see the aircraft industry at close quarters. On the whole he was very impressed, but not always:

> *In general the RAF did not challenge the industry view with sufficient rigour. I visited the company I work for today to protest that the landing gear overhaul life was far too short. After some strong discussion it was eventually raised through a process of sampling. Dowty's situation was not helped that day when I visited the repair shop and found five landing gears stripped down in pieces. All the oil bath covers, which carried the serial number of the landing gear, were in one cleaning basket. "How do you know which cover belongs to which gear, and how are we going to track the fatigue life of each gear?" I asked.*

Eventually it became apparent that many of the interesting senior posts in the RAF were not open to its engineer officers. Wanting to do something different, he resigned and took the post of Chief Engineer with British Caledonian Airways, which at the time was the major independent airline in the UK. So he was still in aircraft engineering. But the airline was suffering on the one hand from a serious cash shortage, and on the other from abysmal industrial relations. The staff did not trust the management, management made no attempt to communicate to them the problems facing the airline, and the pay structure depended on inappropriate shift patterns and inefficient working practices to generate extra overtime to increase a low basic wage. There was a proposal to consolidate most of the actual take-home pay into basic pay in exchange for the elimination of inefficiencies and to introduce a sensible progression structure based on qualifications and experience, but it took almost 2½ years of hard discussion to generate sufficient trust for it to be agreed.

> *The results which followed were extremely good — productivity improved in a spectacular manner and the management energy which had been previously expended in fire fighting could be turned to longer term planning and improvements.*
>
> *However outside events took over. The airline consolidation process had begun and in mid 87 British Airways put in an offer for British Caledonian which was cleared by the end of the year. The Industrial Relations climate in BA at that time was even more difficult than it had been in BCal at the start of the change process. There was probably no other course of action than to introduce BA terms and conditions for the BCal staff who joined BA.*
>
> *The direction we had taken — a brave new start ahead of its time in the UK — was cast aside — a somewhat frustrating experience.*

Martyn was one of the British Caledonian people who joined British Airways, and he was given responsibility for "Heavy Maintenance" (2000 people and 20 hangar bays, plus the Concorde operation). But although BA was beginning to improve its management-staff relations, beginning with the cabin staff, it hadn't really percolated far into the Engineering operation, where things were still very confrontational. They did begin to change, but very slowly, and it was frustrating not to be able to move things the way he believed in.

Eventually an opportunity came to move to a new and smaller airline where he might have more influence. Air Europe was in some ways a predecessor of today's "low-cost airlines", run by a young and dynamic team, but undoubtedly risky from a commercial point of view. The fall in business due to the 1991 Gulf War led to the bank withdrawing its support, and the company went out of business.

> *I hope few of you have been through a company failure because it is an exceedingly painful experience. You call the employees to tell them to stay at home, and that any pay they are owed will be a long time coming, if it comes at all. The city men arrive in red braces and loud voices to pick out the remaining assets from the wreckage for distribution to the creditors. No one will do anything for you unless you pay cash in advance . . .*
>
> *During the few weeks it takes to close down the company you feverishly search for another job. And you are one of the few lucky ones because you are being paid by the administrator during this fairly traumatic period. I well remember getting a call from one of my friends who said "Martyn, don't you think you are getting a little old for such character-building experiences?"*

After this, he went to work for Dowty Landing Gear. He showed us some pictures of typical landing gear — in the case of the Airbus 340 it has to support 275 tons during a fully-loaded take-off — and how it copes with landing loads. And it has to be sufficiently reliable to remain in service for 10 years or 20,000 landings between overhauls.

He was taken on initially to "sort out their Product Support". It was badly in need of it. The chances of an airline receiving any spare part within the advertised delivery date was only about 58%, the storage arrangements

(Continued on page 8)

The 15th Jenkin Lecture: Engineering, Management and Aircraft cont.

(Continued from page 7)

were primitive, and emergency telephone calls out of working hours went to the security guard. As he said, this provided "a fantastic opportunity". Today there are locally-manned support centres around the world, and the 58% has risen to 97%, most things being delivered immediately.

> *This has been achieved with . . . essentially the same team — so what has changed? Basically the management style. Previously the requirements of the airline customers were never understood. These have been clearly explained and then the product support team were encouraged, helped, supported with resource and convinced that they could achieve. It takes a while to overcome the starting inertia but once a team reaches critical self-sustaining speed it seems to become self-motivating, and new ideas and new approaches spring from within. Individuals who were previously perceived as ordinary by the organisation come up with the truly extraordinary.*

Dowty Group paid the price of diversifying into electronics instead of sticking with what they were good at, and were taken over by the TI Group, who had a very short-term financial outlook, most unsuited to an aerospace enterprise. So eventually Dowty were amalgamated with their French counterpart Messier (part of SNECMA) to form Messier-Dowty, and TI no longer exists.

For Martyn, this meant a move to France, and we were given some interesting insights on Anglo-French collaboration:

> *For example the French are extremely good planners — in fact I sometimes feel they prefer planning to doing. So it can be analysis leading to paralysis. The British cannot wait to get started and rush into change, which leads to a period of chaos before things get sorted out. If you can combine these two approaches to get the best of both worlds it really gives a good result.*

Messier-Dowty have manufacturing plants in France, England and Canada, and they and their US competitor Goodrich share about 85% of the landing-gear market about equally between them. Their own landing-gear touches down on a runway somewhere 30,000 times a day, once every 3 seconds. Nearly always with no trouble, but as engineers we could not be expected to believe that nothing ever went wrong, so we were given examples of a few occasions when it did — none of them fatal. Two examples:

> *Here is a Virgin A340 en route into Heathrow and you can see what is missing. The Left Hand Main Gear would not deploy because a brake rod had become detached and jammed in the aircraft structure. Not a problem with a Messier-Dowty part I hasten to add. The aircraft landed safely on the nose gear, right-hand main and left engine nacelle, and no one was hurt.*
>
> *Then there was the Air Transat A330 that ran out of fuel over the Atlantic. You would not believe you could glide aircraft like an A330. However 19 long and very quiet minutes later the aircraft made a successful landing on the only piece of terra firma for over 1000 miles. Fortunately the Almighty had put the Azores in exactly the right place. The pilot obviously could not go round again and had to come in very fast and very high and*

> *put the aircraft down very hard. By then the emergency Ram Air Turbine was no longer generating hydraulic power and the brake accumulators give you only one or two brake applications. So it was brakes on and keep them on or go off the end into the sea. In such circumstances the tyres burst and then the wheels get ground flat and then the bottom of the landing gear. But minor injuries only, and the aircraft was recovered.*

A third example, of some technical significance, was a fatigue failure of a leg from torsional stresses, brought about by the aircraft doing tight turns on the tarmac far more frequently than had been expected at the design stage.

But such incidents were very rare, and he was emphatic about the dedication of aerospace people to their task of keeping aircraft safe and reliable, and their awareness of the responsibilities they carry.

To conclude, he gave us his list of "what it takes to be an effective managing engineer":

1. *Personal Integrity*
2. *An Empathy with People*
3. *A sound grasp of Engineering Principles*
4. *Incurable Optimism combined with Pragmatic Pessimism*
5. *A willingness to challenge "Perceived Wisdom"*
6. *A Sixth Sense (that something may be about to go badly wrong, so go and look)*
7. *A Supportive Partner*

He ended with what he called "an impudent challenge to the Engineering Department":

> *As I see it, the consolidation of major industries and the frustrating lack of UK industrial strategy means that many key engineering opportunities for Oxford engineering graduates will lie outside the UK in mainland Europe.*
>
> *So the challenge is this: "Are you equipping today's graduates to compete for those opportunities against their European counterparts from the best Engineering Institutions in France, Germany and the other members of the EEC?"*

Research-in-Progress Lecture: Ultra-Fast Electronics

One of the two research-in-progress lectures from the 2002 Jenkin Day, given by Chris Stevens — report by David Witt

Chris set out to look at ways in which one might improve significantly on the speeds of present electronic devices, which are, roughly:

> 300 GHz for GaAs/Si narrow-band analogue integrated circuits;
>
> 3 GHz for digital CMOS (perhaps extendable to 10 GHz one day).

Five possible future devices were considered, with most attention to the last:

1. Intel THz transistors with buried 30nm channels. These are hard to make and raise a severe problem in heat dissipation;
2. The resonant tunnel transistor, good in theory but even harder to make;
3. The single electron transistor, in which the presence or absence of a single electron on the gate is sufficient to change the logic state. The devices are therefore extremely small and it is a real challenge to make an integrated circuit out of them;

(Continued on page 10)

Research-in-Progress Lecture: Ultra-Fast Electronics cont.

(Continued from page 9)

4. Optical logic, which can switch at the amazing speed of 50 THz. But a single switching "circuit" is impossibly large, requiring a whole optical bench;
5. Rapid Single Flux Quantum Logic.

This last is effectively a set of superconducting rings containing Josephson junctions. Each ring is of a size that can hold just one quantum of magnetic flux passing through it, about 2×10^{-15} Wb or Vs ($=h/2e$). Thus an applied voltage of only 2mV can make the flux move to an adjacent ring in just 1 ps. Chris explained how standard logic gates could in principle be developed using this phenomenon. An experimental device using a niobium superconductor has already been made into a flip-flop that could operate at 750 GHz. Devices using high-temperature superconductors could potentially work even faster.

Chris pointed out that there was a serious problem in testing new devices that were significantly faster than anything out of which one might build test equipment. But the optical techniques (No. 4 above), though no substitute for electronic logic circuits, could be ideal for making the test equipment now needed. Lasers could produce light pulses shorter than 1 ps, and as an example of what might be done he described an interesting technique for generating very short pulse trains or digital signals by combining light beams which had been subject to small differential delays. The delays are got by passing the light through stacks of glass microscope slides, each of which generates a delay of a few ps compared with an air path of the same length. The various delayed signals are then combined with a simple lens.

In conclusion, Chris said that the prospects for much faster electronics were looking good. Major research investment was under way — but we would need to overcome the reluctance to use cryogenics!

Seeing Inside an I.C. Engine Combustion Chamber

Richard Stone

In investigating the performance of internal combustion engines, it is obviously helpful if one can see what is happening in the cylinder during the combustion phase. To this end we have built a single-cylinder spark-ignition engine with a window in the piston. A mirror below, aligned at 45°, reflects the light out sideways. The mirror has to lie between the window above and the gudgeon pin below, so a much lengthened piston is used, with a cutaway central portion, so that it can reciprocate up and down around the stationary mirror. See Figure 1. There are windows near the top of the cylinder wall too, but these are necessarily blocked near top dead centre where most of the combustion occurs.

A fully digital CCD camera system is used to grab images once per cycle. This can be used in two ways:

a) looking at the same crank angle on successive cycles, to study cycle-by-cycle variations in combustion, which can be quite substantial, particularly with very lean mixtures;

b) constructing a library of images from different crank angles, from which an animation of the process can be constructed, by selecting representative samples.

We use not only the natural light from combustion (Fig. 2), but also laser diagnostic techniques, such as Degenerate Four-wave Mixing, developed by Professor Paul Ewart of the Clarendon Laboratory. This can identify temperatures and concentrations of species such as the hydroxyl radical (OH) and nitric oxide (NO).

In parallel with the experimental studies we have developed a multi-zone combustion model that predicts the performance and emissions of spark-ignition engines. It can predict temperature and NO emissions for both homogeneous and stratified-charge combustion. The model is useful both for validating our experimental data (since the model always obeys the laws of conservation and thermodynamics – unlike some experimental data!), and for giving insights into parameters that cannot be measured.

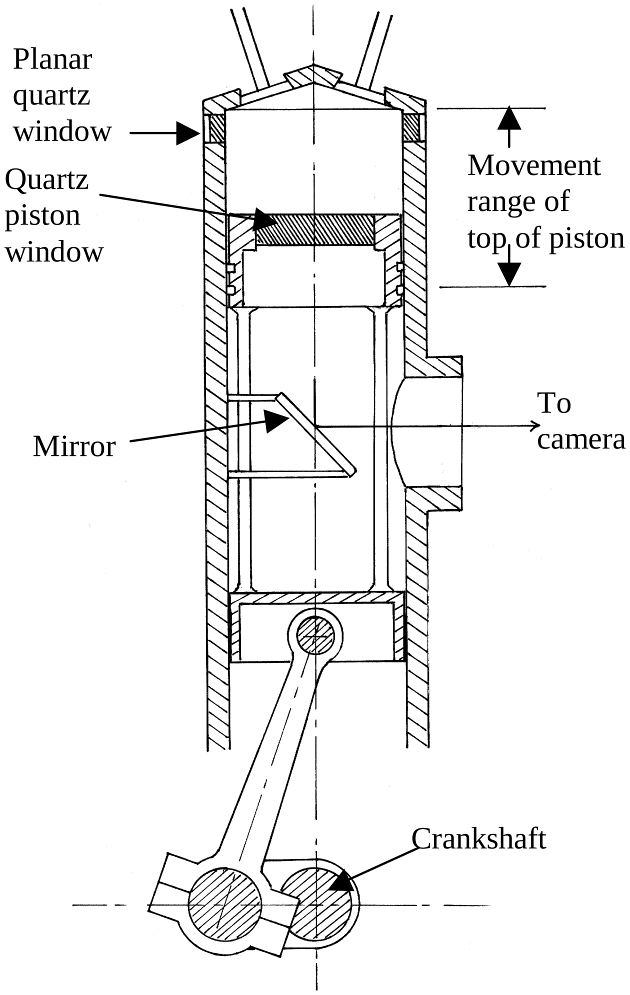


Figure 1 – Engine with optical access

A particular interest is the combustion performance of pure fuel components (liquid and gaseous), and a recent project has been looking at how soot is formed. The camera produces "R, G and B" signals, and their relative strengths (R/G and R/B) are each a function of the temperature of the soot and of how much of it is present. Thus both the temperature and "loading" of the soot can be determined.

Figure 2 illustrates the use of "soot pyrometry" to study a "pool fire". Pool fires occur in cold engines, when the fuel literally floods the engine. Puddles of fuel form behind the inlet valve and do not fully vaporise; when the inlet valve opens the fuel forms a film on the piston. The vaporised fuel that has already mixed with the air burns first. Subsequently the liquid in the film evaporates and burns with a diffusion flame. There is a wide variation of air/fuel ratios, with very rich mixtures close to the liquid, so the flame is quite sooty. (See Proc. I.Mech.E. Vol. 125 Pt C, pp 1041–1052, 2001 for more on this technique.)

Figure 2a – Natural light image

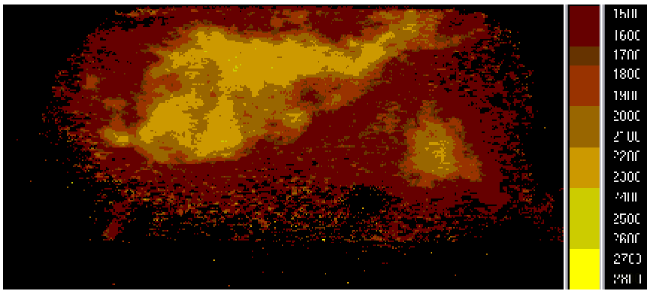


Figure 2b – Temperature colour-coded image

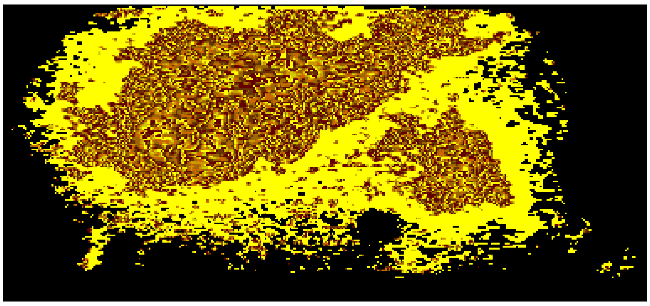


Figure 2c – Soot-loading colour-coded image (grey area is sootiest)

Hypersonics at Osney Lab

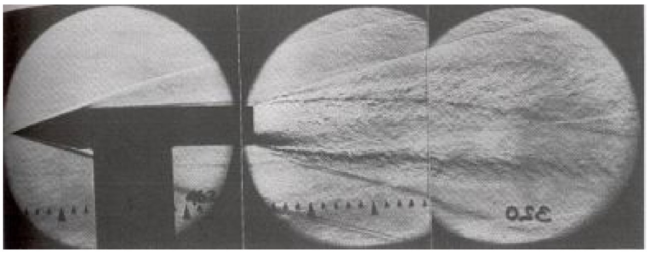
Terry Jones

During the 1960's under the direction of the Head of Department, the late Professor Douglas Holder, assisted by Donald Schultz, there was much activity on research in hypersonic and supersonic flows. This took place in what is now the Thom Building. At one time there were five wind tunnels capable of providing hypersonic flows operating in the building. These were mainly short duration facilities such as gun tunnels and shock tubes. In particular my shock tunnel at the time produced flows of Mach numbers up to 30, travelling at 3km per second for several milliseconds. One facility, the Low Density Wind Tunnel, achieved Mach 6 continuously but at very low mass flows corresponding to low density at very high altitudes.

The measurement of heat transfer to missile models was an important aspect of the research and the ability to make these measurements led to a new application; that of heat transfer and aerodynamics in gas turbine blading. At the beginning of the 1970's the turbine activity required additional short duration wind tunnels and in particular the Isentropic Light Piston Tunnel which I devised specifically for turbine testing. Ultimately this research led to the establishment of the Rolls Royce University Technology Centre in Heat Transfer and Aerodynamics.

It was apparent that such research could not be accommodated in the Thom Building and Professor Douglas Holder championed the acquisition of the old city electricity generating station at Osney to house the wind tunnels. The move to Osney took place in 1975 and Professor Donald Schultz headed the group until his death in 1987.

A new gun tunnel was acquired from Rolls Royce at this time. This had previously been used on intake development of the Bristol Bloodhound missile many years ago and was much larger than the existing tunnel. This Gun Tunnel spent a decade examining the plumes of rockets, for these hot gases emitted radiation whereby missiles could be detected. A typical example of a Schlieren photograph of rocket and plume is shown below. The rocket is flying at a Mach number of 7, the nozzle flow exhausts at Mach 4 and the complex plume flow structure can be seen.



The Low Density Wind Tunnel, essentially the sole tunnel of its kind now operational in the UK, was moved from the Thom Building to Osney. An example of research done in it is the work performed for NASA on measurement of drag on the Mars Pathfinder probe. The vehicle model was tested by suspending it magnetically in a Mach 6 low density flow and as shown in Andrew Owen's thesis, the data obtained compared well with that derived from the flight trajectory by NASA as the probe decelerated in the Martian atmosphere.

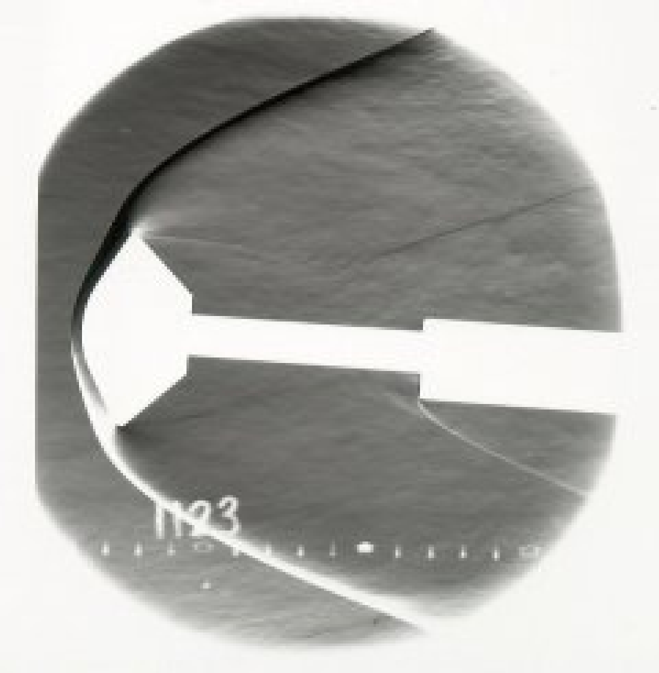
Over recent years hypersonic research has been focussed on Ramjets and Scramjets. Both engines compress the air prior to combustion using the "ram" effect as the air slows down on meeting the vehicle. No compressor is required as in a conventional jet engine. Although SCRAMJETS (Supersonic Combustion Ramjets) have been studied for many years it is only recently that flight testing of such engines has been attempted. The tunnels at Osney have been playing their part in this effort in testing the intakes to ensure that the intake shock is "swallowed" appropriately.

In tests at Woomera in Australia these scramjets were tested by placing them on the nose of a two stage, Terrier/Orion rocket which flew to an altitude of 300 kilometres, well above the earth's atmosphere. At this altitude it turned round and fell back into the atmosphere achieving the correct conditions at 20 kilometres height and a Mach number of 9, whereupon fuel was injected and testing took place for approximately 10 seconds. Two launches have been made so far, one failed due to rocket malfunction and the second was a success and data is still being evaluated in the UK and Australia. The completed Orion rocket/scramjet assembly was tested for stability at Osney Lab as shown in the photograph below.

Osney research student Alex Matthews took part in preparation for these flight tests in collaboration with colleagues from the University of Queensland. The launch of the first rocket is shown below.

Several similar launches to test American and French Scramjet engines using Russian rockets have taken place over the past few years. The current American activity is the testing of HYPER-X; a scramjet / airframe combination model which is launched from a Pegasus satellite launcher in level flight at 20 kilometres altitude. The first test took place a year ago but ended in a rocket failure. NASA continues this development and have asked Osney Lab to look at the HYPER-X — Pegasus separation in the Low Density Wind Tunnel.

The most recent work in the Low Density Wind Tunnel has been on the Beagle 2 Mars Lander. However, before turning to this, its tests in the Gun Tunnel must be mentioned. Beagle 2 is the UK Mars probe which is to be carried to Mars this year (2003) by the European Space Agency Spacecraft, Mars Express. It is to be launched on the Russian rocket Soyuz / Fregat in the middle of the year, to land around Christmas Day. The model of Beagle 2 can be seen below "flying" in a simulated Martian atmosphere at Mach 6 in the Gun tunnel.



Note the strong bow shock which causes severe heating on the front of the capsule necessitating an ablation heat shield during entry. The heat transfer around the capsule was measured in the Gun Tunnel to confirm

(Continued on page 14)

Hypersonics at Osney Lab cont.

(Continued from page 13)

computational predictions which are crucial in the design of the vehicle.

Beagle 2 carries a wide range of instrumentation; a primary aim being the search for life. However, an anemometer to measure Martian winds is also carried and this was developed with the Atmospheric Physics Department.

The anemometer was manufactured at the Osney Lab and tested in the Low Density Wind Tunnel where conditions on the surface of Mars were reproduced. The anemometer operates by measuring the cooling associated with the wind, similar to a terrestrial device, but has to be extremely sensitive in view of the fact that the Martian atmospheric pressure is approximately one percent of that on the earth.

The Mars Lander as it would appear when deployed on the surface is shown here and the Osney probe is clearly seen as the white disc.

A new initiative by QinetiQ (formerly Defence Evaluation and Research Agency) is the SHYFE programme. SHYFE (Sustained Hypersonic Flight Experiment) is in fact a ramjet operating at exceedingly high temperatures. Osney Lab is to analyse the heat transfer aspects of the vehicle and perform gun tunnel testing. Thus hypersonics, which was instrumental in the development of the University Technology Centre in Heat Transfer and Aerodynamics, still maintains a high profile at the Osney Lab.

The Osney Lab, formerly the Oxford Power Station

Northridge and Kobe — Earthquakes That Are Revolutionising Engineering Practice

Tony Blakeborough

Every year, something like five thousand to ten thousand people die in earthquakes worldwide. The worst earthquake in recent times, in 1976 at Tangshan in China, killed over 500,000. By this measure, the moderately large 1976 earthquake at Northridge in Los Angeles (magnitude 6.9), which killed 57 people, and the magnitude 7.1 earthquake that hit Kobe, the principal port of Japan, the following year were relatively insignificant. Although five thousand died at Kobe, most of the victims were killed in fires that took hold in the lightly framed wooden houses in residential districts; the number of deaths in engineered structures was in the tens. Nevertheless, these two earthquakes have changed the direction of earthquake engineering research throughout the world.

The reason that these two earthquakes were notable lies not in the number of dead, but in their economic cost. Each event was a direct hit by a moderate earthquake on a built-up area. In Northridge, around 15,000 buildings had to be demolished, resulting in a total loss of around $15bn; in Kobe, the repair costs alone were estimated to lie in the range of $90bn to $147bn and 180,000 buildings were destroyed or seriously damaged. Each earthquake set a record loss for natural disasters.

Both the US and Japan had well developed seismic codes directed primarily at saving human life, and in this they were successful. But in practice, both codes were too limited and missed a wider purpose — that of saving resources. Withdrawing $15bn from an economy kills more than 57 people in terms of reduced provision for healthcare or road safety improvements.

Following these earthquakes, it was immediately apparent to earthquake engineers that the guiding principles behind the codes had to change. Whereas previous measures had been designed primarily to guard buildings against collapse, the new and much more arduous aim is to keep the main load-bearing structure undamaged, thus removing expensive demolition and rebuilding costs. In consequence, it was no longer acceptable to use the primary structure to absorb energy (and thus become damaged); new ways of damping the structure had to be found. In addition, old structures — now recognised as a risk — had to be made more robust.

Two ways of meeting this rigorous challenge are currently being researched and adopted. In the first, base isolation, the main structure is positioned on rubber springs so that it remains static as the ground moves. This technique had been in occasional use for some years before the earthquakes but the events at Northridge and Kobe have given the idea new impetus, although it can only be incorporated economically for new buildings. A more radical development is the addition of supplementary damping systems to both old and new structures. These can take two forms: elements that deform plastically in response to the earthquake; and shock-absorbing viscous dampers which damp the building to reduce overall response. Both kinds are attached to bracing elements within the structure.

The potential use of viscous devices in this application has been highlighted by the availability of a design of viscous damping devices originally intended to isolate and protect the propulsion motors in nuclear submarines, now brought into the public domain by the ending of the Cold War. The installation of these dampers into buildings has demonstrated the concept's viability, but their expensiveness has prompted a search for similar, cheaper ways of doing the same thing. A number of new avenues of research have now opened up.

At Oxford, Dr Martin Williams and I have developed a test method that allows us to simulate and explore in a uniquely realistic manner how damping devices in a building respond to an earthquake. The "real-time hybrid testing" method simulates the total performance of a structure by splitting it into a

(Continued on page 16)

Northridge and Kobe cont.

(Continued from page 15)

physical part (the damping device) and a computational part (the remainder of the structure). These two models interact at fixed points (the connecting nodes) in the structure. Recordings of real or invented earthquakes are fed into the computational model and the displacements of the connecting nodes are calculated. Hydraulic actuators then apply these displacements to the physical model and the resulting forces are measured. These forces are in turn applied with the next part of the earthquake to the computational model and the new displacements calculated. This loop is repeated until the earthquake is over.

The significant advantage of our system is that we can perform the calculations fast enough for the system to run in real time, reproducing the velocities as well as the displacements of an earthquake response. This is important because the performance of these damping devices is rate dependent. For a truly accurate result, loading must take place at the velocities the devices would actually experience and our method successfully achieves this.

We have also investigated knee-braced frames — a plastic dissipative system that absorbs energy by yielding the web of a steel beam. These are made from standard beam sections and are supplied with a small number of fixed strengths. Our research has shown how drilling holes in the web can allow the designer to vary the strength of the beam to provide a wider range of design options without impairing fatigue endurance to levels unacceptable in an earthquake.

We are now embarking on a programme to test a new plastic energy absorber designed by Professor Uwe Dorka of Kassel University in Germany. The simple design of this device would make it cheap to produce, but real time testing has not previously been possible and it is important to ascertain whether the heat generated by the dissipating energy significantly affects the performance of the device. We shall also be testing some Jarret devices, recently developed viscous devices whose properties depend in a very complex way on the loading rate and the extension of the device.

Research of this nature will both enable us to check the performance of the kinds of damping systems now being installed in buildings and also to develop numerical models that can be confidently used in purely computational models for the design of earthquake-resistant buildings. Producing economic dissipative designs for buildings in earthquake regions will, it is to be hoped, ensure that the revised more challenging goals of seismic design are achieved.

Research-in-Progress Lecture: Recent Developments in Turbomachinery Research

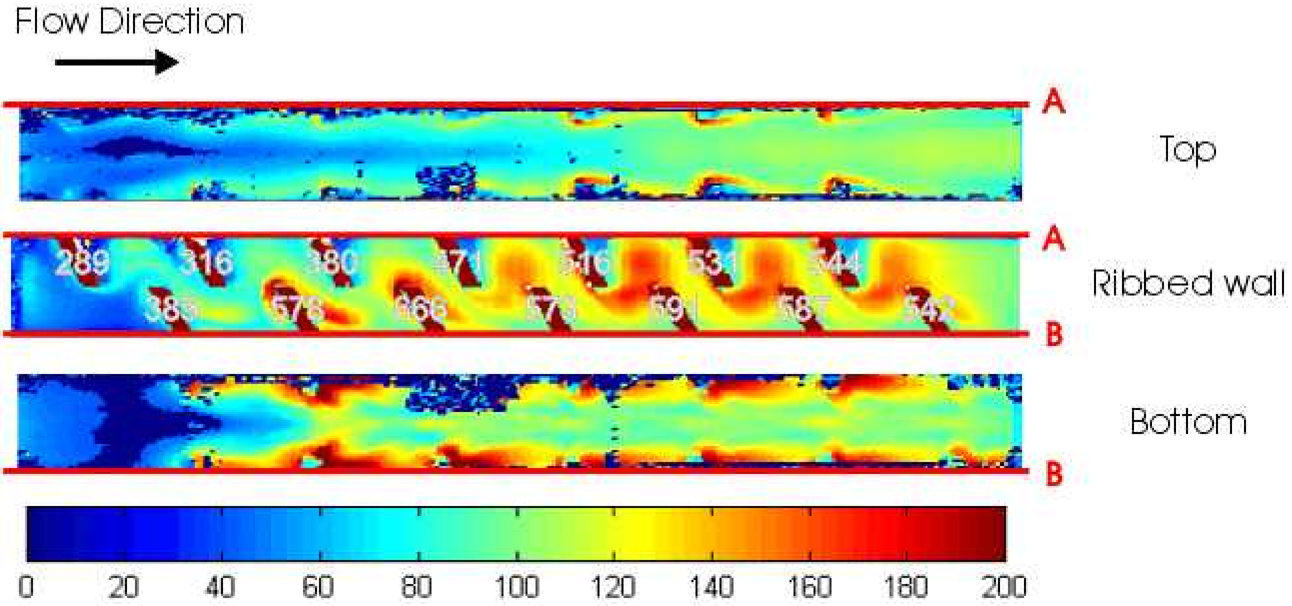
The second research-in-progress lecture from the 2002 Jenkin Day, given by Peter Ireland — report by Fionn Dunne

Turbine heat transfer and aerodynamics research was initiated in the Department by Professors Donald Schultz and Terry Jones with their work on shock tube tests. The research is now closely associated with aero-engines and much of the work is carried out within the Rolls-Royce University Technology Centre. Engine manufacturers, such as Rolls-Royce, strive to produce better efficiencies and reduced fuel consumption, for both economic and environmental reasons. This can be achieved by increasing the temperature at which the engine operates. Currently, the hot gas and combustion products forming the gas stream in a gas turbine engine can reach temperatures of 2375K, with some component temperatures at about 950°C. The lower component temperatures are achieved through careful design and control of both internal blade air cooling and external film cooling using cooler compressor air. Much of the work carried out by Dr Ireland and his colleagues is aimed at the determination of temperature distributions using both sophisticated experimental techniques and the development of accurate mathematical models for boundary layers. An important and difficult problem that arises in the development of the theoretical models is that of turbulence.

Dimensional analysis is often used by the researchers in order to design tests that provide 'similarity' with aero-engine component conditions; that is, using dimensional analysis, laboratory tests can be designed which simulate the conditions to which engine components are subjected, but which are considerably easier to achieve than the actual engine conditions. In such experiments, a number of novel techniques are used to measure accurately the temperatures of model engine components. These include the use of 'chips' in the Rotor facility run by Professor Ainsworth and his team. The chips are implanted into the blades and this enables high frequency heat flux and pressure information to be obtained over just one twelfth of a second. Liquid crystal techniques are also used to measure temperatures in low speed models. Here, components are coated with liquid crystals which change colour according to the temperature. This technique is used in particular for determination of internal cooling duct heat transfer coefficients. The technique allows resolution equivalent to six microns in the actual film cooling holes, which have a diameter of about 0.3mm. This work has enabled the investigation of the use of turbulators within the cooling ducts to improve heat transfer. The function of the turbulator is to destroy the boundary layer and hence increase the heat transfer coefficient. Some results are shown in the figure below in which the ribs, or turbulators, can be seen.

The experimental techniques developed are essential since unfortunately, computational fluid dynamics simulations are currently unable to predict correctly the gas velocities in the cooling ducts.

Dr Ireland completed his fascinating presentation by giving other examples in which his research finds application. These include marine engines and fire event modelling. Turbomachinery research is clearly still thriving in Oxford, with many challenges ahead; circumstances with which Donald Schultz would no doubt be well pleased.



Turbulators destroying the boundary layer and increasing heat transfer

The 2002 Lubbock Lecture: In Pursuit of Creative Synergy . . .

Tony Fitzpatrick F.R.Eng. (Group Board Director, Ove Arup Partnership) — report by Martin Williams

The full title of the lecture, "In pursuit of creative synergy — from the Sydney Opera House to the London Millennium Bridge", gives an idea of its very broad scope. Tony took us on a journey through his long and varied career as a structural engineer, bringing out the excitement of working on the design of some of the world's great buildings, and the constant need for creative interaction between professionals from different disciplines to solve new problems. Arup are, of course, particularly noted for their excellent working relationships with architects which have been key to the creation of many world-famous, landmark structures — the Sydney Opera House, Pompidou Centre in Paris and Hong Kong and Shanghai Bank headquarters in Hong Kong to name just a few.

Of course, no presentation concerning notable Arup projects would be complete without an account of the London Millennium Bridge. This footbridge, designed by Arup and architect Foster Associates, became infamous when it had to be closed only days after opening due to worrying levels of sway vibration caused by crowds crossing the bridge. In the weeks that followed, Arup engineers found themselves inundated by "helpful suggestions" of the cause from engineers around the world, mostly related to the bridge's unusual structural form. Arup kept an open mind and invested in some fundamental research. The cause was eventually identified as the previously little-known phenomenon of synchronous lateral excitation — essentially, when a low-frequency lateral vibration is set up, pedestrians find that the only way they can keep their balance is to walk at the sway frequency of the structure. A vicious circle is thus created, in which the pedestrians' involuntary response to the vibration actually reinforces it, until it reaches potentially dangerous levels. Having identified the cause, Arup were able to argue convincingly that the structural form was not a key factor, to design remedial works and to emerge with their reputation intact.

With structural engineering having such a long history, it is sometimes claimed that there are no major challenges left to overcome. On the contrary, this fascinating talk showed that each new structure still presents a novel set of problems and that creativity and innovation will play key roles in the structural engineering profession for many years to come.

The main lecture was preceded by two research-in-progress talks on Civil Engineering topics:

Martin Williams on *"Structural Vibrations"*

Chris Martin on *"Numerical modelling of soil/structure interaction — conflicts and compromises"*

Project Exhibition 2002

David Witt

The Lubbock day is also the occasion when the 4th year are invited to display exhibits based on their project work. We have had occasional such exhibitions in the past, but since 2001 we have intended to make it a regular event. Last year we had only 8 exhibits, though 8 very good ones. This year it doubled to 16, which was very encouraging. If it doubles again next year we will need Lecture Room 2 as well as LR3, which was just about full this time.

Viewers of the exhibition include not only old members visiting for the day, but present undergraduates too — it is their chance to see what can be done in a project before they start their own, and for 2nd-years in particular, before they decide what sort of project to do.

Prizes are offered by the SOUE, and the £100 prize for the best exhibit went to **Ray Lockton** of Balliol, for "Hand Gesture Recognition using Computer Vision". His working display greatly impressed the judges.

The other exhibits ranged from a diesel engine combustion study to two on the response of structures to earthquakes, with electronic and IT projects in between. Nine other prizes were awarded, to:

SongPol Chuenkhum, St. Edmund Hall. Mixing by vortex stirring;

Marcin Marchewka, St. Edmund Hall. Image Inpainting;

Richard Scullion, Balliol. SAGE, an automatic graphic equaliser.

Robert Aboagye, Balliol. Combustion studies in a Gdi engine;

Susannah Fleming, St. Catherine's. Sonar Navigation System;

Robert Livesey, St. Hugh's. Dyke Break simulation;

Tom Marsh, St. Edmund Hall. CFD and experimental study of vehicle aerodynamics;

Tobias Nevin, Lincoln. Earthquake response of masonry arches;

Alex Watson, Keble. Scaled model of a guyed mast.

Thank you to all the exhibitors for an excellent show, and to the hard-working judges, who were:

Jeremy Cooper, Oriel 1990–4, now with H2eye, London;

Andy Sutton, St. Catherine's 1984–7, now with Cobalt, Leeds;

Sarah Turner, Lincoln 1984–7, now with NAG, Oxford;

Peter Young, St. Edmund Hall 1992–6, now with Arup, London.

Finals Prizes Awarded 2002

The Examiners recommended the following awards in respect of Final Honour Schools in 2002:

Honour School of Engineering Science

Maurice Lubbock Prize for best performance in Engineering Science: **Thomas O Marsh (St Edmund Hall)**

Edgell Sheppee Prizes for excellent performance in Engineering Science: **Songpol Chuenkhum (St Edmund Hall)** and **William Whitby (Pembroke)**

Edgell Sheppee Prize for Laboratory or Drawing Office Work: **Richard G Earnshaw (Keble)**

I.Chem.E. Prize for best performance in Chemical Engineering: **Alastair J W Milne (Magdalen)**

I.C.E. Prize for best performance in Civil Engineering: **Susan E Mantle (St Hilda's)**

I.E.E. Prize for best performance in Electrical Engineering: **Jonathan J Evans (Wadham)**

I.Mech.E. Certificate for the best student in Mechanical Engineering and nomination to the Frederic Barnes Waldron Prize: **Kang J Wong (St Anne's)**

I.Mech.E. Prize for the best project in Mechanical Engineering: **Robert Livesey (St Hugh's)**

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Finals Prizes Awarded 2002 cont.

(Continued from page 19)

Unilever Prize for the best project in Control Engineering: Richard P Scullion (Balliol)

BOC/Shuftan Memorial Prize for the best project in Chemical Engineering: Songpol Chuenkhum (St Edmund Hall)

IEE Manufacturing Engineering (Unipart Industries) Prize: Alastair J W Milne (Magdalen)

Honour School of Engineering, Economics and Management

Maurice Lubbock Prize for best performance in EEM: Richard J Lewis (Keble)

Pilkington Prize for best performance in a Management Part II Project by an E(M)EM candidate: Samuel L Chillcott (Lady Margaret Hall)

Delon Dotson Prize for the best performance in the Part II Management Papers by an E(M)EM candidate: Thomas J Tindall (New)

Honour School of Engineering and Computing Science

Maurice Lubbock Prize for best performance in ECS: Philip R Parsonage (St Anne's)

Ronald Victor Janson Prize for the best 3rd/4th year project in Electronic Communications: Raymond J G Lockton (Balliol)

Motz Prize for the best project in Electrical Engineering: Lyndsey C Pickup (Keble)

The Gibbs Prize for the best Part I Project was awarded jointly to 15 students (names omitted due to lack of space).

Personalia

Those who were undergraduates in the 50s, 60s and 70s may remember being taught surveying by **Alwyn Robbins**, who died in January 2002, aged 82. He had read mathematics at Hertford, and returned to Oxford after war service in 1946. When that colourful character Brigadier Bomford retired, Robbins succeeded him as Reader in Surveying. His research interests were in geodesy, the science of defining the size and shape of the Earth, and hence the framework into which all larger-scale surveys can be fitted, and a very necessary basis for the satellite navigation systems which have evolved subsequently. He taught surveying in the Engineering Department for many years, both in lectures and on the practical courses in the Parks or on Cumnor Hill, which must be among the most frequently surveyed parts of the United Kingdom.

Sergio Giudici was an Australian Rhodes Scholar at Oriel from 1960 to 1963. He did a D.Phil in the Engineering Department under Dr Denis Campbell, on the stability of framed structures. He is remembered by at least one staff member of that time for a particularly lucid seminar he gave on his work. He died in April 2002 after a long career as a civil engineer with the Tasmanian hydro-electric authority. The following obituary was drawn to our attention by Philip Jenkinson (Keble 1965), and is reproduced with the permission of Hydro Tasmania.

> The passing of **Dr Sergio Giudici** on Saturday 27 April 2002 has seen Hydro Tasmania lose a good friend and colleague. Dr. Giudici has left behind an enormous legacy — in engineering innovation and friendship.
>
> Esteemed internationally for his engineering expertise, Dr. Giudici was responsible for the design of the spectacular Gordon Dam and was instrumental in developing the modern method for designing and constructing concrete-faced rock-fill dams now common in dam development world-wide.

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Having emigrated from Italy in 1938, he was the first migrant to be chosen as a Tasmanian Rhodes Scholar. Dr. Giudici began his long and distinguished career with Hydro Tasmania in 1963 at the age of 25 as an engineer in the Dams Department after achieving his Doctorate from Oxford University for a thesis on the buckling strength of framed structures.

In 1977 he was promoted to head of the Structures Department where he directed and helped design the Pieman Road bridges, Murchison and Mackintosh Highway bridges and the Bastyan and Reece power stations.

In 1983 Dr. Giudici was appointed Chief Engineer Design Group One where he managed the hydraulic, geomechanical, mechanical and other technical work on the King and Anthony power schemes.

In 1988 he was appointed Manager of the Civil Investigation and Design Group, managing the specialist departments responsible for design, feasibility studies and maintenance of dams, tunnels, structures, gates, hydraulics, roads and future hydro-electric projects.

However, Dr. Giudici saw the work he did as the founding General Manager of the Consulting Division as his "crowning glory". In that role he was much sought after internationally for his expertise and also played a strong mentoring role for young professional engineers in Hydro Tasmania.

After nearly 37 years of service, Dr. Giudici retired from Hydro Tasmania in July 2000.

Our condolences go out to his wife Ros and their family for their very great loss. He will be sadly missed by his friends, colleagues and the engineering community.

Professor John R. Forrest, who came from Cambridge to be a research student in the 60s (D.Phil 1967), and also gave the Lubbock Lecture in 1997, was awarded the C.B.E. in the 2002 Birthday Honours for services to the radio and communication industry. He is currently a member of the Department's External Advisory Board.

Sir William Proby, who read Engineering and Economics at Lincoln 1968–71, has been appointed Chairman of the National Trust.

Peter Lammer, St. John's, who was a research student in the 80s, is a co-founder of the software company Sophos, which won the Company of the Year Award in the 2001 Real Business/CBI Growing Business Award competition.

Liz Moon, née Montague-Jones, St. Hugh's 1960–3, changed from Civil Engineering to Art at some point in her career, and was the Artist in Residence at St. Hugh's for Michaelmas Term 2002.

A Few Disconnected Jottings

Alan Knight

I retired from the Department at the end of September 2002 and, prior to my departure, I began to recall some of the incidents and changes which have occurred during my thirty-five years battling against ignorance in the fields of engineering drawing, workshop practice and mechanical engineering, which my readers will appreciate are at the pinnacle of engineering.

My National Service was completed in the Education Branch of the Royal Air Force. I had applied to join the Technical Branch, but because I would not sign on for a further year beyond the statutory two which I was compelled to serve, I was put into the Education Branch. Two weeks of teaching practice at Uxbridge using the RAF ceremonial drill squad equipped me with the skills required to pass on my knowledge to others.

After National Service I worked for the Ministry of Aviation, based at various contractors' plants. This enabled me to see many firms who were manufacturing items for military aviation,

(Continued on page 22)

A Few Disconnected Jottings cont.

(Continued from page 21)

and gave me an insight into what firms I certainly would **not** wish to work for.

The nomadic life did not suit me so I left and went to work in South Wales for British Nylon Spinners, who during my three years there were taken over by Imperial Chemical Industries. Working in South Wales was very pleasant, with its very willing workforce and good value housing, but I.C.I. had other ideas. Although one might be recruited to work at plant in a pleasant part of the UK, they had a policy of moving one up to one of their large complexes in the North-East "for experience".

This was the time to start buying the Daily Telegraph on Thursdays, where the job of Design Engineer in the Department of Engineering Science was advertised. I commenced work in Oxford in August 1967, and spent many pleasant years there.

The Thom Building (formerly known as the Main Building) and 19, Parks Road (now known as the Jenkin Building) were then our only locations. The separate facets of engineering, civil, structural, electrical, electronic and mechanical all had their own areas. There were no computers (in the modern sense), no electronic instruments with digital readout (with the exception of a couple of decatron counters), and the oscilloscopes were about as large as an elephant and radiated just about as much heat. The students' drawing offices were located on the sixth floor, where slide rules and some mechanical hand-wound calculators supplemented long hand calculations.

Much of the equipment was obtained from Government surplus auctions, and we even had a water tunnel which was obtained as part of the reparations from World War II. The workshop machine tools also came from Government sources, and even to this day one of the milling machines has still got its wartime identification marks, which can be seen from the Banbury Road.

Incidentally, until I came to Oxford, I had never come across a workshop which had clear glass windows; it just shows how our technicians can concentrate on their work without being diverted to observe the wild life in the Banbury Road.

From the beginning I was heavily involved both in the formal engineering drawing exercises, which originally took up two terms with several sessions per week, and also in the very vague first-year design projects. These were very open, and although we did supply a list of possible design tasks, students were encouraged to suggest their own ideas.

Throughout their time in the Department students had their own drawing desk and storage drawer in which they could leave the equipment they needed for project work in the second and third years.

Now the whole of the sixth floor of the Thom Building has been filled with computers, the D.O. is in the E&T Building, and the first year drawing has been cut down to about twenty hours, with a further four hours spent on a computer-aided-drawing exercise.

In addition to my contact with undergraduates I also gave design guidance to research students who, in the early days, usually had a much better grasp of how things were made than the current D.Phil students, who seem to be able to convince themselves that a computer simulation must be just as good as a piece of hardware. The D.Phil students in those days also seemed to be more colourful in their activities; one such student, who was an excellent mechanical engineer, negotiated the purchase of a large number of diseased elm trees from the University Parks. A large trailer was constructed in the car park (which now lies under the E&T Building) and the trees were transported to Wales on this enormous trailer towed behind a very small Bedford van. The same fellow purchased the J.C.B. which had been used for years in the Frenchay Road car scrap yard, and then attempted to drive it down to Wales. He succeeded after rebuilding the hydraulics at the roadside during the three-day journey.

One undergraduate was also memorable as a founder member of the Dangerous Sports Club. His exploits included bungee-jumping from the Clifton Suspension Bridge (after notifying the Daily Mail), and having a dinner-party on Rockall in full evening dress (worn under the wet suit).

It was obvious to me that our students would be able to design items and assemblies much more satisfactorily if they knew a little about workshop practice. To this end I organised the rental of a workshop in Park End Street which was used by the Oxford College of Further Education. Our own technicians acted as instructors, but after a few terms it was made plain to me that the C.F.E. expected their own staff to carry out the instruction. So we were allocated a room in the double basement of the Main Building which was mainly occupied by the 1919 steam drum which serves as a very large air receiver for the compressed-air supply. This gave us complete control of the workshop practice course, but the room seemed also to serve as a magnet for heat escaping from the main boiler-room next door. We now have an excellent Staff/Student Workshop in the Jenkin Building, with all the usual equipment found in manufacturing workshops. The windows are fitted with frosted glass and all first-year students attend a short formal course, and later manufacture a simulated car suspension system which they have designed.

There cannot be many undergraduates who left the Department more than about twenty years ago who do not remember the Paternoster lift. This remarkable device is sorely missed by all who knew it, although it did challenge newcomers to find out what happened if they remained in the car at the top or bottom of its travel. It was serviced by a self-employed lift "engineer" who could set it up with little more than an oil can, a large adjustable spanner and a packet of Woodbines, which provided shims for packing microswitches, motor mounts etc. The University then decided to have one firm of lift engineers attending to all their lifts. Our special lift engineer went, and so did the reliability of the Paternoster. The new glitzy firm put fancy notices on all our lifts and, surprisingly, found some large cracks in the steelwork of the Paternoster. I was convinced that these "cracks" had been in the structure since it was new, but anyway the Paternoster was replaced, and we got a new conventional lift with mirrors on the wall!

Going back in time a little, the Department purchased the Oxford Power Station in 1969, and staff were based there from 1972. A large low-speed wind tunnel for planning and building work was built between the turbine hall and the boiler room. It has been a great commercial success, and has carried out a variety of simple and complex investigations, from confirming the wind speed required to blow over temporary traffic-lights, to stability work on high-speed trains in hilly terrain.

There are also some high-speed wind tunnels which are supplied with compressed air by water-cooled compressors. Before these compressors were commissioned, we had to put a notice in the London Gazette formally announcing our intention to abstract water from the River Thames. This notice duly appeared, and a research student living on Osney Island produced it in a nearby public house. One local hothead then started a petition because he believed that we were going to drain the Thames. The research student had not explained to the locals that gallons per hour were a rather smaller unit than cubic metres per second!

One sometimes gets involved in debates as to whether the training which our students received about a quarter of a century ago was better than that which is delivered today. In the mid-1960s we did not have posts in information technology, opto-electronics, chemical engineering, production engineering etc etc. One of the dons acted as administrator, and he even went to the government surplus auctions mentioned earlier. We did not have any female lecturers and the course lasted for only three years. The boundaries of each type of engineering were much clearer than they are today.

I will not take sides in this debate, but will only mention that the training is very similar, but the range of technologies is much wider.

Volunteers Needed!

Would anyone like to volunteer to give undergraduates informal advice about careers in their own bit of the engineering profession? The suggestion, which came both from our new President, Brian Cook, and independently from the undergraduates, is that there should be a list of say 10–20 of you who would be willing to be rung up for advice about choosing a career in electronics or chemical engineering or whatever. We think you should probably be in the age range 25–35, so as to be not too remote from your own student days, but yet have acquired some experience of your industry.

And we think you might want to use your home telephone number for this purpose, so that your comments won't be inhibited by colleagues overhearing you! You would need anyway to say whether it was a home or work number you were quoting, so that people would know when to try to ring you.

The scheme is obviously highly experimental, and how you handle any particular approach can only be up to you.

If you would like to volunteer, please let David Witt (david.witt@eng.ox.ac.uk) know. He will handle the scheme at the Department's end. Current thinking is that he should publicise the fact that he has a list, but not the list itself. Anyone wanting a contact would then approach him.

> *"Engineers make the best salesmen — except that in moments of crisis they are likely to blurt out the truth"*
>
> John Fozard, Hawker-Siddeley Aviation, quoted by Martyn Hurst in the Jenkin Lecture.

SOUE News

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