SOUE News

Issue 3 **Summer 2004**

Society of Oxford University Engineers

Welcome to the third issue of SOUE News

We have decided that the best time for SOUE News to come out is about now, when the academic year is over, and it can share an envelope with the announcement of Jenkin Day. Issue 1 came out in December, so we have slipped about nine months. Therefore, to catch up, several reports in this issue cover two years.

In our last editorial we asked people to write about things of interest, "not necessarily bang-up-to-date. If you were involved in something rather fascinating back in 1940, why not write about it now, while you still can!" Brigadier Douglas Henchley has gone one better than that, and written about the engineering school in the early *1930s*, when he was an undergraduate. As you will read, he was one of the *nine* men taking schools in 1933. He went on to become one of the founder members of REME, the Royal Electrical and Mechanical Engineers, in 1942 at the height of World War 2.

Colin Snowdon has written an account of the first ten years of chemical engineering at Oxford, and there are obituaries of three former members of the academic staff. And David Witt describes a long series of final-year undergraduate projects on pedal-driven boats.

Although getting articles from people in the Department is comparatively straightforward, the overwhelming majority of our members are outside it and should perhaps be contributing at least half the articles! Please send them to SOUE at the address on the back page, or via e-mail to souenews@soue.org.uk.

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

In This Issue

Head of Department's Report to SOUE 2002 – 2004

Rodney Eatock Taylor

Summary

The two years have generally been good ones for the Department of Engineering Science, with recruitment of some very good new members of staff, many awards on the national and international scene, a continuing high research profile, and excellent progress on the new Information Engineering Building, which is now virtually complete. Sadly, however, four past members of academic staff have died during the period.

Honours

In the New Year's Honours 2004, a knighthood was conferred on Professor Sir Michael Brady, BP Professor of Information Engineering.

A knighthood was also conferred at that time on Sir John Taylor, who was made a Visiting Professor in the department in October 2003. He has recently retired as Director General of Research Councils.

Significant Awards

- Our undergraduates scooped 4 of the 12 national Science, Engineering and Technology Student of the Year Awards 2003, announced at a gala dinner in the Guildhall, London. Given that our students were only eligible for 7 of the 12 categories, this was a remarkable achievement. Their names and projects are as follows:
  - Spirent Award for the Best Electronic Engineering Student: Paul Brimicombe (University): Investigation into a novel liquid crystal device (supervised by Professor Peter Raynes).
  - Lloyd's Register Award for the Best Maritime Technology Student: Tim Moore-Barton (St Peter's): Optimum sail design (supervised by Dr Colin Wood).
  - GKN Award for the Best Mechanical Engineering Student: Jonathan Eddolls (Christ Church): Modelling the working process of twin helical screw compressors (supervised by Dr Peter Ireland).
  - Microsoft Award for the Best Use of Information Technology: Matthew Snowdon (St John's): Noise cancellation — intelligent hearing and design (supervised by Dr Penny Probert Smith).
- Moira Smith (Jesus) and Ian Watson (Jesus) were amongst the 27 winners in 2003 of the Royal Academy of Engineering's prestigious national competition for second year MEng students. In 2004 Jane Kendall (Queens) and Hersh Shah (St John's) were two of the 25 winners. As well as receiving a financial award, they will join the Academy's Engineering Leadership programme, which provides professional development advice and training designed to promote leadership qualities.
- David Hughes (Wadham) who graduated in 2003 was awarded a Salters' Graduate Prize. Candidates are selected on their potential for occupying a leading position in the chemical or related industries.
- Cleo Choong, a third-year DPhil student, was awarded the 2003 BP Younger Engineers Award of £5000 and the Gold Medal for Excellence in Engineering by a Younger Engineer (supported by Exxon Mobil).
- The Prize for the Best Product at the 2002 ISA New Product Showcase was awarded to the Invensys Digital Coriolis Flow Meter. (ISA is the US-based Instrumentation, Systems and Automation Society, and the annual ISA meeting is the largest event and premier forum for introducing new technology in this area.) The significance for us is that the Digital Coriolis meter was developed

by Professor David Clarke and his colleagues here in the Invensys University Technology Centre for Advanced Instrumentation. Invensys has since made an award of £3.5M to secure a five year extension to the centre's research into intelligent instrumentation for industrial applications.

- Professor Andrew Zissermann has been awarded the Marr Prize at the 2003 International Conference on Computer Vision. The prize has been awarded nine times since it was inaugurated in 1987, and Andrew has won it twice previously with his colleagues (1993, 1997).
- Dr Amy Zavatsky was awarded a Philip Leverhulme Prize for her work in biomechanics and orthopaedics.
- Emeritus Professor John Allen won the 2003 Von Engel Prize for the contributions he and his students have made over the years to a range of topics spanning from dusty plasmas to solitons.
- Two post docs in the Department, Dr Martin Booth and Dr Patrick McSharry, were awarded RAEng/EPSRC Post-doctoral Research Fellowships. Eight such awards were made nationally.
- Roderick Kennedy (Christ Church) was awarded the 2003 Culham/IOP Prize for the Best Doctoral Thesis in Plasma Physics. His thesis was entitled: "Potential acquired by a dust particle immersed in a plasma".
- Dr Peter Ireland and his DPhil student Janendra Telisinghe won the IMechE Thomas Stephen Group Prize for their paper "A detailed loss analysis of a dual seal lattice blade butterfly valve".
- Dr Ian Reid and his student Philip Tresadern (Exeter) were awarded the Best Science Paper Prize at the British Machine Vision Conference 2003, for their paper "Synchronizing image sequences of non-rigid objects".

Academic Staff Movements

There has been more than the usual number of retirements and appointments. The four retirements listed below all took place at the end of September 2003

- Dr Colin Wood (Wadham) retired after 42 years in the Department.
- Dr David Kenning (Lincoln) retired, having joined us in 1963.
- Professor Brian Bellhouse (Magdalen) retired after 37 years on the staff (though he came to the Department in 1962 as a research student with Don Schultz).
- Dr Colin Snowdon, who joined us in 1992 from ICI to help establish the Chemical Engineering course, also retired.
- Dr Carl Brown and Dr Julia Stegemann moved on from their Departmental Lecturerships to Senior Lecturerships at Staffordshire University and University College London.
- The following University Lecturers have been appointed:

  Dr David Gillespie (St Catherine's): Turbomachinery

  Dr René Bañares-Alcantara (New): Chemical Engineering

  Dr Yiannis Ventikos (Wadham): Mechanical Engineering/Fluids

  Dr Frank Payne (Lincoln): Electronic Materials Engineering

  Dr Nik Petrinic (Exeter): Impact Engineering (Nik had previously been a Departmental Lecturer here)

- Two industrially funded fixed-term University Lecturerships were taken up:

  Dr M Bacic (Control Engineering, Invensys plc)

  Dr C Coussios (Biomedical Engineering, PowderJect plc)

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Head of Department's Report to SOUE 2002 – 2004 cont.

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- Six new Departmental Lecturers have been appointed: Dr Paul Newman, Dr Jun Zang, Dr Diganta Das, Dr Stephen Payne, Dr Alex Matthews and Dr Mengxing Tang.

Obituaries

We were very sorry to learn of the deaths during the year of four past members of academic staff.

- Professor William Hemp, Stewarts and Lloyds Professor of Structural Engineering
- Professor Ted Paige, Professor of Electrical Engineering
- Professor David Spence, University Lecturer and Reader in the Department (before he moved to a Chair at Imperial College)
- Mr Stuart Wilson, University Lecturer

Other News

- Two companies linked to the Department have been in the news. PowderJect plc, which was founded in 1993 by Professor Brian Bellhouse (initially as Oxford Biosciences), was acquired by Chiron Corporation in July 2003 and incorporated into Chiron Vaccines. The University received a multi-million pound bonus from the realisation of its investment. Mike Brady's spin-out Mirada Solutions Ltd, which develops medical image analysis software, has been acquired by CTI Molecular Imaging Inc.
- On 28 March 2003 the Ground Breaking for the new Information Engineering Building was performed with a JCB by Professor Sue Iversen, Pro Vice-Chancellor. The construction of this exciting new addition to the Department is making excellent progress, and hand-over is scheduled for 23 August 2004.
- A special event was held on 27 June 2003, to mark the first 10 years of the Chemical Engineering course in Oxford. This MEng course is unique in having Chemical Engineering taught within the framework of a wider General Engineering degree. An active research programme has also been developed in Chemical Engineering with two main thrusts, "Bioprocessing and Tissue Engineering" and "Environmental Technology and Sustainability".

Postscript

On completion of my five-year term as Head of Department, I handed over on 1 July 2004 to my successor, Professor Richard Darton FREng. In closing this my last report to SOUE, I should like to express my sincere thanks to the President and members of the SOUE Committee, and particularly to the officers, for all their work on behalf of the Society. I offer SOUE my very best wishes for the future, and I look forward to the continuing pleasure of meeting members of the Society when they return to Oxford.

How Chemical Engineering came to Oxford

Colin Snowdon

Chemical engineering came late to Oxford. John Bridgwater, who lectured in the Department in the 1970s, and who is just this year retiring as Shell Professor of Chemical Engineering at Cambridge, led an earlier attempt to introduce it as a mainstream option but this failed from a combination of circumstances. Although Oxford had taught and researched engineering science for nearly 100 years, and had the largest chemistry school in the country, the lack of a chemical engineering course remained a notable omission, denying a lot of talent the opportunity to enter the profession.

The champions of the second and successful initiative were Mike Brady, the then Head of Department, and Peter Whalley within the Department of Engineering Science, Rob Margetts and Peter Davidson of ICI, and John Collins of Shell UK. The industrial support included seconding Richard Darton from Shell (August 1991) and myself from ICI (January 1992), but equally important was the support and encouragement from the rest of the department. This required some not inconsiderable forgoing of self-interest. Because there would be no overall increase in undergraduate numbers, civil, mechanical, electrical, and information engineering had, in effect, to give up lectureships to chemical engineering.

We first had to define what was required to offer a four-year course accreditable by the Institution of Chemical Engineers. Fortunately, this was much simpler than setting up a stand-alone course as so much of what is conventionally taught within chemical engineering — mathematics, fluid mechanics, basic thermodynamics, computing, control, etc., was already in the course. The third year lectures therefore needed to cover the quintessential aspects of chemical engineering — chemical thermodynamics, mass transfer, reaction kinetics and reactor design, and the fundamentals of process design. And the fourth year teaching, in addition to covering advanced aspects of these subjects, introduced specific topics which built upon the research strengths of the departmental staff, e.g. fluidisation, two-phase flow, heat transfer, and membrane separation.

In practice, our first task was to prepare two coursework modules for delivery in Trinity Term 1992. A lot of effort went into these as they were the 'shop window' for chemical engineering, and in the Oxford system that enables students to vote with their feet, we had to portray chemical engineering as an attractive option. I remember that in the early years, there was a day trip by a rather uncomfortable minibus to Billingham to see the only methanol plant in the UK, but later on ICI used to put us up for a night! Other companies deserving thanks for hosting 3YP visits to their sites over the years are BP, BOC, and Johnson Matthey.

Having the design project in the third year caused both us and IChemE a problem! Us because we had to help students get started on their projects in parallel with, rather than after, receiving lectures; and IChemE because they felt (not unreasonably) that the design project is best done in the fourth year, enabling the students to apply more of their degree course knowledge. In the medium term, the latter problem was overcome by requiring students seeking IChemE accreditation to augment their design project in the fourth year, though only the truly dedicated students volunteered for this extra work! Latterly, however, with students' accreditation being assessed on learning outcomes from the whole course — including the substantial fourth year research project — revisiting the design project is no longer a requirement. From my perspective, I saw the 3YP as an ideal vehicle for teaching the principles of chemical engineering. Over the years, the project has covered topics as diverse as oil and gas extraction from under the Parks, air separation, pure terephthalic acid, municipal hydrogen plants, and bioalcohol.

In parallel with developing the lectures, we needed to set up and equip a teaching

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How Chemical Engineering came to Oxford cont.

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laboratory. A chance visit by a former colleague led to ICI sending us three technicians from Wilton for several weeks to construct three fluid mechanics and distillation experiments, and when Shell heard of this and that ICI had paid for these rigs, they defrayed the cost of three further experiments we had bought in, and sent us one of their experienced technicians to commission and test-run all the experiments! Other industrial sponsors we would like to acknowledge were BP, Albright & Wilson, and Esso.

So, looking back, what has been achieved so far? The first third year course ran in 1992/93 and our first students graduated in 1994. Zhanfeng Cui joined as a lecturer from Edinburgh in 1994 and was appointed as the first Donald Pollock professor of chemical engineering in 2000, and Richard Darton has recently been appointed Head of Department. The medium term future of chemical engineering is in good hands. A great strength of chemical engineering within the department is the overlap with other disciplines; for example, Brian Bellhouse, Gillian Sills, David Kenning, Richard Stone, and Chris Knowles have all been members of the chemical engineering subject panel because their research interests fell within a broad definition of chemical engineering. Although still modest, undergraduate numbers are building up and some 15 to 20 students per year are completing the full complement of courses required for IChemE accreditation, with another 25 or so taking the third year course, thereby acquiring a good appreciation of chemical engineering principles and the systems approach so justly valued by the profession. In recent years, we have had three Salters' scholars. A realistic target is to have 20% of the 120 per year engineering science graduates as accredited chemical engineers.

On the research front, there are currently 20 research students and six post-docs. Research interests mainly focus on biochemical engineering, environmental technology, and sustainability. Professor Cui's interests include tissue engineering, membrane bioreactors, and cryopreservation of engineered tissue and cells. Under Professor Knowles, the Oxford centre for environmental biotechnology (OCEB) hosts a Faraday partnership for innovative soil remediation. Robert Field, who joined the Department in 2001, researches enhanced membrane mass transfer. Thus the emphasis is on the application of chemical engineering principles within other disciplines.

On a personal note, I enjoyed my time in the department immensely — and continue to do so on the half day per week I come in to help with the third year design project. I honestly can't think of a better way to spend the last 10 years of my career. I have been continually impressed with the quality of the students (well, most of them!), and it is always a pleasure to bump into them again, for example Paris Golden in Sydney, and Andrew May on a flight to Chicago. It's a small world!

People often ask me how big a change it was to move from industry to academe. One of the first differences I noted was that whereas in industry it is very easy to start a project, it is very difficult to stop it; in academe it is extraordinarily difficult to reach the consensus necessary to start a project (that lovely expression 'herding cats' springs to mind), but it is frequently very easy to torpedo a project simply by withholding help. Academic freedom is a two-edged sword! Quite rightly, Peter, Richard, and I felt we were on probation for the first year, but the rest of the department gave us the support and encouragement we needed, and I hope we and our successors justified that support.

Sadly, Peter Whalley died in 2000, but he had the satisfaction of seeing a project in which he was instrumental being assured of success. Chemical engineering has landed amongst the dreaming spires.

The Engineering School in the 1930s

Brigadier Douglas Henchley OBE (Keble 1930)

The attached photograph, taken in Trinity Term 1933, was taken on the roof of the then Engineering School which consisted of the existing red brick building[1] in the fork of the Parks Road and the Banbury Road where there are now traffic lights — these of course did not exist in the early 30s.

The top two rows of the photo — nine men in all — took schools in 1933. The row of six men below that were men on postgraduate studies and the front row consists of the two technicians who devised and set up the equipment for our practical work (Mr Mundy and Mr Canning) the Professor's Secretary (Miss Castle) and four of the five lecturers — AM Binnie was away as he held a Rhodes Travelling Fellowship.

The course in those days lasted two years[2], the men taking Schools in 1934 were not included in the photo.

In those days there were also some external tutors — mainly for men at colleges who did not have an engineer on their staff. For example my own college — Keble — only had one Science fellow and he was a chemist but he had to keep an eye on any student who was reading a Science subject. None of the lecturers[3] were fellows of colleges — that status came along later. The head of the School was RV (later Sir Richard) Southwell. All the tutors were Cambridge graduates. Southwell had graduated I think early in the First World War. I was told that he was on the design staff of one of the early airships — R34 I think[4] — which crashed on its maiden voyage. I was told that this blighted his career for a bit but he was elected to the Oxford professorship I think in 1929 and attached to BNC.

Southwell was a first class lecturer and attendance at his lectures was a pleasure. EB Moullin was the Reader and lectured well on electricity. He was an ambitious man and aiming for a professorship. I gather he achieved an Associate Professorship and some time after the end of the Second World War was appointed President of the Institution of Electrical Engineers — perhaps this compensated for his failure to become a professor![5] Victor Belfield (better known as Toby) was a colourful character, originally an officer in the Navy he was struck by polio and had to retire. I think he then qualified at Cambridge and in due course came to Oxford and was attached to BNC. He was referred to as the most attractive bachelor in Oxford. He had a very fast car — Alfa Romeo I think — and a powerful motorbike, a Harley Davidson. He lectured on mechanics. I saw him briefly when I dined at BNC in 1943 when the College had been taken over by the Royal Armoured Corps — and I was invited to give a lecture about my corps — the Royal Electrical & Mechanical Engineers which was founded in October 1942. I saw him again in the 1970s when he came up to Oxford to visit the widow of a BNC don who lived near us on Boars Hill.

The lecturer missing from the photo was AM Binnie, he was attached to Balliol, his subject was hydraulics. When I went up to Cambridge after the war to stay with Southwell, who after being director[6] of Imperial College retired early as he wanted to write his book, I dined with him and Binnie at Trinity (Cambridge) where Binnie was a fellow and tutor. He told me that he had done some research work, in his field, for Bristol Aero.

Turning now to the men of my year, Wilfred Merchant — a Scholar of Corpus and ex Manchester Grammar School — obtained a first

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[1] Now known as the Jenkin Building

[2] Oxford engineers at that time spent their first year on mathematics and/or physics [?]

[3] The Professor and Reader held Fellowships: Southwell at Brasenose, and Moullin at Magdalen from 1933

[4] The R101 perhaps? R34 made a successful voyage across the Atlantic. Southwell came to Oxford before the R101 disaster

[5] Moullin got his professorship — in Electrical Engineering at Cambridge

[6] Formally called Rector

The Engineering School in the 1930s cont.

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and became a professor after the war, in the North-West, possibly Manchester.

Meiler Jones — Merton — lived in Chepstow and I saw quite a bit of him in the late 30s as my wife's father was Vicar of Magor in Monmouthshire and about 10 miles from Chepstow. Sadly he was afflicted with TB and had to give up work until he had been cured. I heard that he had recovered and taught Mathematics at Christ's Hospital. Herbert Ingram got a Second and went to work on the Stock Exchange. I next saw him in 1944 when he was a Captain in the Grenadier Guards in an uninteresting administrative job. I persuaded him to transfer to REME and he was posted as a Major to the 43 Infantry Division where he did excellent work as 2ic to a friend of mine who commanded REME in the 43 Division. I heard nothing of Dennis Matthews who got a 2nd until well after the war when I was told he had gone into structural engineering and rose to considerable heights.

ADB Weigall (Dinny) went straight into the BBC on leaving Oxford and I heard of him in the 60s and 70s when I was told he was Deputy Director of Engineering at the BBC. Arthur Wrigley was my partner in the Engineering Laboratory — we dined together regularly. I understood that he was an only son and had six sisters — all of whom he had to take to commems. I heard after the war that he had been killed in a tank during the fighting in Italy.

Tom Fitton went into the technical side of the Air Force and I next met him in 1959 when I was in the Far East as Director of REME at GHQ. I found that he was my opposite number as Senior Technical Staff Officer Far East Air Force. Finally there was the most colourful character of our group George Venables Llewellyn who managed to get to lectures when he was not riding with the local hunt — the Bullingdon. He joined the Royal Engineers at the start of the war and was killed in the ill-fated attack on Norway in early 1940.

Of the post-graduates the most successful was SG Hooker who was interested in aeronautics and worked under Richard Southwell. He finished up at Bristol Aero and was the designer of the RB211 turbine — for which he got a knighthood[7]. He reappeared in the Engineering Department in the 70s and I met him quite often. He dined with me in Keble and I managed to persuade him to get Rolls Royce to endow a Keble fellowship in Engineering. Sadly he died early but was just able to see his autobiography in print before he did so.

Finally there were three items outside Oxford which were part of the training towards becoming an engineer. In the Hilary vacation of 1932 two of us spent the vacation at the English Steel Corporation in Sheffield. There were enormous shops with great lathes required for turning barrels for Naval guns. These were silent as there was no work for them. The furnaces for making steel and the machines for converting billets into strip were all working, as were the foundry, the blacksmiths and drop forging departments. However the lack of work made us wonder whether our choice of engineering as a profession was in fact sensible.

In the Summer vacation we had three weeks in the Cotswolds on a Survey course. Our instructors were a retired Colonel in the Royal Engineers and two lecturers — Binnie and Belfield. The weather was good and our survey work in the villages around Stow-on-the-Wold — where we lived — was very useful practically. Also in the Long Vacation two of us went across the Atlantic from Southampton to New York. We did four hours on and eight hours off and life in the engine room in a hot August was a fair trial of stamina. My partner and I were on the "Olympic" built in Belfast — with two main engines and a turbine. It was a magnificent ship and we had a most interesting time learning how a ship of that size was laid out.

I have not mentioned the tutors who were not attached to colleges. Keble had no engineering don and so I was tutored by Mr Hume-Rothery.

[7] Hooker went to Rolls-Royce before Bristol, and later returned there. The RB211 is a Rolls-Royce engine

He lived at the top of Headington Hill — I was able to get a bus in the Banbury Road near Keble which took me up to about 100 yards from his house. He was a wonderful tutor — extremely patient and prepared to go over a subject several times until I was able to say I understood. Quite early on he told me that I was to stop him if I did not understand and I was able to stop him as necessary throughout the two years when he taught me — I owe a great deal to him.

One cannot pretend that in the two years one worked at the Engineering School one reached anything like what students are achieving now[8], but it was a good introduction to all aspects of Engineering and it stood me in very good stead when four years after leaving Oxford I took a Commission in the Royal Army Ordnance Corps in the spring of 1937 as an ordnance mechanical engineer — and attended a one-year course at the Military College of Science at Woolwich. There were 18 on the course all of whom were engineering graduates and I passed out sixth at the end of the course.

I look back on my three years at Oxford with much pleasure; living in College I learnt a lot about life from my peers as well as what I learnt in the Department of Engineering Science.

Boars Hill, Oxford

June 2004

(Footnotes 1–7 by Alastair Howatson)

[8] Editor's comment: it would be interesting to see how present undergraduates would cope with the Schools questions used as end-of-chapter examples in Southwell's Theory of Elasticity, 1936.

The final year undergraduates (back two rows), postgraduates and staff in 1933.

H Ingram TEJ Fitton GW Venables-Llewelyn DD Mathews

W Merchant MB Jones ADB Weigall AEL Wrigley DV Henchley

H Dodd H Hallam F Llewelyn-Smith SG Hooker JB Bowen AW Backhurst

S Mundy SE Landale EB Moullin RV Southwell V Belfield E Castle B Canning

Obituaries

Professor EGS Paige FRS

Peter Raynes

Ted Paige joined the Department of Engineering Science in 1977 as Professor of Electrical Engineering. Since 1955 he had been at the Radar Research Establishment at Malvern where he had a distinguished research career and was one of the first to realise the potential of Surface Acoustic Waves (SAW) for constructing devices as important components in radar and telecommunications.

Ted was born and brought up in East Sussex in the years prior to and during the second world war. He attended Rye Grammar School, which for his first three years was based in Bedford where Ted was billeted with a variety of families. As a boy he spent a lot of time roaming Romney Marshes investigating wildlife and taking samples home to examine under a microscope. This interest in the natural world, and of birds in particular, remained throughout his life, developing into a passion for photography in his later years. In 1949 he was awarded a County Scholarship and obtained a place at Reading University to read Physics. When he was awarded a first he decided he wanted to stop on at Reading and study the application of quantum mechanics to solid state physics; this was how he became Bill Mitchell's (later Sir William Mitchell, FRS) first research student. Ted's PhD research was on the optical effects of radiation damage in quartz and the major part of the work was a study of the change in infra red absorption produced by X-rays and neutrons.

Finding research to his liking, Ted applied to the Civil Service Commission for, and was awarded, a Junior Research Fellowship. He had a choice of where he held it, and after a tour of several laboratories, he opted for the then Radar Research Establishment (RRE) at Malvern. He moved to Malvern in 1955 and joined the recently formed Transistor Physics Division under Dr A F Gibson (later Prof Alan Gibson FRS). For the next 13 years he was an integral part of the great push forward on semiconductors with the invention of devices and the understanding of the relevant physics; his own contribution was on the electrical, optical and acoustical properties of Ge, Si and II – VI semiconductors.

Towards the end of this period Ted, together with Dennis Maines, realised that Rayleigh waves propagated on the surface of a semiconductor might have considerable device potential. In 1968 they successfully applied for MoD funding which resulted in Ted being appointed leader of a 15-strong team which he built into a world-leading group to research and develop SAW devices and applications. It says much of Ted's leadership abilities that under his guidance the Malvern SAW Group became so successful and acquired such a high international reputation. I first came across Ted when I moved to Malvern in 1971, and it was always very clear to me that he was not simply a manager, he was intimately involved with and contributed to most of the scientific activities within his group. There were many inventions, patents and publications, and in 1973 MoD presented their Wolfe Award to the SAW team for their pioneering work. Ted oversaw the design and development of SAW pulse compression filters which were used to improve the performance of radar systems fitted into the Nimrod fleet of aircraft used by the RAF for reconnaissance. His work on these filters resulted in a Queen's Award for Technological Achievement to the Royal Signals and Radar Establishment (as RRE had become) in 1989. There were many other device successes, but rather than give a comprehensive list I will list the ones that Ted himself highlighted. Working with Dennis Maines and later with Meirion Lewis, he invented and developed a SAW oscillator. With Graham Marshall he invented the SAW multistrip coupler and developed a subsequent wide range of components based on the structure. It became one of the most important SAW components and for many years, all colour TVs had an IF filter containing a SAW multistrip coupler. His other inventions included an electronically controlled variable chirp filter, a novel directional coupler based on comb transmission lines and a travelling wave

transducer.

Throughout his time at Malvern, Ted did his fair share of 'scientific administrative duties'. He helped with policy and monitoring of MoD extramural research, he led the SAW Liaison Group and had overall responsibility for the MoD extra-mural research programme on SAW. He organised international conferences and sat on Research Council committees.

In 1977 Ted became Professor of Engineering Science, a title he was instrumental in changing to Professor of Electrical Engineering, and a Fellow of St John's College, making as he himself said, 'the simultaneous changes from physicist to engineer, from research to teaching and from a government establishment to a collegiate university'. He rose to the challenge and using his long experience in pure and applied physics and industry he started to revitalise the Electrical Engineering teaching and research laboratories. Under his influence the University appointed its first visiting Professor (Professor Sir Gareth Roberts FRS, then of Thorn-EMI and now President of Wolfson College) and two new Chairs in Information and Optoelectronic Engineering were established. He also played a leading role in the bids for the new joint Honours Schools on Engineering and Computing Science and in Electrical and Structural Materials Engineering. In 1984 he was acting Head of Department for four months.

Ted enjoyed his new role as a teacher of undergraduate and postgraduate students and relished the opportunity to pass onto them his love of engineering. For several years he continued his research interests in SAW devices, and during this period he devised a new type of spectrum analyser for microwave frequencies as well as a new type of convolver. By the 1980s he realised that the research community was increasingly focused on meeting exacting specifications with known devices and he decided to look into other research areas. He took the opportunity of a sabbatical year at Stanford to update his knowledge of optics and to consider some possible research topics in optoelectronics. Upon his return to Oxford he focussed on programmable spatial light modulators and opened up a rich vein of research using ferroelectric liquid crystal devices as phase-only spatial light modulators, developing techniques for sub-micron lithography, optical pattern recognition and 3D imaging. This latter work particularly pleased Ted as it arose from a chance lunchtime conversation in St Johns with a colleague from Experimental Psychology, nicely illustrating to him one of the advantages of a collegiate university.

His last area of scientific work, started after his retirement in 1997, was unknown to most of his engineering colleagues until recently. Just before retirement Ted had been diagnosed with haemochromatosis, a genetic disorder causing the body to absorb an excessive amount of iron from the diet. He joined the Haemochromatosis Society, became a director and spent much of his retirement helping the Society by applying his scientific skills to help analyse data and write reports on the geographical distribution and the extent of under-diagnosis in the UK.

Ted's achievements in science were recognised by many personal awards. In 1978 he was awarded the Rayleigh Medal of the Institute of Acoustics and the Duddel Medal of the Institute of Physics. In 1979 he was awarded (with others) what is regarded by many as Europe's most eminent physics prize, the Hewlett Packard Prize for Outstanding Achievement in Condensed Matter Physics awarded by the European Physical Society for: 'The Physical Principles of Surface Acoustic Wave Devices'. He was a Fellow of the Institute of Physics and of the Institution of Electrical Engineers. In 1983 he was elected a Fellow of the Royal Society.

Ted was by nature a quiet, even private, man. However, this mild exterior hid an inner firmness, and when he was roused by some perceived injustice, he would see off the opposition with an impeccable logic few could match and an honesty and politeness that gained great respect. It was noticeable that at his funeral and memorial service, a large number of colleagues from his distant Malvern days were present and many had travelled

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Obituaries cont.

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large distances, some for a second time having already visited him in his final days. Ted was very modest about his achievements. Many at his funeral and memorial service from outside science were heard to comment that they had not known of his illustrious scientific career. He was happily married to Helen, whom he had known from schooldays, and together they had a family of two sons and two daughters. Ted Paige died on 20 February 2004, aged 73.

Professor David Allan Spence

A memoir by David Kenning

David Spence died on 7 September 2003 after a long and courageous fight against Parkinson's disease, throughout which he had the equally courageous and selfless support of his wife Isobel.

David was an early member of the group of Antipodean academics who have contributed greatly to the development of the Department of Engineering Science. Born in Auckland, New Zealand, he read Mathematics at the University of Auckland. In 1948, he moved to Cambridge to undertake graduate studies leading to an Engineering doctorate on aerofoil boundary layers in 1952. This set the pattern for his working life as an outstanding applied mathematician, interested in problems generated by the physics of fluids and solids. He joined the Aerodynamics Department of the Royal Aircraft Establishment, Farnborough, where he expanded on his studies of aerofoil flows and by 1963 achieved the distinction of promotion to Senior Principal Scientific Officer (Individual Merit). In 1964 he was head-hunted by Professor Douglas Holder to join the rapidly-growing Department of Engineering Science at Oxford as a University Lecturer and the first Tutorial Fellow in Engineering at Lincoln College. It was then that I first met David and I owe him a debt of gratitude for piloting me from a Demonstratorship without a college home towards the second Fellowship at Lincoln, where we worked happily together for 15 years.

David was a kindly man, who delighted in his family, enjoying the company of small children (and later grandchildren) and large dogs. This made him well-suited to dealing with students. In the early years, we refined our double act for entrance interviews. David struggled between his natural tendency to give a candidate the benefit of the doubt and his mathematician's recognition of evidence that the candidate was not quite up to it. In those days, the admissions process was enlivened, for tutors, not only by the candidates' attempts at writing essays for the General Paper but also by the contest between tutors sparked by the College Scholarship scheme, which spread the talent around between colleges in a way that is now done by computer. Colleges' armaments in this war were limited by treaty and their use governed by precise but complicated rules, covering Open and Closed awards applicable to Chemistry, Mathematics and Physics, as well as Engineering. David and I would first meet to plan our strategy, before groups of science tutors from eight colleges gathered in what was then the 6th floor drawing office in Thom Building. David's analytical skills and respect for the minutiae of rule-books, derived from his Civil Service experience, equipped him well for the multi-handed poker game that followed. The consequence of this process, as with subsequent schemes, was that tutors had a personal investment in every successful candidate that lasted through and beyond their undergraduate careers so they became an extended family, with the usual occasional differences of opinion. David was a keen participant in orienteering and he recalled with amusement one Saturday meeting at which he was overtaken with a cheery greeting by a pupil who was supposed to be preparing for a penal collection on the Monday. David took delight in the successes of former pupils and sympathised with them in adversity. A few months before his death, by an effort of will, he attended a gathering of many of our former pupils, organised by his Lincoln successor, David Hills, and enjoyed meeting pupils he remembered clearly after nearly 40 years.

In the Engineering Department, David pressed strongly the view that Mathematics was the unifying thread for a broad Engineering Science course, and his influence can still be seen in the course. His own research interests expanded from fluid mechanics to solid mechanics and, in a fruitful interaction with an old friend Donald Turcotte at Cornell University, geophysics problems of plate tectonics, earthquakes and oilfields. The common theme was the solution of boundary-value problems by a variety of analytical techniques. David enjoyed making his expertise available to those with lesser mathematical ability but who could pose interesting problems. I had the pleasure of co-authoring just one paper with him, on heat transfer at the triple contact line between a hot plate, a liquid and its vapour. His elegant treatment of a singularity that was not obvious to me from physical arguments has left me with a healthy distrust of numerical simulations with coarse grids. David was an enthusiastic participant in the brain-storming meetings with industrialists organised in the Mathematical Institute and developed by Alan Tayler into OCIAM, the Oxford Centre for Industrial and Applied Mathematics. David's distinction as a mathematician was recognised by the award of an Oxford DSc in 1967 and election to a personal Readership in Theoretical Mechanics in 1977. His research students went on to distinguished mathematical careers in their own rights. As his research activities became more centred on the Mathematical Institute, so did his teaching and his fellowship at Lincoln was redesignated as a Tutorial Fellowship in Applied Mathematics. In 1981, Imperial College made him an offer he could not refuse and he accepted a chair in Mathematics that he held until his retirement at age 65 in 1991, while he and Isobel continued to live in the family house in Headington. Even before his retirement, the first signs appeared of the cruel roller-coaster of physical constraints associated with Parkinson's. Lincoln elected him to a Senior Research Fellowship and OCIAM provided him with a base, so that he could remain active in research after his official retirement, without making frequent trips to London. He enjoyed the social occasions in college, although they became more restricted to 'good' days as the disease progressed. He fought it with great determination. It was perhaps the periodic physical restriction on communication that most hurt this quiet, gifted man who so enjoyed interacting with others.

Stuart Wilson

David Witt

Stuart Wilson retired 20 years ago, but he will be well remembered by the older generations of alumni, particularly those from the decades following the Second World War. Stuart was one of that stalwart band that carried the Engineering Department through the years when it was much smaller than it has since become, and much less valued in the University than it is now.

Stuart Swinford Wilson was born on 11 August 1923, the son of an electrical engineer, and educated at William Hulme's Grammar School in Manchester. He won a scholarship to Brasenose, and read Engineering Science there from 1941 to 1944, leaving with a First. He then spent about sixteen months working at the Admiralty Experimental Works, Haslar, Gosport, mainly on means for sweeping up a new type of naval mine then being laid by the Germans.

But in 1946 he returned to Oxford to teach in the Department, and except for vacation periods in industry and a sabbatical in Australia, remained here until his retirement in 1984. His interests were wide, within the broad field of mechanical engineering, and with a strong practical bias. He was a sailing enthusiast, and designed for the University Yacht Club one of the first fibre-glass sailing dinghies, the 12 ft Alpha, when the wooden Fireflies which the Club had been using were showing structural distress under punishing use by undergraduates at Port Meadow. The Alpha, which was built locally by Bossoms, had some of the faults which might be expected in a pioneering design, but it was a trend-setter, and fibre-glass is now the norm in this application.

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Obituaries cont.

(Continued from page 13)

In the 1950s the University debated whether its tiny Department of Engineering Science should be abolished or enlarged. It plumped for enlargement, and the result was the Thom Building, completed in 1962/3. Stuart was responsible for the planning of the Heat Engines and Fluid Mechanics laboratories. He also took a lead in the "revolt" by the academic staff when the architect proposed to put some rather pathetic (as was thought) murals on the exterior walls of Lecture Rooms 1 and 2. The University authorities at first backed the architect, but the revolt was ultimately successful, and the murals gave way to the charcoal-coloured bricks that are there today. A few years later Stuart was influential in the founding of the joint school of Engineering and Economics. This was a forerunner of the triple school of Engineering, Economics and Management which we have today.

His undergraduate lectures were usually on thermodynamic cycles or heat engines, and had a practical flavour. This field inspired many of his research activities, e.g. small "Rankine-cycle power packs" using high-molecular-weight fluids such as monochlor-benzene, water-injected diesels, combined-cycle power plants and combined-heat-and-power (these last two well before their present vogue). Younger academics in this field have expressed appreciation of his practical engineering advice. He was also very active over many years in the field of "appropriate technology", believing that there were many ways in which good engineering design could significantly improve the quality of life at quite modest cost. He was a particular advocate of the proper use of pedal power in under-developed countries. His improved version of the pedalled rickshaw was frequently seen on the streets of Oxford in the 70s and early 80s. It was unfortunate that it never got into significant production.

He tutored undergraduates from Brasenose (and many other colleges) in the days when a tutor was generally expected to be able to teach two-thirds or more, sometimes all, of the syllabus. Brasenose never elected him to a tutorial fellowship, but he became one of the Founding Fellows of St. Cross, when that and another college (now Wolfson) were founded in the early 60s to tackle the problem of the numerous tenured academics who were not fellows of any college.

He and Elsie, whom he married in 1953, and with whom he spent a very happy 50 years, spent their retirement mainly in Somerset and Dorset, but he was a regular visitor back to Oxford, and a strong supporter of the SOUE. In his last years he had written the typescript of a book, "Small Expectations — a wide-ranging survey of the value of human scale". It reflects a dissatisfaction, which many of us might share, with numerous aspects of modern life arising from urbanisation and centralisation, and from, as he puts it "the separation of the thinking from the doing". It perhaps loses some force by taking on too many targets at once.

Stuart died on 6 October 2003, aged 80. He leaves his widow, Elsie, and a son and two daughters.

Stuart Wilson pedalling the Oxtrike in 1977

Personalia

Nigel Perry (St Peter's 1976–9, and a former SOUE Committee member) is setting up a new "Centre for Process Innovation" on Teesside. The chemical industry is well represented in the North-East (ICI, Procter & Gamble, GlaxoSmithKline etc.), and the purpose of the Centre is to do contract research and development work on advanced processing and use of materials, and at the same time to enhance the image of the North-East as a key area in the process industry. Nigel spent 22 years with ICI after leaving Oxford, and more recently worked with IBM and PWC Consulting.

Robin Salvesen (Univ, 1956–9) has written his memoirs, entitled "Ship's Husband" (The Memoir Club, Spennymoor co Durham, 2003). His working career was spent with the family ship-owning firm Christian Salvesen of Leith, Edinburgh. The book describes this, from his early days at sea through to shore-based management, but also deals with his many activities in public life, for instance in relation to lighthouses and education.

Clark Brundin, who came from California as a research student and later returned to be one of the engineering tutors at Jesus, and was subsequently Vice-Chancellor of the University of Warwick and then Master of Templeton College, Oxford, has found himself a new retirement occupation by standing for Oxford City Council in the Liberal-Democrat interest, and getting elected for the North Oxford Ward.

James Teacher (Christ Church 1957–61) died suddenly on 23 April 2003, at the age of 65. Though an SOUE member, he had never worked as an engineer. But in 1976 he inherited lands in Perthshire and Kent, and became well-known for his work on nature conservation, both practically on his own land, and as a Council Member of various conservation bodies, including the RSPB and Nature Conservancy. He leaves a wife and four children. (See Times obituary 5 May 2003.)

The 16th Jenkin Lecture: Oil Production: from Nitroglycerine to Fibre-optics

Paul Martins (Pembroke 1972–5) — report by David Witt

After reading Engineering Science at Pembroke, 1972–5, Paul worked as a Civil Engineer for three years, and then did a PhD in soil mechanics at Imperial College. With this behind him he went to work for BP, at first doing research on the fracturing of underground rock formations to increase the flow of oil from them, and then putting the research into practice in North Sea oil and gas fields. The techniques that were developed proved very effective, and apart from boosting production, won for Paul and his colleague Tim Harper the 1992 MacRobert award, the Royal Academy of Engineering's premier award for engineering innovation.

Paul described the new fracturing technique in his lecture. It is to pump into the well, at extremely high pressures (e.g. 1000 bar, 100 MPa, at the surface), a slurry composed of a viscous polymer gel and ceramic granules. The fluid pressure opens up cracks in the rock, and the granules lodge in these cracks and stop them closing when the pressure is removed. The cracks can be 50–100 m high and, though very narrow, can extend hundreds of metres radially from the well. They can thus increase by up to 10,000 times the area of rock surface from which oil can flow into the well.

Success did not come at once. At first the industry was sceptical, and drillers reluctant to cooperate. Much larger volumes of gel were

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The 16th Jenkin Lecture: Oil Production: from Nitroglycerine to Fibre-optics cont.

(Continued from page 15)

needed than had been expected, and they realised that for maximum benefit the wells had to pass perpendicularly through the oil-bearing strata, which meant they had to be drilled S-shaped if they were to tap strata at some horizontal distance from the drilling platform [how to do this is yet another remarkable development, but not part of Paul's lecture]. Experiments on a well could cost millions, and there was a risk of destroying the well altogether. Eventually they were able to increase the flow from a well by up to a factor of seven compared with an unfractured one. This meant they could exploit a field with many fewer wells, thus saving enormous sums of money.

Paul then went on to talk about current developments in well technology. Wells are now drilled in water 1000 m or more deep, and can go down more than 2000 m into the seabed underneath. Since the hire of a drill-ship can cost $250,000 a day, it is clearly important to make the most of each well. Various "down-hole" sensors have and are being developed to tell the engineers what is going on there. Since the temperature at these depths can reach 150°C, the development of sensors that can operate with complete reliability is something of a challenge. Fibre-optic technology is coming in useful here, for instance to measure temperature and three-phase flows, and pick up the seismic signals used to determine the geological surroundings.

[We were very distressed to hear in August 2004 that Paul Martins had died in a swimming accident while on holiday with his family in Devon. Our deep sympathies are with his wife Charlotte and their children. His death is also of course a great loss to his colleagues in the oil industry.]

Lubbock Days, 2003 and 2004

29th Lubbock Lecture, 23 May 2003

This was given by Dr Paul Drayson, Chief Executive of PowderJect Pharmaceuticals Ltd, and entitled *"Building a world-class company from Oxford Engineering Science: the PowderJect Story"*.

The PowderJect company had been formed to exploit Brian Bellhouse's invention of a new method of getting medical drugs into the bloodstream, by forcing particles into the skin with a blast of air released by a rupturing diaphragm. It was envisaged that this would be more effective than swallowing pills, and less distressing to the patient than needle injection. The company had now broadened into pharmaceuticals more generally, and Dr Drayson gave us the story of how this had happened.

The main lecture was preceded by Lionel Tarassenko outlining the Department's plans for an Institute of Biomedical Engineering, and two related research-in-progress talks:

Stephen Duncan on *"Controlling ultrasound treatment for cancer"*

Lionel Tarassenko on *"Home monitoring of chronic conditions using GPRS mobile phone technology".*

30th Lubbock Lecture, 21 May 2004

This was given by Sir David Brown, Chairman of Motorola UK and President of the IEE, and entitled *"Engineering in the Information Age"*.

Sir David, who had worked in the tele-communications and electronics industry since graduating in 1972, had joined Motorola in 1991, initially to direct UK operations on the "infrastructure" for the mobile phone network,

and since 1992 as Chairman of the UK Company.

He contended that we were now in the "Information Age", which had succeeded the Industrial Age of the last two centuries, and he discussed what this meant for the nature of engineering, and the challenges and opportunities facing today's engineers, and society in general.

The lecture was preceded by two research-in-progress talks on information engineering topics:

Paul Newman on *"Autonomous navigation in unknown environments"*

Stephen Roberts on *"Information, complexity and learning"*.

Lubbock Day Project Exhibition 2003

There were 10 entries, and SOUE prizes of £100 each went to:

Hardware section: Alan Coombs, LMH, for "Multi-axis gyro-stabilised camera platform" (a most elegant marriage of mechanical engineering and electronics)

Poster section: Michael Chappell, Univ, for "The intelligent land-mine detector".

Runner-up was Tim Moore-Barton, St. Peter's, for "Optimum sail design", and other prizes went to:

Edward Allen, Magdalen, "Sound production in flue organ pipes"

Andrew Cotter, Wadham, "An articulated finger"

Marcus D'Arcy, Trinity, "Self-regulating compact heater"

Philip Valvona, St. Peter's, "Control of 3 stepper motors for automotive applications"

Eugenie Von Tunzelmann, Magdalen, "Augmentation of video sequences".

Our thanks to the judges, who were:

Alex Macro, Mansfield, 1991–5;

Angus Palmer, BNC, 1984–7;

Simon Turner, Lincoln, 1984–7.

Lubbock Day Project Exhibition 2004

There were nine entries, and SOUE prizes of £120 each went to:

Hardware section: Charles Bibby, LMH, for "Visual tracking at sea", with a gimballed camera, and a computer simulation of the visual tracking of small vessels in a rough sea.

Poster section: Richard Scott-Smith, Keble, for "Giant Robotic Spider", fortunately a design study rather than the real thing!

Other prizes went to:

Nick McSloy, Magdalen, "The effect of shock waves and particle penetration in the skin on cell viability following gene gun delivery"

David Latham, Trinity, "Coaching aid for ergometer rowing"

Russell Whitehead, St Anne's, "Friction effects in cable networks".

Again, our thanks to the judges, who were:

Neil Childs, Pembroke, 1991–5;

Tamsin Lishman, St Hilda's, 1995–9;

Andrew Pyle, Balliol, 1995–9;

Hugo Spowers, Oriel, 1978–81.

Note that LMH have taken a top prize for two years running. In the four years we have been running this competition so far, Balliol have picked up four prizes, Magdalen and St Edmund Hall three each, and 13 other colleges one or two each. Nine colleges have yet to produce even an entry, but perhaps it would be tactless to name them here!

Projects on Pedal-powered Boats

David Witt

Between the years 1985 and 1999 I supervised 35 people on final-year projects relating to pedal-driven river-boats. Now, five years into retirement, it seems a good idea to report what we got up to.

Oxford has long been the home of human-powered boats driven by oars, sculls or poles, so it should be a suitable place to explore alternative ways of turning muscle power into forward motion on the water. It seemed that there might be enough engineering involved to justify undergraduate project work, and that the topic might arouse some enthusiasm. There was, and it did. The activity was inevitably a shared one, the division being roughly that I did the dynamic analysis and the wood-carving, while the undergraduates did the mechanical engineering.

The ideas behind most of the work, up to 1991 at least, were:

1. Pedalling is an effective and agreeable way of generating power from human muscles;
2. A propeller ought to be more efficient than oars, especially if there is room for a big slow-speed one;
3. To have low drag, a displacement hull needs to be long and narrow;
4. A bicycle frame placed, with its rider, on top of a narrow hull, is going to be statically unstable;
5. But then so is a bicycle. It doesn't stop us riding one.

Dynamic analysis, and other people's experiments, show that what makes a bicycle ridable is having the steered wheel at the front, whereas most boats have the rudder at the back. So why not put the rudder at the front, and see if the rider could keep a statically unstable boat upright by steering to the right when falling to the right, and vice versa, as one learns to do on a bicycle?

For our first attempt we managed to acquire a "manufacturer's reject" windsurfer board, and mounted a bicycle frame on top, and rudder and propeller below, with a chain and home-made bevel gearbox to take the drive from the crank axle to the propeller shaft. The undergraduates were warned that they would probably need fins aft as well as a front rudder to make the vessel properly ridable, but they were perfectly happy to learn this the hard way, and did, spectacularly! With fins added, "Propedalica" (meaning "with her rudder in front") was easy to ride, though Jonathan May, one of her builders, became adept at demonstrating capsizes for the benefit of photographers. But with 0.68 m beam, she was *almost* statically stable, and not particularly fast. Her rapidly increasing weight, as her stuffing soaked up water, showed why the hull had been a reject in the first place.

The principle having been established, we went for something more daring. Indeed our next design was christened "Daring", and was 4 m long on the waterline, with only 0.4 m beam. The hull was thin fibreglass on top of polystyrene foam, very light, and of similar lines to a destroyer or frigate. The idea behind *this* was that if one does a dimensionless plot of "power-for-size" against "speed-for-size", a one-man boat comes in the middle of these naval craft, so *perhaps* their shape would be the optimum shape for us. Figure 1 shows her as a one-woman boat, with Joanna Coleman trying her out on the Thames, here at quite a low speed. The object on a pole behind her can be lowered either side to act as an outrigger float, if one wants to stop in midstream, or go backwards. The rudder shaft can be seen about 0.8 m back from the bow, operated by a linkage from the handlebars. Important but invisible are twin fixed fins on either side of the propeller shaft, just behind the rider (having two fins and a rudder means the boat can be stood, tripod-like, on the river-bank — most convenient). The propeller is 0.36 m diameter, right at the stern.

Figure 1: "Daring" in 1988

"Daring" has been through many modifications since this photograph was taken in 1988. Ultimately she could do about 3.5–4.0 m/s (8–9 miles per hour), depending on who was pedalling, in a 100 m sprint. 2.2 m/s (5 mph) is a comfortable cruising speed.

It turned out that while the destroyer hull shape, sharply Vee'd at the bow, flattening towards the stern and rising to a transom, gives good speed for a given length without needing to plane, it is NOT good at tight turns with a front rudder. With a stern rudder it is fine. The bow moves in the direction it points, while the stern sideslips outwards. The gradual increase in crossflow velocity, from bow to stern, produces the centripetal force necessary to make the boat follow a circular path, and there is little force on the rudder. But with the rudder at the front, the forces are distributed very differently. The rudder has to drag this deep narrow bow sideways through the water, which needs a lot of force, and since there is little outwards sideslip, the total force it has to supply is substantially in excess of the centripetal force. If it is overloaded it stalls, so the rider loses control and the boat capsizes. A 24 m diameter turning circle was about the best we could get with "Daring", which makes the Thames, even down by the boathouses, seem a bit narrow. Our general conclusion, for any vessel, is that a front rudder gives far better control of the path taken than does one near the stern, but it won't do such tight turns.

Some interesting model experiments, and theory as above, suggested we needed a much shallower bow, and a new hull, "Skippy" (Figure 2) was built in 1989. "Skippy" managed to halve "Daring's" turning circle, to about 12 m, so we were right. She is easier to ride, though not so fast flat out, and an excellent cruising boat. Her longest one-day trip has been the 32 miles down the Thames from Oxford to Pangbourne.

Figure 2: "Skippy" in 1991

Parts other than the hull were also being improved, many of them being made interchangeable between the "Daring" and "Skippy" hulls. We built a special-purpose frame out of aluminium tubing, a better outrigger float and an NC-machined propeller to replace the earlier ones, which had been cruder in both design and construction (Figure 2). With an electronic dynamometer on the propeller shaft to measure torque and thrust, we deduced that the "propulsive efficiency" was about 72%.

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Projects on Pedal-powered Boats cont.

(Continued from page 19)

Our last effort, ultimately unsuccessful, was a pedal-powered hydrofoil. Such things had been built already elsewhere, and in 1984 one in the U.S. covered 2 km in 6m 39s, faster than the world record for a single scull. A later one originating in M.I.T., a fantastic vessel with two-stage hydrofoils and an air propeller, did 10.08 m/s (about 22.5 mph or 19.6 knots) over 100 m. Figure 3 shows ours taking off in 1998. She looks as if she is bound for the stratosphere, but in fact was flat on the water again a second later. We never did manage to get her longitudinal stability right, and she was a bit too heavy. An earlier version incorporated one of the most embarrassing engineering "howlers" I have ever had responsibility for. At that stage the "wing" had ailerons, which covered the outer three-quarters of the span, and were pivoted at their ends. What we all forgot was that when the 2 m wing flexed under the load, the ailerons would remain straight, so a great part of them was raised 10 mm or so above the trailing edge. No wonder we couldn't then get enough lift for take off!

Figure 3: The hydrofoil in 1998

In 1997 we took "Skippy" and "Daring" to Cologne for the "Human Powered Vehicles" Championship, which included two days of boat events. There was an enormous variety of vessels there. The most spectacular was the two-man hydrofoil "Af Chapman II" from Chalmers University, Sweden. The University of Duisburg in Germany showed that one can make something simple and very fast by joining two "scull"-type hulls into a catamaran, and putting two pedallers on the centre-line, one facing left and the other right, with simple chain drives to propeller-shafts in each hull. Their latest vessel, "Close to Perfection", seemed indeed to be so, as a racing boat at least. The majority of entrants were two- or even three-person boats, which naturally gave them a speed advantage over ours, but we showed up quite well among the single-handers. We noted that the designers of the faster boats had all decided, as we had too, that the right propeller for this work looks much more like a two-bladed aeroplane propeller than the sort of thing one usually sees on boats.

Vessels similar to our displacement boats have been produced, and even marketed, in Canada and the USA, but I believe we were first!

Figure 4: "Skippy" in 2004 with her new outrigger floats (photo by Tyson Rigg)

"Daring", "Skippy" and the unnamed hydrofoil still exist, though with the Department's demands for space, they have been exiled to my garage. But I regard myself as custodian rather than owner, so if anyone would like to see them in action or try them out, they should get in touch. In the last 12 months I have arranged that either "Daring" or "Skippy" can be fitted with a pair of inflatable outrigger floats (Figure 4). These are normally clear of the water so do not affect the speed, but prevent capsize, at least for a rider of up to about 80

kg, who can stop in midstream and lean on one. They undoubtedly enhance the confidence of a senior-citizen rider, and possibly of a beginner too. And the gear-ratio has been lowered, to a value more suitable for cruising than for sprinting.

Cruising a river in these boats has its charms. It does not take much effort to maintain 5 mph, the speed-limit for powered boats on the Thames, so one can cover a good distance; one is facing forward (unlike a rower), and high up (unlike a canoeist), so the view is good; and there is little noise to disturb the wild-life.

I owe thanks to the Department's Project Committee for letting me run these projects, and to the Workshop for the enthusiasm with which they helped the undergraduates build the boats.

[A fuller account of the displacement boats appeared in "Human Power", Vol 13.1, 1997]

Finals Prizes Awarded 2003 and 2004

The Examiners recommended the following awards in respect of Final Honour Schools in 2003 and 2004:

Engineering Science

Maurice Lubbock Prize for best performance:

2003: **Felicity CJ Allen, Jesus**

2004: **Alexander R Quayle, Lincoln**

Edgell Sheppee Prize for excellent performance:

2003: **Paul A Trodden, St Hugh's**

Edgell Sheppee Prize for Laboratory or Drawing Office Work:

2003: **Timothy C Moore-Barton, St Peter's**

2004: **Michael P Coulson, Keble**

ICE Prize for best performance in Civil Engineering:

2003: **Felicity CJ Allen, Jesus**

2004: **Russell J Whitehead, St Anne's**

IMechE Certificate for the best student in Mechanical Engineering and nomination to the Frederic Barnes Waldron Prize:

2003: **Christopher M Churchman, Worcester**

2004: **Geoffrey J Holmes, St Peter's**

IEE Prize for best performance in Electrical Engineering:

2003: **Alan D Coombs, Lady Margaret Hall**

2004: **Matthew R Forrow, St John's**

IChemE Prize for best performance in Chemical Engineering:

2003: **David J Hughes, Wadham**

2004: **Sarah E Lewis, Hertford**

IEE Manufacturing Engineering (Unipart Industries) Prize:

2003: **Michael P Matthews, St John's**

2004: **Elizabeth A Smith, St John's**

Babtie Prize for best project in Civil Engineering:

2003: **Daniel AG Walker, St Catherine's**

2004: **Edmund CJ Hazell, Jesus**

IMechE Prize for best project in Mechanical Engineering:

2003: **Jonathan FC Eddolls, Christ Church**

2004: **Mark J Goodchild, Keble**

Motz Prize for the best project in Electrical Engineering:

2003: **Paul D Brimicombe, University**

2004: **Mark L Potter, Exeter**

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Finals Prizes Awarded 2003 and 2004 cont.

(Continued from page 21)

Ronald Victor Janson Prize for the best project in Electronic Communications:

2003: **Michael B Campin, Keble**

2004: **Ripan Sen, St Anne's**

Best Project Prize in Chemical Engineering:

2003: **Wee L Cheong, St Hugh's**

Unilever Prize for the best project in Control Engineering:

2003: **Istvan J Gyongy, New College**

Worshipful Company of Scientific Instrument Makers Project Prize:

2004: **Hazel V Lucas, Hertford**

Gibbs Prize for the best Part 1 Project:

2003: **Peter W Dale, St Catherine's; Matthew R Forrow, St John's; Matthew Galloway, Balliol; Esteban Gonzalez-Torres, St Anne's; David RJ Gregory, Exeter; Marcus OT Haggers, Lady Margaret Hall; David P Latham, Trinity; Clodia N O'Neill, Lincoln; Richard G Scott-Smith, Keble**

2004: **Kemal Cenan, St Catherine's; Graham R Faragher, St John's; Camilla L Halewood, St Hilda's; Mark B Lewis, Lady Margaret Hall; Xiang Li, St Hugh's; Daniel J Payen, St Peter's; James E Reid, St Catherine's; Jonathan DS Smith, Trinity; Chem Y Yong, Pembroke**

Engineering, Economics and Management

Maurice Lubbock Prize for best performance:

2003: **Yiu H Chan, Wadham**

2004: **Theodoros A Kyriacou, Balliol**

Edgell Sheppee Prize for the best Engineering project:

2003: **Penelope L Hull, Brasenose**

2004: **Ganesan V Letchumanan, Lincoln**

Pilkington Prize for the best Management project:

2003: **Teoman R Ozsan, Balliol**

2004: **Anthony CF Man, Wadham**

Delon Detson Prize for best performance in management papers:

2003: **Michael J Heal, New College**

IMechE Certificate for an outstanding mechanical engineering project:

2004: **Stephanie H Kember, Wadham**

Engineering and Computing Science

Maurice Lubbock Prize for best performance:

2003: **Ognjen Arandjelovic, St John's**

2004: **Matthew R Jenkins, St John's**

Edgell Sheppee Prize for excellent performance

2004: **Charles C Bibby, Lady Margaret Hall**

Engineering and Materials Science

Maurice Lubbock Prize for best performance:

2003: **Marcus J D'Arcy, Trinity**

2004: **Timothy J Woolmer, St Hugh's**

IMechE Certificate for an outstanding mechanical engineering project:

2003: **Marcus J D'Arcy, Trinity**

The Banbury-Road Front of the New Information Engineering Building

The building replaces two old houses and joins the original Engineering site at the tip of the Keble Road triangle (the Jenkin Building) to the yellow-brick Engineering & Technology Building put up in the 1990s. It will house mainly the Robotics and Image Analysis research group, previously spread over four widely separated sites, and allow scope for further expansion, e.g. in activities shared with other information engineering research groups.

The building has six stories, including a "lower-ground floor" which is lit by windows looking up towards the Banbury Road pavement. The design, by architects RMJM, aims to maximise the net usable space, subject to constraints of the site and Town Planning controls. It maintains as far as possible the qualities of natural light and ventilation currently enjoyed in the adjacent buildings.

Note the builders' skip, still to be removed!

Career Advisers

This sounds rather formidable, but isn't meant to be. We are building up a list of people who are willing, if called upon, to give informal advice to individual undergraduates about engineering careers in their own speciality. We have ten volunteers so far, but could do with a few more, perhaps especially in the general area of mechanical engineering. And someone in aeronautical engineering? But all are welcome. The way the system works is that I let it be known that I have a list, and welcome enquiries. When someone contacts me about a particular field, I get in touch with an "adviser" on the list, and if the match seems suitable, put them in touch with each other.

David Witt (david.witt@eng.ox.ac.uk)

From a notice in the First-Year Electronics Laboratory:

"Insulation does not conduct electricity very well. If you wish to make electrical connection to a piece of wire you must either apply several thousand volts, or else remove the insulation"

SOUE News

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