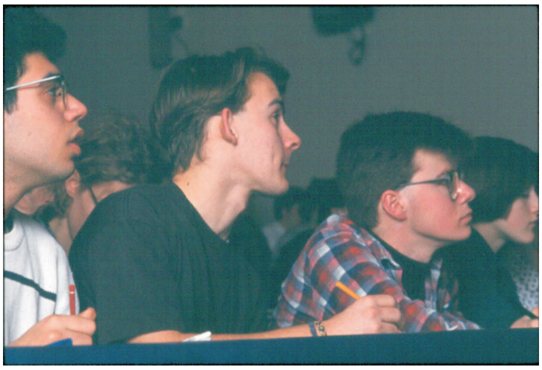
Oxford Mathematical Institute

Spring 2004 Issue 2

Newsletter

Undergraduate Mathematics in the Twenty-First Century

A new undergraduate course in mathematics was launched in 2002. A radical overhaul of the syllabus has been undertaken in order to create a more flexible and broadly based course without losing the best aspects and aspirations of an Oxford degree. One dramatic change has been the introduction of examinations at the end of the second year which, to our surprise, has been welcomed by the undergraduates!


Rob Judges

Other changes have been inspired by the need to adopt some of the new ways of teaching and examining that have recently been developed. Thus the form of our examinations, which has not changed for many years, has been redesigned in a way that we hope will test the very best mathematicians and will also provide a satisfactory assessment for the whole cohort.

Inside this issue

To summarise what we have done:

1) We have introduced some statistics into the first-year syllabus, reducing the amount of physical applied mathematics. The style of the exams has changed to make questions less intimidating and encourage students to cover the syllabus fully.

2) The second year has seen the most radical change with the introduction of more options and a new examination containing some papers with short straightforward questions to allow all students to show what they can do.

3) In the third and fourth years, students will choose from a menu of mathematical options as well as other topics such as history of mathematics, philosophy and languages. The Undergraduate Ambassador scheme will allow some students to teach mathematics in local schools and gain credit.

So far, student feedback on the new structure has been positive and applications for places at Oxford have increased.

Mathematics is of increasing importance in modern society. The recent Smith report, 'Making Mathematics Count', tells us of a decline in numbers studying the physical sciences and mathematics, and a shortage of teachers trained to teach mathematics. With our new course we aim to attract the most promising mathematics students and foster their enthusiasm for the subject. We hope that our graduates will include a good number who will return to the schools to teach and contribute to a revival in mathematics education in this country.

Mathematics meets Industry

Oxford Centre *for* Industrial *and* Applied Mathematics

The 49th European Study Group with Industry was held in Oxford from March 29th to April 2nd this year. At this workshop-style meeting, representatives from 8 companies presented specific problems of current interest to an audience of applied mathematicians ranging from professors to doctoral students. The week was spent exploring ways to attack these problems and a written report on each one will be produced within a few months.

This unique form of technology transfer was pioneered in Oxford when Alan Tayler of the Mathematical Institute and Leslie Fox of the Computing Laboratory held the first meeting in 1968. Since then, the idea has spread worldwide. There is an annual meeting in the UK which is part of a European series and is now run by the Smith Institute Faraday Partnership. There are regular Mathematical Study Groups with Industry in Australia and the US and there have now been three meetings in China.

OCIAM remains the nerve centre for much of this activity and further details can be found on: `www.math-in-industry.org`

The following is a list of the problems presented:

Uncertainty in flow in porous media. ***Schlumberger.***

The design of robust networks for massive parallel micro-fluidic devices. ***Unilever.***

Models of consumer behaviour. ***Unilever.***

Modelling of melt on spinning wheels and the impact of scale-up on the various parameters. ***Thermal Ceramics UK.***

Real-time traffic monitoring using mobile-phone data. ***Vodafone.***

Optical measurement of glucose content of the aqueous humor. ***Lein Applied Diagnostics.***

Distribution-independent safety analysis. ***National Air Traffic Services.***

Data-packet loss in a queue with limited buffer space. ***Motorola***

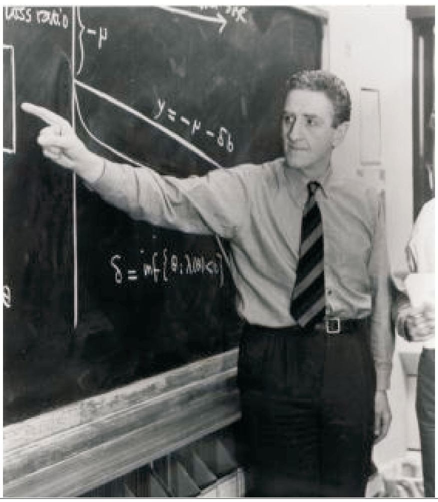
John T. Lewis

By **Keith Hannabuss**

Those who remember the Mathematical Institute in the 1960's and early 1970's will have been saddened by the news of the death of John Lewis in Dublin on 21 January at the age of 71. John was born in Swansea on 15 April 1932, but the family moved to Belfast after the war, and it was there that he studied at Queen's University. After completing his doctorate in Applied Mathematics, which introduced the now well-known Dalgarno–Lewis method into perturbation theory, he came to Oxford in 1956 as a Research Lecturer at Christ Church. Three years later he moved to a Tutorial Fellowship at Brasenose, and in 1965 became a University Lecturer. He left Oxford in 1972 to take up a chair at the Dublin Institute for Advanced Studies (DIAS).

During the 1960's until his departure John supervised 15 successful Oxford doctoral theses applying functional analysis, operator algebras, group representation theory, and differential geometry to quantum theory. The revelation that the most abstract modern parts of pure mathematics could also be used in applied mathematics, alongside the techniques traditionally taught, inspired a generation of students.

His research acquired two new strands following a visit to Oxford by Mark Kac and John's subsequent sabbatical at Rockefeller. Kac enquired whether John's work with Brian Davies on quantum measurement could shed any light on the question of how the reversible dynamics of molecules in a gas could give rise to the irreversible Langevin equation for Brownian motion. With his student Lyn Thomas, John came up with a beautiful general theory of dissipation based on the dilation of semigroups, one application of which answered Kac's question. (It also linked back to Lamb's 1902 mechanical model of radiative damping as a semi-infinite string attached to a mass sliding on a rod, a topic still included in Mods with no hint of its significance.)



The second topic, started with his student Joe Pulé, was the study of Bose– Einstein condensation. This took a new direction in the 1980's, with John's realisation of the power of large deviation theory to illuminate the investigation of the interacting boson gas, and culminated in work with Charles Pfister and another former Oxford student, Wayne Sullivan.

This took on a new significance after 1988 when the Irish Government decided, in a cost cutting exercise, to close DIAS. John used his considerable political skill to get the closure rescinded, but decided that he needed to back his fundamental research with applications which even politicians could recognise. Taking his lead from the probability group in Moscow, he moved into telecommunications, where he realised that surges in telephone or internet traffic could also be investigated by large deviation techniques. Others were also aware of this approach, but it required a knowledge of a "rate function", which they found by computer simulation, a procedure too slow to be useful in practice. John knew from statistical mechanics that the rate function was essentially entropy, and that when engineers needed to know the entropy they took a couple of temperature measurements and then looked it up in steam tables. Following trials on the local computer network, he quickly verified that his method not only worked but indicated that existing techniques drastically overestimated the capacity needed to cope with bursts in traffic. This soon attracted international interest and industrial support, and out of it emerged John's company Corvil Ltd.

Few people take up a new job at 70, but, once a new Director had been appointed to succeed him at DIAS, John resigned to concentrate on Corvil and to head his newly established Communication Networks Research Establishment at the Dublin Institute of Technology, supported by a large European grant.

His impressive scientific achievements were matched by an engaging personality with a strong sense of fun. He had little time for the pompous or self-important, but was always ready for serious scientific discussion about practically any problem. One always felt better after talking to him, for he offered energy, enthusiasm, and encouragement.

He is survived by his wife Maureen, and by four children and five grandchildren.

Tectonics on Venus

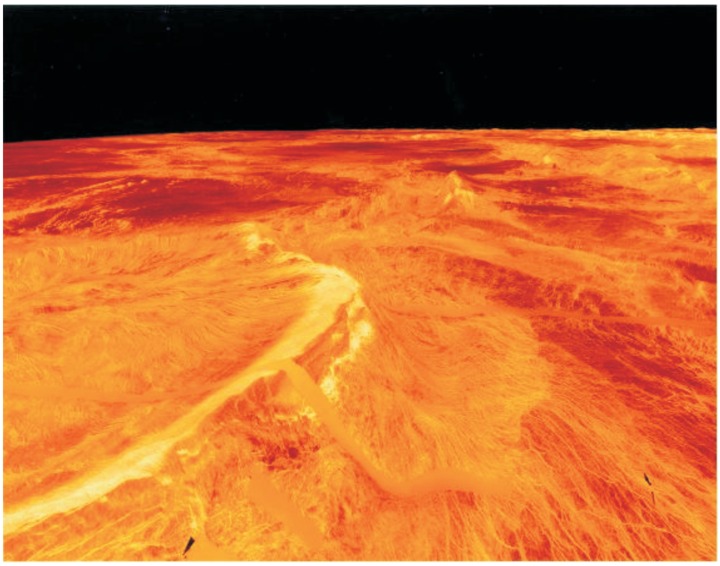
By Andrew Fowler

Venus is a planet which is superficially very different to Earth: the surface temperature is 750°K, and the atmosphere is filled with sulphurous clouds but contains no water. Nor are there oceans. But below the surface, Venus and Earth are more similar. They are of similar size, and both consist of a mantle of silicate rocks surrounding an iron rich core. It is a surprise, then, to learn from the detailed surface topography mapped by the Magellan space mission of the 1990's that plate tectonics is absent on Venus. On Earth, plate tectonics is the surface expression of a deeper, thermally driven convection within the Earth's mantle, and it causes the continents to form and to move relative to each other: somewhat appropriately, North America is moving away from Europe at about the rate your fingernails grow, and has been since the Cretaceous period.

It is therefore something of a puzzle why plate tectonics does not occur on Venus, despite much evidence of a vigorously convecting Venusian mantle. More puzzling still is the fact that the surface of Venus appears to be of a uniform age (around 500 million years), which suggests that there was a vigorous episode of mantle convection at that time which caused resurfacing of the planet. The most obvious hypothesis to explain these observations was put forward by Don Turcotte in 1993: he explained it to Andrew Fowler while walking down to lunch in Corpus while on a visit to OCIAM. The idea is that convection at high Rayleigh number can occur periodically, and in the extreme case the oscillations can take the form of violent overturnings followed by periods of apparent inactivity: just what is seen on Venus. The question is, is this description consistent with a theoretical model?

Much has been learned about thermal convection since the time of Bènard and Rayleigh a century ago, and this idea was mooted and studied in a justly seminal paper of Lou Howard in 1966. But there is a problem. The silicate rocks of the mantle do convect; although solid, creep occurs because of the migration of dislocations within the crystalline lattice; however, the effective viscosity is very temperature dependent: the viscosity decreases by around an order of magnitude for every 100°K increase in temperature. Over the 3000°K (at least) increase in temperature from the Earth's surface to the coremantle boundary, for example, the temperature driven change of viscosity would be about 10^{40}!

This and other effects (the viscosity also depends very strongly on pressure and, to a lesser extent, stress) preclude resolution of the conundrum by numerical means. The very best thermally driven viscosity contrasts that can be used numerically are 10^{15}, and these are a good deal short of what is necessary. The nature of the problem is this. Vigorous, high Rayleigh number convection causes thermal boundary layers to appear at the top and bottom of a convecting layer. When the viscosity is temperature dependent, the cold (top) boundary layer becomes very thick because the flow is so sluggish there. When the viscosity contrast is exponentially large, the velocity becomes exponentially small, and the surface "plate", technically known as the lithosphere, and equivalent to the thermal boundary, becomes rigid. This is what we see on Venus!



Computer generated perspective image of Latona Corona and Dali Chasma, Venus. The image was created by superimposing Magellan radar data on topography vertically exaggerated by a factor of 10. The eastern part of the 1000 km diameter Latona Corona is on the left, and the view is from the northeast looking along the 3 km deep Dali Chasma. This view is approximately at 20S,165E. Image from http://nssdc.gsfc.nasa.gov/imgcat/html/object_\,page/mgn_\,p40697.html

The problem is now turned around: how can you get the tectonic plates of the Earth to move at all? Andrew Fowler suggested in 1993 that high stresses in a stagnant lithosphere generated by the high negative thermal buoyancy there (something has to hold the heavy lithosphere up) could cause plastic failure, and thus allow the plates to move and subduction to occur, as it does on the Earth at the deep oceanic trenches. An asymptotic theory of 1985 showed that such high stresses do occur, and they were subsequently found in numerical computations. In 1993, and later in 1996 with his colleague Stephen O'Brien of the University of Limerick, he found that subduction could be initiated by this mechanism on the Earth if the plastic failure stress was of the order of 200 - 300 bars, similar to the observed stress drop on subduction zone earthquakes.

More recently, again with O'Brien, Fowler has shown that this same physical mechanism is consistent with Turcotte's idea of episodic subduction and consequent overturn. The theory predicts periodicities of the correct range, hundreds of millions of years, if the failure stress is in the range 100 - 200 bars, and it also suggests that failure will occur at distances of hundreds of kilometres from an upwelling plume, which would be expected to be the first signal of convection from below following a surface overturn. Gerald Schubert suggested in 1992 that trenches at the rims of coronae (circular plateaus on Venus, see figure) were incipient subduction zones, and coronae themselves are thought to be the surface expression of thermal plumes below the lithosphere. The question remains, is this purported convective style unique to Venus, or could it also apply to the Earth? These and other such issues await future investigation.

Andrew Fowler is a University Lecturer at the Oxford Centre for Industrial and Applied Mathematics. He leads the group working on mathematics applied to environmental issues. Further details about his work on Venus can be found in a paper in the Proceedings of the Royal Society, Volume 459.

Sylvester's surfaces

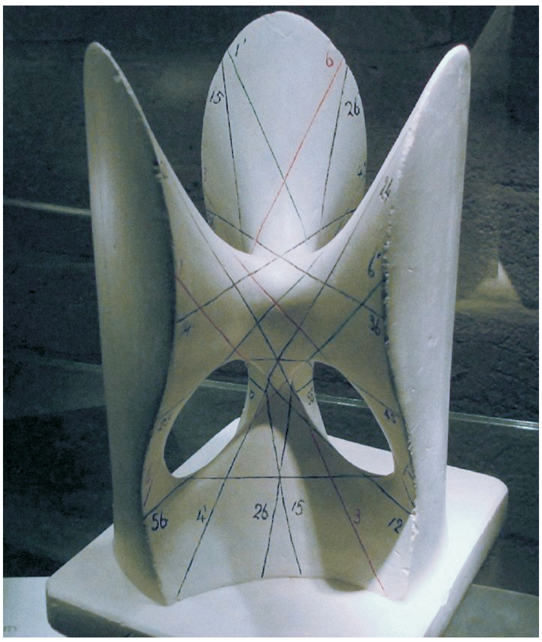
By **Nigel Hitchin**

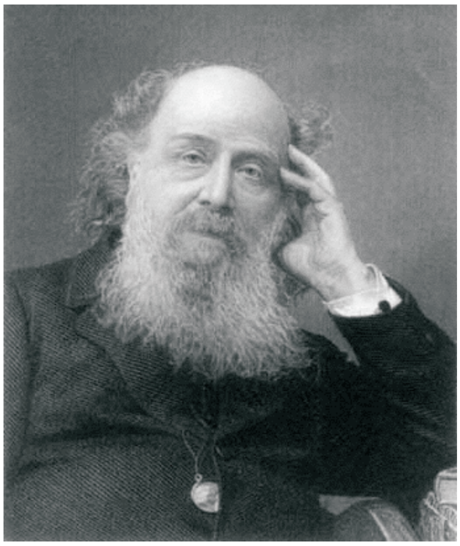
Most old-established mathematics departments around the world have somewhere, gathering dust in a corner cabinet, a collection of plaster models of surfaces. In the 1880's these were a "must-have" item for geometrically-minded mathematicians and James Joseph Sylvester, the Savilian Professor of Geometry in Oxford, accordingly acquired a set from Germany. They were not cheap, and in October 1886 Sylvester had to cancel a series of lectures because a cash-strapped University hadn't approved his equipment grant. They relented, and by January the following year he was able to run his course.

Sylvester's models lay hidden away for a long time, but recently the Mathematical Institute received a donation to rescue some of them. Four of these were carefully restored by Catherine Kimber of the Ashmolean Museum and now sit in an illuminated glass cabinet in the Institute Common Room.

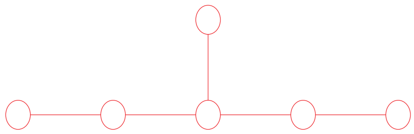
What were they for then, and what good are they now? The past may well be a foreign country but we can guess that nobody was seriously interested in measuring lengths and angles on these models – they represented something deeper and more abstract than that. Perhaps the most famous is the cubic surface and its 27 lines.

On the model there are 6 disjoint red ones, 6 disjoint green ones and 15 black ones intersecting two of each. Sylvester and his colleagues knew without looking at the model that there are 72 ways of choosing 6 disjoint lines, and that a group of permutations of order 51,840 changes the labellings of the 27 lines preserving their intersection properties. This was a hot topic in 19th century mathematics: in 1849 Cayley and Salmon discovered that every cubic surface has 27 lines on it and by the end of the century over 200 papers were published on the subject. The model was a reminder of this deep and curious fact and an aide memoire for the configuration.





And what of today? Nowadays we would replace the model with this simple diagram:



All the information about the 27 lines and the subsets of 6 can be read from this, which is called the E_6 Dynkin diagram. For each vertex of the diagram we associate a generator of order 2 of an abstract group. If two vertices u, v are adjacent we take the relation $(uv)^3 = 1$ and if not $(uv)^2 = 1$. The six generators then give the group of order 51,840, the symmetries of our 27 lines.

Looking at the diagram differently, we can get a more familiar group – if u denotes the top vertex, v the far left one and w the one on the extreme right, we count the number of vertices to the central one and insert these as exponents:

$$u^2 = v^3 = w^3 = uvw = 1.$$

These multiplication rules generate the group of rotational symmetries of the regular tetrahedron. Dynkin diagrams occur all over the place in mathematics, in the theory of Lie algebras, critical points of functions, the symmetries of the regular solids, and in String Theory. It is all part of the ubiquitous ADE classification. Adding extra vertices gives us E_7 and E_8 and the second rule above produces the symmetry groups of the other Platonic solids, the octahedron and the icosahedron. Sure enough, in Sylvester's time there were geometrical manifestations of these symmetries too: the 28 bitangents of a quartic curve and the 120 tritangent planes of a curve of genus 4, discovered in 1850 and 1863.

It seems that these unavoidable objects emerge in a different guise in every age. The models serve to remind us of the persistency of mathematical ideas.

Nigel Hitchin is the current Savilian Professor of Geometry and received the Sylvester Medal of the Royal Society in the year 2000.

Connections

By **Marcus Du Sautoy**

In 1972 the famous quantum physicist Freeman Dyson wrote a paper called 'Missed opportunities'. He describes how relativity could have been discovered many years before Einstein announced his findings if the mathematicians in places like Göttingen had talked to the physicists who were poring over Maxwell's equations describing electromagnetism. The ingredients were there in 1865 to make the breakthrough which was only announced by Einstein some forty years later. Indeed it seems that in the decade following Maxwell's discovery, only Oxford mathematician Henry Smith was aware of the great mathematical potential contained in Maxwell's equations: "For electricity has placed before the mathematician an entirely new set of questions requiring the creation of entirely new methods for their solution". The mathematicians of the later nineteenth century remained blind to the possibilities Smith has foreshadowed and, as Dyson writes, an opportunity was missed.

It is striking that Dyson should have talked about scientific ships passing in the night unaware of each other. The very same year that he wrote his 'Missed opportunities' paper he was responsible for one of the most remarkable collisions of mathematical ideas to emerge over the last decades. The discovery that quantum physics and prime numbers are inextricably linked came about from the chance discussion over tea between two mathematicians who at first sight had little common interests.

In the spring of 1972 the American number theorist Hugh Montgomery had just finished his doctorate in England. He had become fascinated by Riemann's ground-breaking ideas about prime numbers and in particular the Riemann Hypothesis, the greatest unsolved problem of mathematics. In a short paper delivered to the Berlin Academy in 1859, Riemann had revealed a strange connection between prime numbers and the zeros of a complex-valued function called the zeta function. He showed how the coordinates of the imaginary numbers where the zeta function is zero could be used to explain the distribution of the primes. It was an extraordinary shift in our attempts to understand the mysteriously random looking sequence of primes. Riemann's worked unearthed this strange wormhole linking primes with the world of imaginary numbers.

Although the primes looked wild and erratic, Riemann's calculations suggested that the behaviour of the zeros of the zeta function were, in contrast, extremely orderly. Instead of being randomly scattered across the complex plane, the few zeros he could calculate were lining up along a straight line, the real part of each zero being equal to ½,. Although he could not prove it, he believed that every zero would lie on this critical line. No one has been able to confirm his hunch, now known as the Riemann Hypothesis. Even the recent incentive of a million dollars offered by the businessman Landon Clay has failed to elicit a proof.

Over the ensuing years mathematicians became obsessed with trying to prove the Riemann Hypothesis knowing that it would imply important things about the distribution of prime numbers. By the time Montgomery became a graduate student, mathematicians were stuck. Montgomery decided to do something which at first sight looked completely crazy. He began to explore how these zeros were lining up along Riemann's critical line. Most thought it foolhardy to start trying to ask such a question when no one could prove they were really on this line in the first place. Montgomery thought that although the real part of the zeros were all expected to be ½, the imaginary part would look very random, like rain-drops scattered along this line. Somewhat to his surprise a new pattern emerged. Like the random arrival of buses or winning lottery numbers, Montgomery expected to keep seeing batches of zeros in close succession as one marches along Riemann's critical line. But the opposite seemed to be happening zeros did not appear to like being close together.

Montgomery managed to produce a model to predict the way he believed zeros were arranged. It was unlike any model he had seen before. On his way to a new position in the University of Michigan, he took a detour via Princeton to talk with the number theory group at the Institute for Advanced Study. Montgomery admits: "I was a little bit troubled because I thought there was a message in what I had done and I didn't know what the message was." It was not the number theorists who would help him decode that message but another member of the Princeton Mafia.

After talking for many hours Montgomery and his number theory colleagues broke for that important ritual of most mathematics departments: afternoon tea. Tea has always been regarded as especially important at the Institute since it allows members from different disciplines to exchange ideas. Montgomery was introduced to Dyson who politely asked him what he was working on. As Montgomery described the model he had produced to understand the zeros of the zeta function, Dyson's eyes lit up. It was exactly the model that quantum physicists had produced to describe the possible energy levels in the nucleus of a heavy atom when it is bombarded with low energy neutrons. If you take a strip of zeros from Riemann's critical line and place it alongside the experimentally recorded energy levels in the nucleus of something like erbium, the 68th atom in the Periodic Table of chemical elements, the two were uncannily similar.

Montgomery couldn't quite believe it but it seemed that the patterns that he was predicting for the way zeros were distributed were the same as the patterns predicted by quantum physicists for energy levels in the nucleus of heavy atoms. They were such distinctive patterns that it seemed hard to believe that it was just coincidence that they happened to be the same.

Here was the message that Montgomery was looking for. If one understands the mathematics which explains the energy levels in heavy nuclei in quantum physics, then maybe the same mathematics is responsible for explaining the locations of Riemann's zeros.

That chance meeting in the common room resulted in one of the most exciting recent advances in the theory of prime numbers. Collaboration is often about providing the missing rungs on the ladder which allow both mathematicians to climb to the top. Without the opportunity to interact each individual can find themselves stuck with nowhere to go. Dyson might be right that an opportunity to discover relativity forty years earlier was missed, but who knows how long we might still have had to wait for the discovery of the connections between primes and quantum physics had mathematicians not enjoyed a good chat over tea.

Marcus du Sautoy is a Royal Society Research Fellow. His book 'The Music of the Primes' (Fourth Estate) and website www.musicoftheprimes.com tells more about the stories of mathematician's attempts to crack the Riemann Hypothesis.

Mathematics is the language of science


John Ball

IMU International Mathematical Union

Professor John Ball, the Sedleian Professor of Natural Philosophy at Oxford, has been President of the International Mathematical Union since January 2003 and his term will finish after the International Congress of Mathematics (ICM) in Madrid in 2006. Last year he was interviewed by **Malen Ruiz de Elvira** for an article that appeared in the Spanish daily newspaper *El Pais* and the following is an extract from this interview.

Malen Ruiz de Elvira. What do you want to do as president of IMU?

JB. One important project is the World Digital Mathematics Library, whose aim is to retro digitize, and make available through the Internet in searchable form, everything that has been published up to now in mathematical journals and books. In mathematics work can retain its interest for many years, whereas in other sciences such older work would generally be considered obsolete. This is a very expensive project, and there are major problems in implementing it, such as copyright, establishing norms and protocols, and negotiating a period after which new material will become freely available.

In particular this project would be wonderful for developing countries, although it is also necessary that researchers in such countries have sufficiently fast internet access to download the published material. More generally, I would like to improve the support IMU gives to mathematicians in developing countries. Human talent is a natural resource, both for individual countries and for the international mathematical community, and should not be wasted. In connection with this I would like to increase the number of member countries of IMU. Currently there are 65 member countries, out of the 192 (or 193) countries in the world. There is currently a requirement for membership of independent scientific activity (that is, a research presence) in the country, and we need to consider whether this is appropriate.

MRdE. Is mathematics a science?

JB. Mathematics is the language of science but it has its own intrinsic structure. It is extremely important for science, and its importance is increasing. For instance, in medicine there was almost no influence of mathematics 20 years ago, but now its influence is growing fast, with techniques like X-ray tomography, models of tumour growth, genome analysis, and so on.

MRdE. Would you say to young people that they can earn money with mathematics?

JB. Yes, I am seeing that with my students. Even though they may not use mathematics after they graduate or get a doctorate, they have an advantage in understanding how to formulate and analyse problems, to use the mathematical way of thinking. There is a big demand for mathematicians and it is very difficult to keep good people in the academic world because they can earn much more outside.

MRdE. But many children find mathematics difficult ...

JB. One of IMU's most important commissions is ICMI, the International Commission on Mathematical Instruction, which is concerned with mathematics education. Mathematics should not be difficult to learn, and it depends on how it is taught. I think it is especially useful for children to learn geometry, because of its visual appeal and way it teaches ideas of proof.

MRdE. What are the most promising areas in mathematics?

JB. First of all, as subjects become better understood, such as medicine, they become more mathematical. Major mathematical advances increase the interest in the areas in which they have been made; that happened with number theory after Fermat's Last Theorem was proved by Andrew Wiles. Each area develops at its own pace and I could not say which will be the most important in the future. What is clear is that mathematics will have more and more influence in everything.

MRdE. Do you mean applied mathematics?

JB. I do not like to make a division between pure and applied mathematics. Most of the great mathematicians of history contributed to both theory and applications. Let me explain with an example why I don't like to make such a division (he shows a wire with two small balls at the ends). This is a wire made of shape memory alloy. It can be twisted, bent ..., but when you put it into hot water it recovers its original shape (he shows this). When the wire bends, the geometry of the microstructure of the material changes. How this microstructure changes is related to deep questions of what might be called pure mathematics which are not well understood, related to the quasiconvexity condition of a certain branch of mathematics known as the calculus of variations.

Thus there is a model which predicts what happens to a shape memory material, with potential practical applications, but studying it also deepens our knowledge of an area of mathematics. When two different disciplines get in contact both benefit, even though initially there may be resistance to such contact.

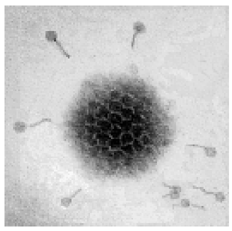
This edited version is printed with the permision of *El Pais*. We are grateful to **José Carlos Bellido,** a visiting *EC Marie Curie Fellow*, for help with the translation.

Collaboration with the Life Sciences

How can we improve the delivery of gene therapy? What are the major factors causing spinal disc degradation which lead to back pain? How does a novel wound gel deliver its oxygen? These are just some of the questions that Applied Mathematicians based in the Oxford Centre for Industrial Applied Mathematics (OCIAM) and the Centre for Mathematical Biology (CMB) are faced with in a new initiative which is forging collaborations across disciplines and into industry.

Dr. Marcus Tindall has recently been appointed the Bioliasion Officer and his remit is to initiate contact with Life Science researchers inside and outside Oxford including experimental biologists, biomedical researchers, clinicians, ecologists, zoologists and biotech companies.

One current project involves optimising the delivery of gene therapy used in cancer treatment. Virus particles are used to transport the genes, but are often destroyed by the patient's immune system before they can reach the target tumour. In order to overcome this problem, experimentalists in the Department of Clinical Pharmacology have proposed a novel way of coating the virus particles with polymers, thus providing a protective barrier. A student on the MSc in Applied and Computational Mathematics is working on modelling particular aspects of the coverage provided by the polymers.


An electron micrograph image of a human virus particle

Marcus Tindall is always interested in new problems and projects as well as discussing the current initiative and his own work. He can be contacted by e-mail at tindallm@maths.ox.ac.uk.

The Mathematical Institute building

By **Nick Woodhouse**

It was G. H. Hardy who first persuaded the University that Oxford needed a mathematical institute, a place for undergraduate lectures, and a home for the mathematical community, where professors, college fellows and graduate students could meet. It was not enough for a University that should stand alongside the great mathematical centres in Europe and the United States to elect a few professors and handful of fellows, and then expect them to work alone in the glorious isolation of their college rooms. Mathematicians he wrote “are reasonably cheap, but they cannot be had for nothing”.

The response, at first, was modest, and the momentum gained under Hardy's leadership towards growth and engagement with the international currents of twentieth-century mathematics was slowed in the war years. The new Institute was granted only a small and temporary foothold in an extension to the Radcliffe Science Library.

In the 1950’s, the community expanded rapidly, following the arrival of Henry Whitehead as Waynflete Professor, and the Institute moved first into a Victorian house on the opposite side of Parks Road and finally into its present home in St Giles’.

The St Giles' building has many advantages. Its detailed design was overseen by Charles Coulson, who understood well the needs of his colleagues. Its large lecture theatres could hold an entire year-group with ease and provided the acres of blackboard, enough for even the most enthusiastic lecturers. Above all, it was close to the centre of Oxford. Undergraduates could attend a lecture, and cycle back to their colleges for tutorials in the following hour.

Size, however, rapidly became a problem. Funding constraints did now allow for a vision of future growth; nor did they allow enough space to tempt tutors away from their college rooms. The building was barely sufficient to house the professors, university lecturers, visitors, and graduate students, and before long it was overflowing into a house in St Giles’, and then into one floor after another of a utilitarian block in Little Clarendon Street, where OCIAM and the Centre for Mathematical Biology now thrive despite their surroundings.

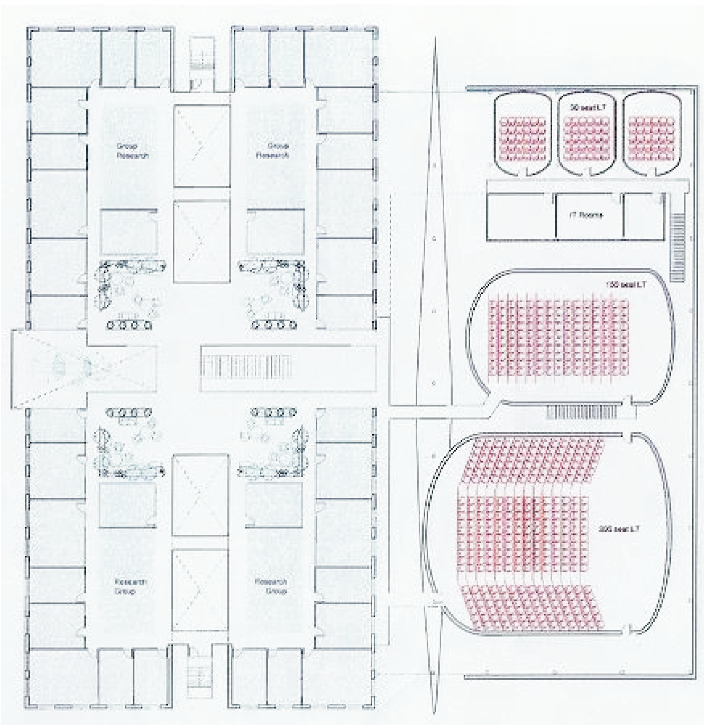
It is time to move again, and we are very fortunate that we have the opportunity to do so. Just across the Woodstock and Banbury Roads, the University has bought the site of the Radcliffe Infirmary, which is shortly to become redundant as a hospital as the Oxford consolidates its medical work in Headington. Behind the splendid facade on Woodstock Road is a warren of poor-quality buildings over several acres, most of which must be cleared. The Institute again has the opportunity to design from scratch a purpose-built home for mathematics in the centre of Oxford.

The new building must serve the whole mathematical community; professors, lecturers, and students at all levels. It must also look outwards, and provide proper facilities for the many distinguished visitors who are drawn to Oxford, and who contribute so much to its mathematical culture.

We are not yet certain where on the site the new Institute will be built, and before serious work can start, we must make progress on raising some £40M. We have, however, sketched its outlines, with the help of our architect, David Heslop of the Architects Design Partnership. He has drawn up plans for a four-storey building of academic and administrative offices, with the a 300-seat lecture theatre, other lecture rooms, and a library in a lower extension to one side. This plan keeps the teaching and research functions in one building, but allows the circulation space around the lecture rooms to be sufficiently isolated to avoid disturbance.

The ground floor of the main block will be taken up with administrative offices, and common rooms for junior and senior members - in contrast to the St Giles' building, the aim is to encourage undergraduates to spend time in the building outside the actual hours of lectures. It will be a home for them as well as postgraduates and faculty.

The main part of the building is divided by a cruciform atrium that rises through the height of building, and divides the upper floors into twelve interconnected areas. This division allows for the areas to be identified with particular groups, but the openness of the internal space will discourage isolation and the forming of rigid boundaries. The 100 or so principal academic offices are distributed around the outside of the upper three floors. Facing into the interior space, the twelve areas will also have space for informal discussion, and rooms that could be used for small seminars or as additional workspace for students and visitors. With their doors shut, the academic offices will provide privacy and quiet for serious concentration. Open, they will invite interaction. The design encourages an “open door policy”, so that people can be seen to be in the building. The intention is to create the lively buzz so many of us envy in well-resourced North American departments.



Proposed plan of the first floor in the new Institute

News

Newcomers

Dr Jan Kristensen is a *CUF lecturer at Magdalen*. He joins Professor Ball's group and works on the calculation of variations.

Dr Alan Lauder has been appointed to a *Faculty Lecturership at Hertford College* and initially he holds a Royal Society Research Fellowship. His work is in computational number theory.

Professor John Wilson is a distinguished algebraist who has taken up a part time post in Oxford on his retirement from the University of Birmingham.

Prizes and Awards

Dr Peter Neumann was awarded the *Senior Whitehead Prize* of the London Mathematical Society in recognition of his contribution to and influence on research into diverse branches of group theory and for his broadranging service to British mathematics over many years.

Professor John Ball was awarded the first *David Crighton Medal* for services to Mathematics and the mathematics community. This medal is awarded jointly by the London Mathematical Society and the Institute of Mathematics and its Applications.

Dr Marc Lackenby was awarded a *Whitehead Prize* of the London Mathematical Society for his contributions to three dimensional topology and to combinatorial group theory.

Professor Dominic Joyce was awarded the *Adams Prize* for his work on differential geometry. This mathematical prize is awarded each year by Cambridge University.

Dr Ben Hambly, together with James Martin and Neil O'Connell, received the first *Ito Prize* for their paper 'Concentration results for a Brownian directed percolation problem'. The prize is awarded for a paper published in the journal 'Stochastic Processes and their Applications'

Abel Prize

The second *Abel Prize* has been awarded to **Sir Michael Atiyah**, who was Royal Society Professor in Oxford from 1972-1990. The prize, which is shared with Professor Isadore Singer (MIT), is for "their discovery and proof of the index theorem bringing together topology, geometry and analysis, and for their outstanding role in building up new bridges between mathematics and physics". The winner of the first Abel Prize, *Professor Jean-Pierre Serre,* gave the algebra seminar in Oxford on 10th February

Other News

Dr Richard Earl has been appointed as the new *Schools Liaison and Access Officer*. His duties are to promote the study of Mathematics in schools and to encourage all students from all backgrounds to continue their studies at the tertiary level and particularly in Oxford.

The ***London Mathematical Society Popular Lectures*** this year were given by two Oxford mathematicians:
'*Mathematics, Magic and the Electric Guitar*' by **David Acheson** and
'*The Music of the Primes*' by **Marcus du Sautoy**.
Both lectures will be given again in Oxford on June 26, 2004.

David Acheson gave a ***Friday Evening Discourse at the Royal Society*** entitled '*1089 and All That*'.

Marcus du Sautoy's '*Diary of a Mathematician*' was featured as 'book of the week' on Radio 4.

The Mathematical Institute is a department of the University of Oxford
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