



Imperial ENGINEER

EL HIERRO

BIG DATA AND PRIVACY

NEW KID ON THE BLOCK

THE ENGINEERING BRAND

VIRTUAL PALAEOLOGY

For members of City & Guilds College Association
and The Royal School of Mines Association

ISSUE NINETEEN *AUTUMN 2013*

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Cover: The newest addition to the London skyline, the Shard, dominates the view from the Thames. The foundations and spire of this stunning building were designed by alumna Roma Agrawal, author of the feature article 'The Engineering Brand'. See pages 14-15

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Imperial ENGINEER

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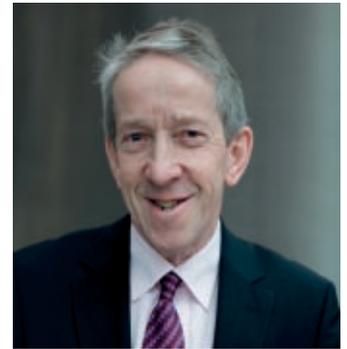


Those readers who were fortunate to be present at the One Hundredth Dinner of the CGCA, held back in May of this year at the City of London's Mansion House, will have heard the Dean of the Engineering Faculty, Professor Jeff Magee, announce that the College building known generally as the 'Mech Eng' building was to be named the 'The City and Guilds Building' in recognition of the role played by City and Guilds in the creation and establishment of Imperial College and to cement the existing and future relationship between the two organisations. A special event to formally mark the naming was held on Wednesday 18th September. The large assembly of guests, that included many representatives from CGCA, heard both the Rector of Imperial, Sir Keith O'Nions and the Chairman of City and Guilds Institute, Sir John Armitt, speak warmly about the importance to both bodies of their historical ties and their future partnership. The event took place in front of the 16 shields of those City Livery companies who were instrumental in the founding of Imperial; the Masters of several of those companies were, of course, present at our Dinner.

For this year's Annual Dinner we have decided to revert to our more modest arrangements – a **One Hundredth** event does, by definition, only come along every so often – so we will gather in the Cutler's Hall on the evening of Friday 14th May 2014. We will, however, retain two features from the One Hundredth: we have selected a Friday in order to give those wishing to attend who reside outside London more flexibility in making their arrangements and we will close the guest list a few weeks in advance of the event so as to make the preparation of the seating plan, drawing up the personalised menus etc. more manageable. So, the combination of a smaller capacity hall and tighter control on reservations all points to one thing: those of you wishing to attend need to act promptly and decisively.

With the new Academic year about to start, the full programme of CGCA gets going. Because this has been steadily expanding we are forming a programme subcommittee to ensure that we arrange events in the best manner throughout the year. We are also anxious to mesh with appropriate student events as CGCA continues its endeavours to increase its engagement with the student body as part of its aim to make membership of CGCA a natural accompaniment to graduation. With this in mind we will be changing the make-up of our General Committee so as to align it more closely with the Imperial Engineering Departments.

As the temperature in London drops and the nights draw in CGCA will continue to provide a link between memories of life at Imperial and some of the College's current developments.



**David
Nethercot**



**John
O'Reilly**

PRESIDENTS REPORT

It was an honour to be asked to undertake the office of President and I look forward to the next two years and the opportunity to closely interface with the Institution where I enjoyed four happy years, albeit half a century ago, and to continue to ensure that the RSMA gives the students the support and mentoring that they deserve, as well as maintaining and fostering the links between members of the Association.

Whilst the RSM has undergone enormous changes in the last few years in line with major changes in both the global mining and petroleum industries but more particularly within Imperial College, a key objective of the RSMA remains as embodied in the 100 year old constitution i.e. "to foster an enduring link between members of the Association and with the staff and students of the RSM thereby providing comradeship and a source of mutual help and advice". In this vein, a careers day is planned with the students, faculty members and RSM alumni and will take place in November, dependent on the college calendar. It will also be an opportunity to discuss with the students the importance that the RSM may play in their lives and the significant part that the RSM has played in the history of mining and associated industries. The significance of De la Beche and Bessemer and the busts of Beit and Werner, guarding the RSM entrance, are probably not at the forefront of students' current interests but their significance in history is unique.

Hopefully by the time the IE is issued, all RSM alumni on the college database will have received a letter promoting our current membership drive. **If the RSMA is to survive as a credible body then we need the financial support of alumni.** The RSMA relies on this generous support so I would ask all to give careful consideration to the appeal as outlined in the letter. With increasing costs, the necessity for increased funding is an inevitable consequence. We will be utilising social media (LinkedIn, Facebook) to better interface with alumni and to hopefully resurrect old friendships whilst at the same time promoting better awareness of the RSMA.

At the last AGM in June the committee approved two additional offices, Membership Secretary and Vice-President, International. Coen Louwarts, a past-president, was elected to the former role and John Sykes, a former Vice-President, now based in Perth, Western Australia, to the latter. The Membership Secretary role will improve the communications with RSMA members and provide a focal point for any membership issues that require addressing, and for ideas, complaints etc. that need to be brought to the committee's attention. John, in his new role, will greatly enhance the ability for interaction between and with overseas alumni and his social media skills will be invaluable!!

I would like to thank Mark for his work over the last two years which he has superbly managed despite a gruelling work schedule and a new baby boy, and the rest of the committee for their efforts. Most also have full time occupations, often involving extensive travel, which makes their commitment even more appreciated. As ever, a special thank you to Teresa for her unstinting efforts and support.

The RSMA website (www.rsm-association.org) has recently been given a face lift, and many thanks to Elly Jay for her great efforts in undertaking the bulk of the task, which will also enhance the communication with members.

The annual final year student Bar-B-Q was held in June, following the AGM, and Eddie Gadd helped calm the nerves of those awaiting their exam results with his donation of a keg of Ramsgate brewery's finest ale. It was good to see in attendance at the AGM a couple of my contemporaries from the 60's in Tom Pugsley, visiting from Toronto, and Jeff Bennett, slightly more local.

The annual dinner this year will be held on 29 November at the Rembrandt Hotel, 11 Thurloe Place Knightsbridge (opposite the V&A and a short walk from South Kensington underground station). The Polish Club which we have enjoyed for many years is presently undergoing a major refurbishment. A booking form can be found on the back of the magazine's address carrier, and the sponsorship of students will, as ever, be very much appreciated.

The student executives for this year are Emily Pennington, President, and Jack Judd, Honorary Secretary, and the committee looks forward to working with them.

If any alumni have ideas or comments to improve the service that the RSMA provides, they will be most welcome.

City and Guilds College Association

Keeping in Contact

As an Alumnus of Imperial College you have an entry in the College Alumnus System. The Association uses the entries for our members on this same system to track memberships, subs payments and to stay in contact with you. The mailing list for IE is an extract from this system.

If you haven't already, you can register for online access to the Alumnus System. This enables you to maintain your own information and to search for colleagues and friends. Indeed a new facility has been added solely for the use of Association members so you can search for other members using criteria like name, department, year at college and current location. Of course the search is only as good as the information that members supply, hence the importance of keeping your information up to date.

To register go to <http://imperial.ac.uk>, select the Alumni tab on the options across the top of the screen and to the right of the screen you'll

see the 'register' option. Just follow the instructions and you'll have an online account set up!

When you have an online account, go to the same site, again take the Alumni tab but this time take the 'login' option. Once logged in you will see the new search CGCA specific search option towards the bottom of the screen. Also on the screen that comes up after login there is a 'manage my account' option and this allows you to keep your address and other details current. Note that when updating your details virtually every entry has a 'Make Private' flag in the right hand column. If you select this the information to the left will not be available to other CGCA members in the members search facility. For example if you mark your country in your postal address as private then your record will not be returned to other members when they search for people in that country, so consider these flags carefully!

CGCA Web Presence

CGCA web presence continues to support our communications with members.

The CGCA Website at <http://cgca.org.uk> provides information about the Association, the events we have planned and allows non-members to submit a membership application on line. Over 25 new members have joined us this way so far. The site also has a special area designed to provide information specifically for current students. This area allows students to take up the offer of free membership while they are at College. The Old Centralians' Trust has also added an online form for students to apply for a grant from the Trust. The facility includes a full

online review process for the Trust Board to efficiently look at and vote on the applications, enabling us to respond more quickly to requests.

The LinkedIn group continues to attract new members. (Note the CGCA LinkedIn Group is open to anyone who is or could be a member of the Association.) We have 925 Group members as of 17th September. All Group members can create and join into discussions. Go to <http://linkedin.com> and create a LinkedIn account if you do not have one, then once you have an account search the Groups List for 'City & Guilds College Association' to find us and join in.

Imperial ENGINEER to become online only

The cost of sending Imperial ENGINEER by mail has been rising steadily. At recent CGCA committee meetings it has been resolved that CGCA members who pay annually, but less than the correct amount of £15, will receive some or all editions of Imperial ENGINEER via email instead of in the post. Those paying £10 or more will get a printed copy of the Spring edition but their Autumn one via email. Those paying less than £10 will get both editions via email only.

It has also been decided that Life members who wish still to receive Imperial ENGINEER in the post must 'opt in' to do so. Otherwise it will be assumed that they are happy to receive all editions of the magazine via email.

If this affects you then it is important that we have your correct email address. Please review your contact details on the Imperial College alumni database (go to <http://www3.imperial.ac.uk/alumni>).

If you'd prefer always to receive a printed Imperial ENGINEER then please note the following. If you have an annual standing order of £15 then you need do nothing. If you pay less than that, then please adjust your Standing Order to be £15. If you are a Life Member, please email cgca@imperial.ac.uk (preferably quoting your eight digit membership number, on the A4 sheet which came with this edition) and let us know you wish to continue to receive the magazine in the post.

100th Dinner

The 100th Dinner was held at The Mansion House on Friday, 17th May 2013 with over 250 members and guests in attendance, including The Lord Mayor of London, Alderman Roger Gifford. From the welcome reception and organ recital when entering the banquet hall, through a 3-course meal with fine wines, and set of lively and inspiring speeches, the splendid venue gave a superb evening to all!

A key point was the announcement by Professor Magee, Dean, Faculty of Engineering, that the City & Guilds name will return to the South Kensington campus with the Mechanical Engineering building being renamed as the City and Guilds Building. The announcement was greeted with loud applause from the diners, particularly from the several representatives of the founding Livery Companies present.

The speeches by Sir John Parker, President, Royal Academy of Engineering and Professor Sir Michael Sterling, Chairman, Science and Technology Facilities Council which ranged broadly across the issues facing engineers today, both challenged and entertained those present.

Bo was on hand outside as diners arrived, bolt and spanner joined the dinner and CGCU President, Temi Ladega led the Boomalaka, reminding all present of student days at College.

From the top: Professor Magee and Sir John Parker arrived in Bo.

Spanner and Bolt bearers led the procession.

David Nethercot and his wife welcomed the guests including immediate past president Chris Hankin, Chairman of the OC Trust Board Chris Lumb, and our very own Colleen Shilstone Richardson.



Lam Gordon Kam



Xiaojie Wang



Lam Gordon Kam



Lam Gordon Kam



Xiaojie Wang

CGCA AGM

The CGCA Annual General Meeting was held on 4th June 2013 at Imperial College and was attended by over 30 members. Professor Anthony Bull, head of Imperial's Department of Bioengineering, was the guest speaker and gave the audience a vivid presentation on research helping people to survive blast events, as well as the need for professional recognition of Bioengineering.

The key item in the AGM itself was the proposed change to the Association's constitution. The General Committee had recommended a shift from having

representatives for year ranges, e.g. 2002-6 to representatives aligned to Faculty departments. This was presented to and unanimously agreed by the Meeting. This change now needs to be reflected in the Constitution and the Meeting also agreed that the General Committee should be the body to draft and review those changes, coming back to the 2014 AGM with a recommended revised wording.

After the AGM most attendees adjourned to the Queen's Tower Rooms for the President's Evening to enjoy a very sociable hot supper!

CITY & GUILDS BUILDING



Lam Gordon Kam

Mansion House was a splendid venue for the 100th Dinner



Lam Gordon Kam

CGCA President David Nethercot



Photographs: Sean Conner



Lam Gordon Kam

The Lord Mayor of London, Alderman Roger Gifford



Lam Gordon Kam

Sir John Parker



Lam Gordon Kam

Professor Sir Michael Sterling



Xiaojie Wang

Professor Jeff Magee



Lam Gordon Kam

CGCU President Temi Ladega



Xiaojie Wang

The Lord Mayor complimented CGCA on its wine cellar!

On Wednesday September 18, 2013, Imperial marked the launch of a major redevelopment programme for what we all knew as the Mech. Eng. building, due to be completed in 2017. It has been renamed the City & Guilds Building in recognition of the historic connections with City & Guilds. The current building was built in the early 60s on the site of the former City & Guilds College building of 1885. The City & Guilds College was founded in 1884 by the City of London Livery Companies. In 1907 it merged with the Royal School of Mines and the Royal College of Science to form Imperial College London.

Sir Keith O’Nions, Imperial’s President & Rector, and Sir John Armit, Chairman of the City & Guilds of London Institute, both spoke at the naming ceremony.

Sir Keith said: “We are proud of our historic connections with City & Guilds, which pre-date the founding of Imperial College. It is wholly appropriate that we acknowledge this legacy. The Royal School of Mines and Royal College of Science already have permanent homes in South Kensington. We are completing the historic picture with the City & Guilds Building.

“The work that takes place here, within the Departments of Mechanical Engineering and Aeronautics, epitomises what makes Imperial great. The engineers, students, technicians and support staff working here are world-class; they deserve world-class facilities.”

Sir John spoke about the work of the City & Guilds of London Institute as a pioneering provider of vocational education that still maintains deep links with Imperial.

He said: “City & Guilds and Imperial are two organisations that will play important parts in the future of the UK, and they are bound together by a shared past. City & Guilds is the leading name in technological and vocational qualifications, while Imperial leads the world in engineering.

“I am delighted to see that Imperial’s engineers still call their student body the City & Guilds Union, and that Imperial’s City & Guilds College Association is thriving with more than 4,000 alumni members. The naming of this building cements our historic connections.” The refurbishment of the building will provide new study and breakout spaces for students, improve all learning areas, upgrade the research environment, refresh administrative facilities and update the core infrastructure. Specialist facilities will include two new wind tunnels capable of producing 100mph wind speeds for use in research and teaching.

The City & Guilds Building’s Exhibition Road façade will be completely modernised, showcasing a flight simulator alongside other elements of the College’s work to passers-by.



Sir John Armit speaking afterwards with Morton Neal

Royal School of Mines Association

RSMA AGM

On 27th June the RSMA held an Extraordinary General Meeting to introduce two new positions into the committee structure, followed by the Annual General Meeting at which the officers for the new academic year were elected. Those elected were:

Officers

President:	John O'Reilly (Metal 66, 67)
Senior Vice-President:	Eleanor Jay (Materials 08, 12)
Junior Vice-President:	Tim Cotton (Min Res 93)
Past-President:	Mark Burrige (Geology 90)
Hon. Secretary:	Paul Holmes (Min Res 94)
Hon. Treasurer:	Daniel Hill (Earth Sci 09)
VP International:	John Sykes (Earth Sci 06)
Membership Secretary:	Coen Louwarts (Earth Res 96)

Committee Members

Members:	Lorraine Craig John Monhemius (Metal 75) Rees Rawlings (Metal 64, 67) Liv Carroll (Earth Sci 01) David Bishop (Metallurgy 70) Emily Pennington (President RSMU) Jack Judd (Hon. Sec. RSMU) Luc Vandepierre (EDU 08) Matt Cockayne (Geology 99, 01) Hannah Bungey (Earth Sci 12)
Overseas:	
Canada:	Giles Baynham (Min Res 95)
Australia:	Leah Glass (Earth Sci 06)

RSMA Trust Board

Chairman:	Prof. Rees Rawlings (Metal 64, 67)
Members:	John O'Reilly (Metal 66, 67) Fiona Cassidy (Metal 78) Coen Louwarts (Earth Res 96) David Bishop (Metal 70)
Trustees:	Prof. John Monhemius (Metal 75) Daniel Hill (Earth Science 09) Paul Holmes (Min Res 94) Emily Pennington (President RSMU)
Hon. Secretary:	Glynne Lloyd Davies

We will soon have some limited opportunities to advertise in Imperial ENGINEER.

Our readers include many of the best engineers in the world.

If your business wants to reach this audience of professional engineers, please contact the editorial team for details and a rate card.

New RSMA President

We asked John O'Reilly, the new RSMA President to introduce himself.

John O'Reilly MSc, DIC, BSc(Eng), ARSM, FIMMM
Age 68.



Attended RSM from 1963 to 1967. Graduated in Metallurgy in 1966 and then completed the Mineral Process Design MSc course in 1967. Vice-President of the RSM in 1966-67. Captained the RSM rugby club in 1964-65 and captain of IC rugby in 1966-67 ("got an MSc whilst playing rugby and other non-academic pursuits"). Played in four consecutive winning Bottle Matches, which was rare in that era.

On leaving college took the well trodden route to the Copperbelt in Zambia to join numerous RSM contemporaries, working there for six years, aside from an 18 month secondment to Iranian Selection Trust at Sar Cheshmeh. Got married whilst in Zambia. Moved from Zambia to Selibe-Pikwe in Botswana where stayed for four years and two children born in the Selibe-Pikwe "clinic". From Africa, in 1977 it was back to Sar Cheshmeh in Iran until the Ayatollah dished out the red cards. Witnessed the revolution in Tehran from the inside. After Iran, a short hop across the Gulf to Oman to run Oman Mining until 1987.

Returned to the UK in 1987 to join RTZ (Rio Tinto) Technical Services in Bristol. In 1993 despatched by Rio Tinto to Papua New Guinea, responsible for the construction, commissioning and initial operation of the giant Lihir Gold Mine in which Rio Tinto was the major shareholder. Following the success of Lihir, returned to London in 1998 as Head of Gold & Other Minerals for Rio Tinto and in 1999 switched hats to Head of Technology for the group. Sat on the Rio Tinto board committee for Social and Environment Accountability.

President of MIRO, UK (Minerals Industry Research Organisation) from 2003 to 2006.

Retired from Rio Tinto in 2005 and now spends his days between travelling, his grandchildren and the golf course.

A Global Village

You may notice at the end of the Big Data and Privacy feature, a note that a previous version appeared in *A Global Village*, but you may not be aware what that is. It is Imperial College's publication on International Affairs. There is huge interest and appetite around the College for international issues – more specifically the interface between science and technology, policy, politics and implementation. It should equally appeal to alumni.

The publication offers original insights to both the Imperial College community, and external industry experts and policy-makers, and tackles a broad range of issues from energy and environment to agriculture and development, economics and finance, global health, and geopolitics. Through emphasis of the wider context in which science takes place, *A Global Village* provides a platform for scientists to engage with current global challenges. It attracts article contributors of the highest calibre from advanced undergraduates to established academics and external experts. The developing reputation has spread to other universities both in the UK and abroad.

The print journal is published three times a year – in January, May and October – with an annual print circulation of 10,000 copies. It is distributed freely on the Imperial College campuses and at select external events, as well as online. In parallel with the publication of the journal, *A Global Village* promotes dialogue on science policy and global issues through hosting a series of events and attracting high-profile speakers to Imperial College.

The vision for *A Global Village* is to provide a platform for scientists to communicate the relevance and applicability of their work to the greatest global challenges currently facing mankind, and to enable them to directly impact implementation and policy decisions. In the long term it is hoped that *A Global Village* will make a meaningful contribution to dialogue and debate for science-related policy issues, questions in which Imperial College plays a prominent role, and inspire a new generation of global innovators.

You can read *A Global Village* online at <http://aglobalvillage.org/>

Short URLs at the end of news items enable you to read the full story online. All the news links in this issue can also be found in our IE19 bundle at:

<http://bit.ly/IE19links>

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Manufacturing Futures Lab

Launched in June, the Manufacturing Futures Lab (MFL) is bringing together experts from around Imperial who are working on developing technologies and processes that will make manufacturing in the UK more efficient, cost effective and ultimately more profitable. Along with industry and the Government, researchers at the Centre are also aiming to turn research ideas into new businesses.

Academics at the MFL are focussing on a range of projects including ways of making stronger, more durable parts for cars and aircraft using less material and energy.

Professor Jianguo Lin, from the Department of Mechanical Engineering, and his team combine two processes in one, where aluminium alloy is heated and stamped into a shape to make a part. Heating the alloy makes it more malleable, which means that it can be formed into shapes that are much stronger. The MFL is supporting Professor Lin in his efforts to commercialise the technology, which will be licensed to manufacturers.

Other research programmes underway at the MFL include creating ways of mass producing microscopic 'factories' made from bacteria and DNA, to produce new drugs and fuels; exploring the structure of the wonder material graphene, to harness its unique qualities; and developing new ways to manufacture electronics as well as creating more sustainable types of feedstock.

"Manufacturing currently only accounts for nine per cent of the UK economy, which is dismal by world standards. The average size of a manufacturing business is around 14 employees, which demonstrates that we have become better at craft industries such as making bicycles than developing the hi-tech industries that make products like iPhones," said Professor Nilay Shah, Director of the Manufacturing Futures Lab, from the Department

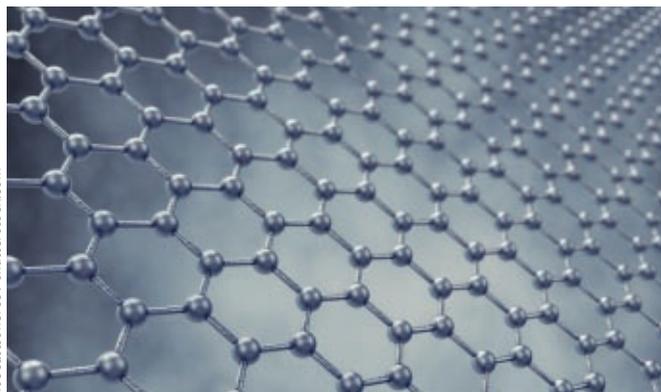
of Chemical Engineering.

"The challenge now lies in the UK's ability to industrialise on a large scale. It's true that industries can't go back to the old days of making cost intensive, low value machinery such as ships. What we need to be developing are innovative processes to improve industries or creating the next Samsung or Apple corporations – hi-tech industries that will generate long-term wealth and employment for the country.

"We believe that the Manufacturing Futures Lab will provide an important focus, helping to nurture and grow the next generation of businesses to help the country make a transition to a rebalanced, stronger economy."

For the past 40 years the UK has been focussing on growing business such as finance and insurance. An over reliance on these service industries has made the UK economy vulnerable to external shocks such as the 2007-2008 financial crisis. The UK government is now working towards rebalancing the economy, with a greater emphasis on developing hi-tech industries that can compete with economies in the developed world. Imperial is working with the Government and industry and harnessing its considerable research expertise in advanced manufacturing to help meet this challenge.

"The UK cannot compete with developing economies that can produce products at low cost because of lower wages and living standards. The MFL aims to promote manufacturing technologies where the UK has a clear scientific advantage. Ultimately, this will see the production of high-value products that are developed by a skilled, well paid workforce. Researchers at the MFL are already working on a range of projects that should lead to jobs and prosperity for the UK," added Professor Jeff Magee, Dean of the Faculty of Engineering.



Research includes exploring the structure of graphene

IET Social Fund supports student-run charity



Simon Maddison and Davy Thielens, present the IET cheque to e.quinox chairman Rushabh Mehta

In the Autumn 2012 edition of Imperial ENGINEER (IE17) we featured the work of BBOX, a company started by three of the founders of the e.quinox charity at Imperial to take the non-profit concept of e.quinox to the next level.

e.quinox is a student-run social enterprise that works to bring sustainable and scalable clean energy solutions to developing countries. It was founded in 2008 by Engineering Students from Imperial and has grown to provide electricity to an estimated 4,000 people in East Africa, running 5 energy kiosks and one standalone solution. The organisation is completely open-source and aims to develop 'blue-print solutions' that local entrepreneurs or external entities can replicate themselves, which allows e.quinox's ideas to have an even larger impact on the energy landscape in the developing world. The organisation is founded on innovation and the e.quinox team continues to develop new rural electrification solutions, collecting data from each project and making it available for anyone willing to replicate e.quinox's ideas.

Earlier this year, the IET's London Network decided to make a significant donation of £7000 from its Social Fund to e.quinox. The former IEE London Branch's Social Fund had been dormant for some time, and it was decided to donate to a worthy cause consistent with the Institution's aims of promoting the engineering profession and developing students and young engineering professionals.

"We looked at various possibilities, and after careful deliberation decided on e.quinox. We were particularly impressed for several reasons," says Simon Maddison (Elec Eng 70, Computing 73), past chairman of the London Network, responsible for the fund. "This is an entirely student initiated and run activity. They have been proactively bringing original

solutions to rural power in Africa. The credibility of the scheme has become such that it is now officially advising some governments as to power policy. The solutions are highly practical, genuinely sustainable and develop the skills of the local community. We particularly liked the way that a workable business model has been considered from the outset, and that it is 'open source', which they encourage to be freely adopted by others around the world".

Davy Thielens, current Chair of the London Network added "Through this donation, not only do we want to support the amazing work of these talented young people, but we believe that together with the IET we can promote their activities around the world through the Institution's global membership and Industrial partners. We are also very keen to use their initiative to inspire other students and young professionals as a model of what youthful talent and enthusiasm can achieve. We see this as the start of a fruitful long term relationship."

Rushabh Mehta, chairman of e.quinox said: "This donation will be key in enabling the implementation of the latest innovations engineered by e.quinox in its push towards electrification of rural Africa. The funds will be used to launch the 2nd generation of the standalone system, a fully automated rural electrification solution with the largest distribution radius from solutions provided by e.quinox. This will provide basic power and lighting to over 350 more people in Northern Rwanda while providing a platform to serve many more in the future. All the data collected from this venture remains open source allowing other parties to launch similar projects more expertly, and with maximum impact. The donation allows e.quinox to expand the range of solutions that it provides and help more people light up their homes."

www.e.quinox.org

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Researcher names fossil after Johnny Depp

The 505 million year old fossil called *Kooteninchela deppi* (pronounced Koo-ten-ee-che-la depp-eye), which is a distant ancestor of lobsters and scorpions, was named after the actor Johnny Depp for his starring role as Edward Scissorhands – a movie about an artificial man who has scissors for hands.

Kooteninchela deppi is helping researchers to piece together information about life on Earth during the Cambrian period when nearly all modern animal types emerged.



Imperial College, London

David Legg, who carried out the research as part of his PhD in the Department of Earth Science and Engineering, said, "When I first saw the pair of isolated claws in the fossil records of this species I could not help but think of Edward Scissorhands. I am also a bit of a Depp fan and so what better way to honour the man than to immortalise him as an ancient creature that once roamed the sea?"

Kooteninchela deppi lived in very

shallow seas, similar to modern coastal environments, but the sea temperature would have been much hotter than it is today.

David believes that *Kooteninchela deppi* would have been a hunter or scavenger. Its large Edward Scissorhands-like claws with their elongated spines may have been used to capture prey, or they could



David Legg

have helped it to probe the sea floor looking for sea creatures hiding in sediment.

Kooteninchela deppi was approximately four centimetres long with an elongated trunk for a body and millipede-like legs, which it used to scuttle along the sea floor with the occasional short swim. It also had large eyes composed of many lenses, like the compound eyes of a fly. They were positioned on top of movable stalks called peduncles to help it more easily search for food and look out for predators.

Energy Futures Lab students rock Blue Peter

In our last issue we reported on the Racing Green Endurance team's SRZero electric car. Another team in the Racing Green project has been developing a zero-emission hydrogen fuel cell powered generator over the last five years. As well as contributing to the electric vehicle project, it enables the students to raise public awareness about the environmentally friendly technology they are developing.



Imperial College, London

One such opportunity was afforded recently, when PhD students Billy Wu, Michael Parkes and Sam Cooper took their generator along to the BBC's Energy Day. By playing their electric guitar, powered by the prototype generator,

live on the world's longest running children's show, Blue Peter, and on the BBC Breakfast programme, they demonstrated how their sustainable generator could replace the noisy and environmentally unfriendly diesel generators typically found at music festivals.

Held at Media City in Salford, the BBC's Energy Day showcased sustainable energy technologies to the public. Billy Wu says: "The BBC is a great platform for public outreach and I think we generated a lot of awareness of hydrogen fuel cell technology."

One of the highlights of the day for the team was appearing on Blue Peter, the iconic children's television show. Michael Parkes was interviewed by hosts Barney Harwood and Lindsey Russell and got to play some tunes on his guitar. "It was great being interviewed on a show that many of us grew up watching," said Michael.

You can hear more about the project in the Imperial Podcast at:

<http://bit.ly/IEI9EFL>

Imperial team complete zero emission race



Victor López Photography

A team of third and fourth year undergraduates from the Department of Mechanical Engineering came seventh in the Isle of Man TT Zero race this summer. The race covers a 37 mile circuit considered to be one of the most gruelling races for electric motorbikes.

For the past four years, consecutive Imperial teams have tried to take part in the race but with limited success. Two years ago the bike did not complete a lap; last year, upgrades to the bike weren't ready in time to take part. This year it was looking like bad luck had struck again when their rider Antonio Maeso broke his leg two days before the race, but they soon had offers from many other riders. Luke Foreman, fourth year undergraduate from the Department of Mechanical Engineering, said "Antonio recommended David Madsen-Mygdal, who is a TT legend, has experience riding electric bikes, and holds the record for the amount of TT finishes, which made him a great choice."

More than 80,000 visitors lined the course to watch teams from around the world compete. "The most nerve-wracking part of the race was when the bike was out racing," said Luke. "For the rider I think the whole course is pretty extreme with lots of hills and a particularly difficult 'hairpin' corner, which presented a real design challenge. When the bike finished the race we were all ecstatic! We had a lot of mechanical problems during practice, but everything worked perfectly during the race. We were in a state of disbelief when we saw the bike reaching the finishing line."

The challenge for the team was fitting enough batteries into the bike so that it had the power to make it around the track, while keeping under the weight limit and enabling it to be handled effectively by the rider. Too many batteries can make the bike very wide at the bottom, instead of being the conventional V-shape which is better for handling on corners.

The team overcame this problem by reducing the spacing between the batteries to make the pack smaller. They also moved the battery pack higher up to avoid it scraping along the road during sharp turns.

Imperial was one of only four university teams to compete and the only team who uses this project to contribute towards their undergraduate degree in mechanical engineering. The project is helping successive groups of students in the Department of Mechanical Engineering to learn more about building low emission vehicles for the future.

As soon as the group returned to Imperial they had to write reports, make presentations and discuss their work, which is graded, making up a large proportion of their marks for the year.

Encouraged by their success, the team are discussing plans for the future. They collected data to use in developing the bike and they are hoping to secure some funding to buy new motors and components to improve the bike's performance. "Now we know what we are doing and what level we need to compete at, there is definitely scope for Imperial to do much better in future years," Luke added.

Computing 2nd in UK rankings

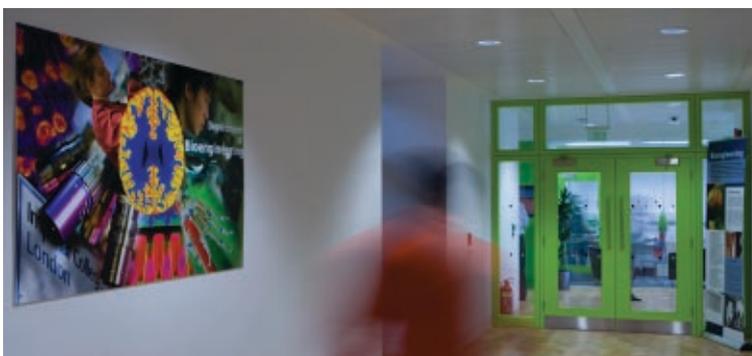
The Department of Computing has traditionally done very well in the annual rankings of UK universities, and this year is no exception. The Complete University Guide and Times/Sunday Times both rank us 2nd (behind Cambridge), while The Guardian ranks us 3rd.

The rankings are based on a range of criteria, including entry standards, student satisfaction, staff/student ratio, academic services and facilities expenditure per student, research quality, proportion of Firsts and 2:1s, completion rates and student destinations.

Anthony MJ Bull (Mech. Eng. 95), Head of the Department of Bioengineering

New Kid on the Block

The societal drivers for major activities at the interface of engineering, medicine and biology are known to us all. These include rising fertility, rising life expectancy and thus huge increases in total population size. Within this growth are the hidden factors of an increase in the proportion, and absolute number, of older people. When combined with an



obesity epidemic in the developed world, and a substantial increase in musculoskeletal problems due to inappropriate physical activity in some subsets of the population, there arise some significant medical issues. The major medical challenges facing society currently, and that are projected to increase exponentially, are chronic conditions (for example, diabetes), dementia (most commonly Alzheimer's), and musculoskeletal pain (for example, due to osteoarthritis). It is, therefore, clear that we need to engineer devices, constructs and interventions for human health. This is my definition of *Biomedical Engineering*.

We are also living in an age of tremendous change in the life sciences: the human genome has been sequenced, new experimental techniques are coming online with great regularity, and engineers are getting involved. The opportunities in the life sciences, when combined with engineering and design technologies, are huge. For example, the precision control of biological matter at the very small scale is likely to change the way we produce very many things, such as fuels, materials and drugs. The new field of synthetic biology allows us now to conceive of a day when we will design living organisms for specific tasks in a scalable manner. Engineers, therefore are engaging in *solving problems related to the life sciences and/or the application thereof*. This is a definition of *Biological Engineering*.

Once engineers start getting to grips with biology, physiology, and anatomy, then new ideas arise. For example, Dr Rodriguez y Baena from Mechanical Engineering has taken inspiration from a wood wasp to develop a surgical drill that does not use rotary motion or impaction. He has found a new technical solution for human application

from this biological system that has developed an efficient engineering solution. Engineers, therefore, can *find ways in which the structures and functions of living organisms can be used as models for the design and engineering of materials and machines*. This definition of *Biomimetics* or *Biologically Inspired Design* is the third main pillar of the discipline of *Bioengineering*.

This new discipline of Bioengineering, which incorporates these three main areas, is thriving at Imperial College and has a strong pedigree going back fifty years. In the 1960s three research groupings formed: the Engineering in Medicine Laboratory in Electrical Engineering (1963), the Biomechanics Laboratory in Mechanical Engineering (1966), and the Physiological Flow Studies Unit based in Aeronautics (1966). Two of these merged in 1989 to form the Centre for Biological and Medical Systems that in 1999 was given Departmental status. In 2001 the Department was renamed the Department of Bioengineering – the newest Department at Imperial. As befits a Department at Imperial, we are taking a national leadership role in the discipline of bioengineering in both research and teaching and now have thriving MSc, MRes and PhD programmes at the postgraduate level and have the largest UK Biomedical Engineering undergraduate programme.

As the discipline is still embryonic in the UK, there are some significant challenges facing bioengineers. The first is quite simply a lack of recognition. Some may argue that bioengineering is not yet a profession, yet if one looks at the some of the key features of a profession – education and training activity, accreditation of degrees, regulation and protection of professional titles, strong industry and research base, recognised history, and presence in league tables – then it is clear that

bioengineering has 'arrived'. The Department established the UK Bioengineering Society in 2008. This learned society has a few hundred members and is now working with appropriate engineering institutions to accredit undergraduate bioengineering degrees. We also play a leading role in the Royal Academy of Engineering's only special interest group – reflecting the

importance of the discipline – the RAEng Biomedical Engineering Panel. There are approximately 5000 chartered engineers in the UK who would call themselves biomedical engineers, bioengineers or medical engineers and the US Bureau of Labor Statistics ranks biomedical engineering as the most valuable degree, with the discipline projected to grow the fastest of any profession over the next five years. The medical devices sector in the UK currently has a turnover of approximately £15 billion and employs approximately 70,000 people, mostly in SMEs. Research league tables rank the UK as third in the discipline (source: SC Imago Country Rank), and the department at Imperial as top in the UK and fourth in the world (source: <http://bit.ly/IE19BioRank>).

It is in the context of this fantastic position



Photographs: Imperial College, London

that the Department at Imperial is now embarking on a new phase in its lifecycle by consolidating its research excellence and providing growth and leadership in new areas such as Cancer Engineering, Neurotechnology, and Synthetic Biology. This will inevitably involve some growing pains as the limitations of space and being ahead of the curve in terms of national funding priorities will have to be addressed. We are confident of tackling these issues successfully not only from an Imperial perspective, but also for the discipline as a whole. Therefore, from its embryonic beginnings fifty years ago, the Department can foresee a strong and healthy future in which staff and students are addressing some of the major issues facing society. We all look forward to the next fifty years.



Anthony Bull is a graduate of Mechanical Engineering at Imperial. After completing his sponsorship duties with Ford Motor Company, he returned for a PhD in Biomechanics, and then after a series of postdoctoral positions, moved to the Centre for Biological and Medical Systems in 2000. This Centre became the Department of Bioengineering and Anthony was appointed Head of Department in 2012.

Big Data and Privacy

It is claimed that 90% of the data in the world today has been created in the last two years. This explosion in data offers new opportunities but also presents tremendous challenges. The opportunities include the generation of new services to enhance quality of life. The challenges arise from the varying sources of data, uncertainty about their provenance and finding ways of extracting information/knowledge from the data and visualising it in ways that are fit for purpose. Overlaid onto these issues is that of personal choice and privacy. Do you want *them* knowing all there is to know about you? Or maybe you don't care? The reactions on all sides generated by the Edward Snowden PRISM revelations show that there is still a great need for debate over the security/privacy balance.

Of course data is one thing, but information and thence knowledge and understanding are quite another. Throughout history, and latterly through scientific disciplines, mankind has sought to make sense of its surroundings. In recent times these *physical* surroundings have moved into the *virtual* or cyber world, presenting massively enlarged data spaces beyond what could be captured, processed and recorded in previous times. The cyber world now contains all sorts of data and virtual manifestations of physical reality, as well as some unique to cyber space.

UK government interest in the data explosion can be traced back to the late 1990s when the anticipated arrival of the Large Hadron Collider provided one of the motivations for the Research Councils' e-Science programme. In the security context the myriad of data that supported the post-9/11 terrorist investigations led the newly formed US Department of Homeland Security (DHS) to sponsor the emergence of the new discipline of Visual Analytics.

Visual Analytics (VA) is the science of making sense of large data sets, that through the use of interactive visualisation and query through semantic extraction and data fusion technologies, supports the analytic reasoning process. Activity in the US has been orchestrated through the National Visualization and Analytics Center (NVAC, based at Pacific Northwest National Laboratory) which has engaged universities through DHS-funded academic Centres of Excellence at Purdue and Rutgers Universities. Since 2009 this activity has included an international collaborative effort with a UK consortium (UKVAC), of which Imperial's Institute for Security Science & Technology (ISST) is a founding partner.



Imperial College, London

VA is the use of interactive visualisations to support the human analytic reasoning process, with tools that facilitate dynamic query, analysis, hypothesis formulation and testing, collation and marshalling of evidence for sense-making (colloquially referred to as 'joining the dots'). VA also requires strong algorithms for 'smart' information retrieval, extraction, and concept searching, and new data structures to support data handling, provenance, ad-hoc querying and methods for handling missing data and uncertainty. VA provides the framework for combining data, visualisation and human sense-making aspects to create integrated workspaces for analysts.

Within the ISST, we concentrate on the data analytics components of VA. We are dealing with data that is incomplete, sometimes unreliable and internally inconsistent; it is a mix of data that includes structured and unstructured text, still and video images, audio feeds and computer media. We have developed new algorithms for abstracting the data and analysing relationships in the data. For example, one abstraction is based on clustering and leads to algorithms for detecting sub-communities. It is then possible to study how these evolve and try to identify which external triggers cause individuals to migrate between communities.

In the national security context, VA could be used legitimately by authorities, under warrant, to tap into private communications and databases as part of intelligence-gathering for countering crime and terrorism. But access needs to be tightly controlled. In the UK this has been written into law through RIPA – the Regulation of Investigatory Powers Act 2000, which sets out the law regarding intercept and surveillance, and the limitations on what can be gathered by the authorities and the use to

which it can be put.

But those concerned with civil liberties question the role of secret intelligence in an open society. As Brill (played by Gabriel Byrne) in the Hollywood film *Enemy of the State* (1998) says: *How do we draw the line – draw the line between protection of national security, obviously the government's need to obtain intelligence data, and the protection of civil liberties, ...*

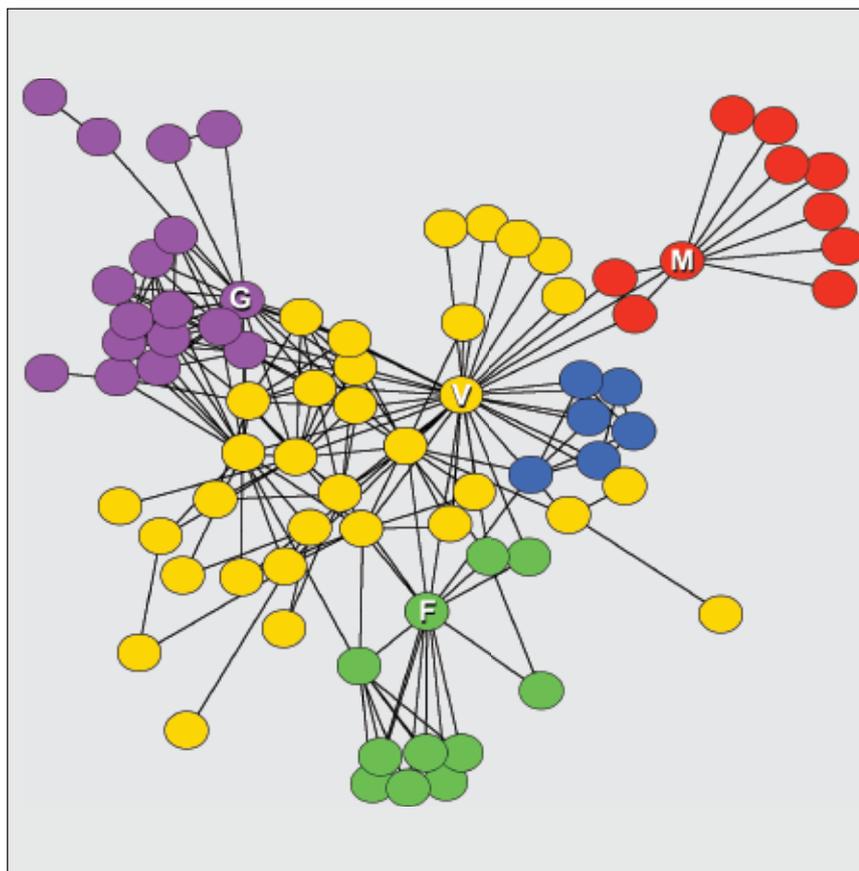
This is a question which is worthy of some debate. With the data explosion, and our increasing abilities to automatically mine and make sense of it, it is not only governments but also big corporations and even other individuals who want to derive value from using our data (assuming, of course, that we can regard it as *ours*), most often for commercial advantage

but with the threat of a surveillance society hanging over us. The challenge is to balance the protection of the state with the protection of civil liberties.

The quote from Brill continues: *... particularly the sanctity of my home? You've got no right to come into my home!*

Yet the European Electricity and Gas Directives mandate the deployment of smart meters in every domestic setting by 2022. Each of those will publish half-hourly read-outs of energy consumption to the energy provider but will be capable of much greater data gathering. A newly published report by the House of Commons Energy and Climate Change Committee supports the ambitions for UK roll-out, but cautions that "consumers must actively and positively engage with them."

One of the earliest attempts to gather and operate on big data was the US program for Total Information Awareness (TIA, which might be viewed as an attempt to realise the fictional capability depicted in *Enemy of the State*.) The TIA program set out, in similar fashion to VA, a requirement to better detect terrorist operations and to inform US agencies' responses. The vision was for an 'architecture' capable of integrating many other program outputs which crucially attempted to predict events (incorporating social sciences) rather than simply respond post event. Despite the acronym being redefined as *Terrorist Information Awareness*, due to much adverse publicity (particularly the issue of intrusion and the compilation of dossiers on hundreds of millions of American citizens), the program was terminated in 2003. TIA elements are, though, to be found in R&D programs funded through DHS, the Department of Defense



Community Detection

The use of sense-making tools for the investigation of large datasets is under investigation by researchers in the Institute for Security Science & Technology. Community detection is the term given to uncovering the structure of networks in organised crime and terrorism investigations. The example illustrated takes its data from Victor Hugo's *Les Misérables*.

A partitioning algorithm based on the technique of stability optimisation results in the detection of five communities amongst the 77 characters in the novel. The first is a central community (yellow) containing most of the main plot characters such as Valjean, Javert, Cosette, Marius or the Thenardier. The second community (green) relates to the story of Fantine, the third (red) to Mgr Myriel, the fourth (blue) to Valjean's story as a prisoner which contains other convicts. The fifth (purple) relates to Gavroche, another main character.

This example shows a main community at the centre that seems to connect all the story while satellite communities represent sub-stories. If this were a network of people under surveillance it would reveal a main community of central actors which could be observed over time.

and others. Visual Analytics could be regarded as a direct descendent.

The modern face of TIA is Reality Mining, an increasingly referenced emerging technology defined as the collection of machine-sensed environmental data pertaining to human social behaviour. This goes beyond the *digital footprint* idea (i.e. the collection of information left behind as one navigates cyberspace through on-line activity such as social networking, email, e-commerce, etc.) and into a much finer grained data space, a *digital dust* comprised of almost every instance of a person captured by electronic means (e.g. adding CCTV, on-line photo archives, etc.). The key ingredient in Reality Mining, as it seeks to predict human behaviour, is to factor in the new discipline of Social Signal Processing to enable automatic recognition and interpretation of our non-verbal behaviour as a basis for the creation of a socially sensitive machine. But, at its heart, Reality Mining, despite its benign promise in areas such as predicting the spread of disease based on networks of infection, relies on the collection of enormous amounts of deeply personal information (e.g. employing always-on smart phone cameras and accelerometers),

raising quite naturally the questions of privacy and trust.

Much has been said, recently, about the growing awareness of individual privacy, with more informed choices now possible on settings in social media interaction. But, how much of your personal data are you actually leaving behind as you navigate cyber space? A 2010 survey by internet security company AVG found that 35% of new-borns had an online presence (email, social media, photos, etc.), with 23% having a prenatal presence through their parents' uploading foetal scans to the web.

So what can an individual do if they wish to be 'forgotten'? The European Commission in January 2012 tabled an amendment to Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data. This is urgently required, as existing legislation has not kept pace with technological change, particularly where personally identifiable information is concerned. Included in the proposed amendment would be the ability of a person to have their personal information deleted including, for

example, any photograph of them held on a social networking site. The sanctions for non-compliance could be astronomical with millions of Euros in fines being levied. This offers a severe challenge for data handling organisations, whether in government or in the private sector, and especially as such data is hosted more and more within a cloud service environment. However, the European Parliament has postponed ratification of the amendment several times, with a new date set for October this year to enable amended legislation to be published in early 2014.

Here is a conundrum. To benefit from the promise of extensive machine intelligence, a brave new world of pervasive data is upon us. The mathematics requires more and more data to make the predictions more accurate and informative. If we genuinely wish to live in a carefree world, in a safe, secure and resilient society with automated convenience goods and services, it will only come about through mining private data ... and in huge quantities. Are we ready for this level of openness with our machines?

A previous version of this article appeared in *A Global Village* (<http://bit.ly/IE19BigData>).



CHRIS HANKIN (left) joined Imperial as a Lecturer in Computing in 1984. He has been Dean of City and Guilds College (2000-2003) and is the Immediate Past President of CGCA. Since January 2010 he has been Director of the Institute for Security Science & Technology.

ANDREW BURTON (right) joined Imperial in 2008 as Programme Manager in the newly formed Institute for Security Science & Technology. He worked previously in various S&T Policy roles in the UK Ministry of Defence, and prior to that as a radar systems engineer in the defence industry.



El Hierro

Climatic impacts of the October 2011 to March 2012 El Hierro submarine volcanic eruption

Volcanic eruptions are a natural cause of climate change. However, the study of their climatic impacts has been restricted to sub-aerial volcanic eruptions, while the role of submarine volcanic eruptions has been neglected. This account highlights the October 2011 to March 2012 submarine eruption of the El Hierro volcano located in the Canary Archipelago, off the northwest African coast, in switching on hot seawater in the Atlantic Ocean to act as the trigger for weather-related events or patterns which have occurred within the North Atlantic Basin the same year.

The North Atlantic Oscillation (NAO) is a climatic phenomenon in the North Atlantic Ocean caused by changes in atmospheric pressure at sea level between the Icelandic low and the Azores high. Two extreme phases exist, positive NAO and negative NAO, when the pressure contrast between the two regions increases and decreases respectively. This exerts control on the strength and direction of westerly winds and storm tracks across the North Atlantic, but is variable without any periodicity. The Atlantic Multi-decadal Oscillation on the other hand is a mode of natural variability in sea surface temperatures of the North Atlantic Ocean with a period of between 60 to 80 years. Because sub-aerial volcanic eruptions and submarine volcanic eruptions are responsible for temperature, pressure and humidity changes, they may be important as triggers for weather-related events or patterns within the North Atlantic Basin. This account is a look-back-and-learn



NASA Earth Observatory image

by Jesse Allen and Robert Simmon, using EO-1 ALI data

NASA image of the El Hierro submarine eruption acquired on January 4, 2012

study of one submarine volcanic eruption.

The submarine eruption of the El Hierro volcano, south of El Hierro Island, the smallest and farthest south and west of the Canary Archipelago in the Atlantic Ocean, 460 km west of the coast of Morocco, has been documented by Wikipedia (http://bit.ly/IE19El_Hierro). On October 10, 2011, the shallow underwater eruption occurred 2 km south of the fishing village La Restinga. On that day, patches of pale-coloured and sulphurous smelling seawater with dead fish were reported. Eruption 'jacuzzis', occasionally reaching 10-15 m high above the sea surface, were seen during the most energetic eruptive episodes. A confirmed Surtseyan type of eruption phase started with several plumes aligned along a north to south

fissure on November 7, 2011. On November 25, 2011 the eruption was ongoing with vigorous explosive bubbles emerging. On November 27, 2011 the Spanish coastguard vessel Salvamar Adhara collected pumice clasts, colloquially nicknamed 'floating lava bombs' or 'lava balloons', some of many that had been ejected by the underwater eruption and floated to the surface of the sea before sinking again.

In early December, swath bathymetry mapping revealed the depth of the submarine volcano to be 60 m below sea level. On December 21, 2011 the eruption appeared to be subsiding but activity increased again in early January 2012 with a wider area of the sea producing steaming pumice clasts and 'jacuzzis' activity. During one stage, the seawater was measured to be heated up by 18.8 degrees Celsius above normal and the pH reached a minimum value of 2.8. By late February 2012 a decrease in seismicity, deformation and gas release was noted. In early March 2012, the El Hierro authority declared the eruption to be over.

In mid-April 2012, webcams revealed the top of the cone was at 86 m below sea level. As of June 2012, passive degassing continued at the main Restinga underwater vent. The total volume of lava released by the vents during the submarine eruption was estimated to be 329 million m³ excluding blobs carried away by currents or trundled into deeper water.

The 'sudden' switching on of hot seawater in the southeastern part of the North Atlantic



NASA Earth Observatory image by Robert Simmon

with data courtesy of the NASA/NOAA GOES Project Science team

NASA image of Hurricane Sandy acquired on October 28, 2012

Date	Affected region	Notable weather-related events or pattern
April-July	England and Wales	Wettest summer in England and Wales in 100 years with annual rainfall of 1331 mm (115% above average) and severe flooding
May-August	Central North America	Drought estimated damage US\$30 billion; most severe since 1895
Summer	Arctic Ocean	Record low sea ice
Summer	Northern/central Europe	Abnormally wet summer with moisture able to penetrate the continental interiors
June-November	US east coast	Extremely active hurricane season, tied with 1887, 1995, 2010 and 2011 for having the third-most named storms on record but few made landfall
July	Virginia	Hottest on record
July	Greenland	Period of extended surface melting across almost the entire ice sheet
July-October	Western/central Africa	Abnormally wet with flood conditions
October	US east coast	Hurricane Sandy estimated damage US\$65 billion; 147 fatalities
October	North Atlantic	Tropical storm Nadine tied record for the longest lasting Atlantic storm
November	England	Wettest week in last 50 years with severe flooding
Winter	US east coast	Abnormally cool and wet due to the active polar airstream
Winter	British Isles	Abnormally cold due to the active polar airstream

Summary table of notable weather-related events or patterns in the North Atlantic Basin during 2012 after the switching on of hot seawater in the Atlantic Ocean by the El Hierro submarine volcanic eruption. Based mainly on National Climatic Data Center, the Meteorological Office and the Browning Newsletter

Ocean has three main climatic impacts. First, the hot and low density seawater immediately beneath the surface speeded up the tropical Atlantic currents, rushing the tropical waters northwards. Second, the hot seawater warmed the atmosphere above causing a fall in air pressure to generate depressions. Third, the polar jet stream was drawn further south than normal in the North Atlantic Ocean. Consequently both the 'normal' oceanic circulation and atmospheric circulation were drastically altered. The combination effect is an extremely negative NAO including the development of a 'Greenland block'.

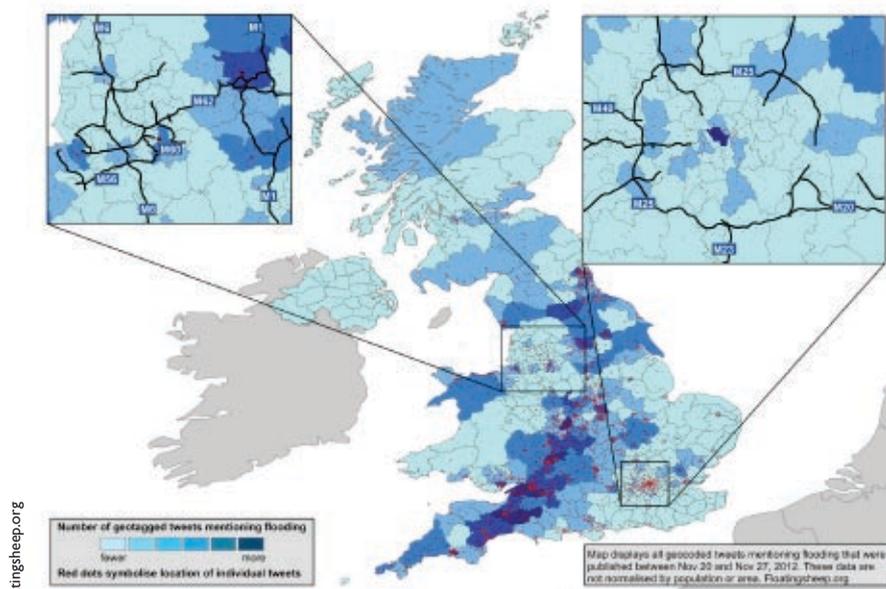
Notable weather events or patterns during 2012 in the North Atlantic Basin are summarised in the Table above.

Because the El Hierro submarine eruption was initiated during mid-autumn 2011 in the northern hemisphere when seawater was already cooling (and seawater is a poor conductor of heat), it took a while for the hot water to have an impact. Hot seawater means lower pressure over the ocean with an increase in the rate of evaporation and the total number of depressions. This was responsible for an abnormally busy hurricane season in the North Atlantic and a long succession of frontal activity storms bringing heavy rainfall to the northern/central Europe during 2012. The summer in England and Wales was the wettest in 100 years, while the wettest week in the last 50 years in England, with severe flooding, occurred in November. The hot Atlantic Ocean also accounted for the record low sea ice in the Arctic Ocean as well as a period of extended surface melting across almost the entire Greenland ice sheet in July 2012 reported in the journal Nature. Away from the Atlantic Ocean, prolonged high pressure conditions led to the severe summer drought over central North America while prolonged low pressure conditions led to abnormally wet conditions

in western/central Africa. In October 2012, Hurricane Sandy, one of the few hurricanes making landfall during the year due to the 'Greenland block', resulted in an estimated damage of US\$65 billion with 147 fatalities.

In this look-back-and-learn analysis of the submarine eruption of the El Hierro volcano it is concluded that we have grossly

underestimated the role played by submarine volcanic eruptions as a trigger of weather-related events or patterns within the North Atlantic Basin. Unlike the conclusions drawn by a number of workers, it is unnecessary to attribute such weather-related events or patterns to anthropogenic global warming.



November 20-27, 2012 tweets on flooding in the United Kingdom



Professor Wyss Yim DSc PhD DIC FGS was at Imperial College in the Department of Geology from 1971-1974. After that he spent 35 years until retirement at the University of Hong Kong where he taught civil engineering, geosciences and environmental management students, and, helped found the Department of Earth Sciences. He was awarded the DSc by the University of London in 1997. Wyss served as the Deputy Chairman and a member of the Climate Change Science Implementation Team of UNESCO's International Year of Planet Earth 2007-2009.

The Engineering Brand

What is an engineer?

At a recent party, I was introduced to some people who asked me what I did for a living. A perfectly reasonable question for a new acquaintance, but one which has always caused me to think twice about how best to describe what I do.

When I describe myself as an ‘engineer’, the usual reaction is one of confusion and surprise, I can see them thinking, “you don’t look like an engineer, where is your site gear? Why are your hands not soaked in oil and mud?”, and then I have to launch into a long explanation of what my job entails.

Putting a ‘brand’ to engineering

This got me thinking about how people perceive careers and the contributions those jobs make to society. We all know what a doctor or a lawyer does. We have an image, perhaps perpetuated by the media, TV shows and movies, of what it means for surgical procedures to save a life, or battles in court to seek justice.

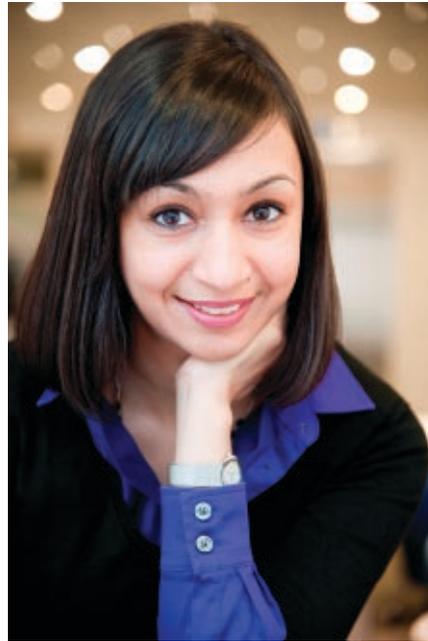
The engineer has no such positive ‘identity’ in the popular consciousness. Perception varies somewhere between a builder, a mechanic and a washing machine repair man (not woman!). This lack of a clear identity deters people from being interested in what engineers do and acts as a barrier for bright young people from different backgrounds seeking the many opportunities and challenges that engineering provides as a career.

We need to create a new brand for ourselves which is independent of stereotypes; one which focuses on the creativity, problem solving, team working aspects and the contribution that we make to our society. This is a massive task, but there are many things we as engineers can do to start this transformation.

Why does it matter?

I remember, when I was looking for summer placements and later for a graduate job, we had a plethora of investment banks, management consultancies, accountancy and law firms approach us during the milk-round. They organised panel discussions, presentations and question and answer sessions to clarify to us what they did, why they enjoyed it and the benefits we could gain from that profession – it left me with the impression that these were my only career options.

So where were the scientists? The engineers? Conspicuous by their absence, the STEM professions are losing the brightest qualified students to other professions, in fact, it



Nicola Evans, WSP

was only by pure chance that I ended up in engineering. My current company WSP does a round of graduate fairs every year and engages widely with universities and schools and as a result about 30% of our new graduate intake was female. But despite this young people today will still choose careers in the city, arts or law simply because they did not know what they could have achieved as an engineer. Fresh talent is the basis of the future of our industry so it is vital that we engage with the young generation.

There are some severe imbalances in the diversity of our industry; at present, the industry comprises 8% women and 6% black, minority ethnic (BME) engineers. Having a diverse team ensures that you get different ideas, varied perspectives and therefore productive discussion leading to the most innovative ideas. A team can comprise the technically most competent engineers in the country, but if all of them are trained to think in a similar way, I don’t believe we can serve our clients well. We need people who think differently working together to create innovation and ideas. I have seen this in play at WSP, where we have more women than the norm with around 1 in 5 of our technical staff being female.

The Royal Academy of Engineering produced a report which warns that “the current pool of science, technology and engineering experts are already stretched thin and ageing rapidly”. It reports this shocking statistic: the median age of chartered engineers rises by 10 years for every 14 that pass.

We have a major skill shortage in the UK,

we need to produce up to 50% more students in STEM careers to help grow the economy. We live in a diverse society and therefore our profession should reflect this. We design homes and transport for people, if our profession doesn’t reflect society, is it really possible for us to provide the best solutions to the problems we are trying to solve?

A manifesto for change

In order to create a fresh and attractive brand or identity for engineers, effective communication by the industry and media is key. Here are five of my ideas on how this can be achieved:

Communicating that engineering is creative

It is vital to engage with young students to show them why science and maths is creative, rewarding and fun. We must speak to teachers, careers advisors and parents, because parents have a big influence on their children’s career choices. In a recent survey by WSP educating teachers and careers advisors and adapting the curriculum was ranked as the best way to achieve this (49 per cent of respondents). We need to show all of them that engineering is a prestigious career to aspire to. I believe our engineering institutions and companies need more visibility to students, to show them what we do, how rewarding it is and dispel common myths to encourage all students to at least consider technical careers.

Supporting students

Once we’ve caught their attention, let us offer work placements and internships so that students can see first-hand the working life of engineers. What better way to experience how engineers work in teams and brainstorming ideas and solving problems? We should mentor them and ensure that this support continues throughout their careers. WSP has a schools engagement programme called Launchpad and just last month I was part of a week-long induction across all of our different businesses for around 35 students.

Where role models for minorities are scarce, it is even more important that this support is maintained. An example is when women take maternity leave and come back to work, it can be a challenging time for them, and mentoring can ensure that the path back is smoother and enable them to navigate their way to leadership positions.

An open mind about educational backgrounds

Keeping an open mind about different

educational backgrounds is important. The industry comprises mainly of those with an engineering degree, however I would argue that my physics degree was just as relevant in providing me with mathematical and problem solving skills as an undergraduate engineering degree. I was fortunate that this was readily recognised by Imperial College and then by my employer. How many more engineers could we produce if we communicated to scientists and mathematicians that engineering is a viable career option?

Addressing unconscious bias

We need to think carefully about how we are marketing ourselves, are we unconsciously pitching to a certain group? There are studies that show men will apply for a job if they believe they fulfil 60% of the criteria whilst women will only do so when they hit 100%. We need to understand that there isn't just one right way to be a successful engineer, we can be technical specialists, managers of teams, business development leaders and many others. If senior engineers in an institution or company are not particularly diverse, you can end up with a self-fulfilling prophecy where new entrants will also be from a similar background.

Using the media

We need more documentaries and shows on television, articles and features in newspapers and online which feature true engineering in order to redefine the term. We need visible engineering role models to whom our children can aspire. Eighteen months ago I was part of a short slot on a documentary, I (wrongly) considered this a unique and one-off opportunity. I've been amazed at the interest level that followed my appearance, people are genuinely interested in a topic which they previously had very little exposure to. Let us build on this.

I believe that implementing even a few of these proposals on a large scale would have measurable benefits to the state of engineering.

The future vision

I was at a party at a flat on the Thames earlier this year with a breath-taking view of the Shard. People were talking about it, saying what a beautiful building it is and taking photographs. Whilst I felt an immense pride



Roma designed the 'spire' of the Shard, seen here during the light and laser show at the opening on July 5, 2012. At 309.6 metres it is the tallest building in Europe.

at having contributed to its design, I also noticed that no one was saying 'what a fantastic engineering feat' it is.

I want to hear people saying 'didn't the engineers do a fabulous job on the Shard' rather than just the architects. I want to see engineers on TV and the media and children fascinated by engineering. I want to see the end of gender stereotyping science toys and books, and children making the connection from building Lego towers to building the

Shard. I want to see a diverse workforce in engineering where stereotypes fall away and everyone considers engineering a prestigious and rewarding career. The responsibility to achieve this vision lies with every one of us, let us all be less modest and tell everyone how wonderful we are as engineers.

You can see WSP's recent research into diversity here:

<http://bit.ly/IE19Diversity>

Roma Agrawal gained an MSc in Structural Engineering from Imperial College in 2005. She is an Associate Structural Engineer at WSP and has designed bridges, skyscrapers and sculptures with signature architects over her eight year career. She spent six years working on The Shard, the tallest building in Western Europe, and designed the foundations and the 'Spire'.

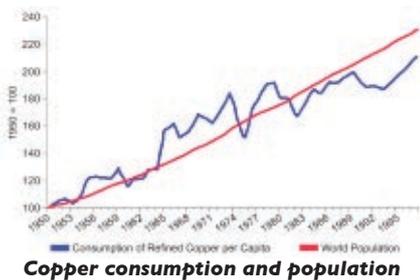
She was awarded 'Young Structural Engineer of the Year 2011' by the Institution of Structural Engineers, 'Best in Science & Engineering' at the British Indian Awards 2013 and was a finalist for the 'Young Woman Engineer of the Year' run by the Institution of Engineering and Technology. Roma was the only woman featured on Channel 4's documentary on the Shard, 'The Tallest Tower'. Her career has been extensively featured in the media, including The Sunday Times, The Guardian, The Independent, Cosmopolitan and Stylist Magazines, and in online blogs.

Outside work, she promotes engineering, scientific and technical careers to young people and particularly to under-represented groups such as women. During the last 3 years, she has spoken to more than 1500 people at over 30 schools, universities and organisations across the country and abroad. Roma has a BA in Physics from Oxford.

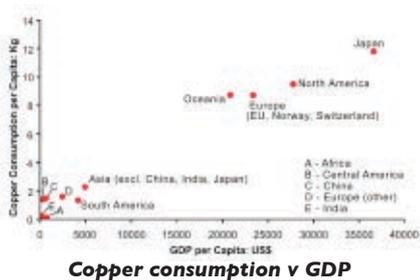
Copper and the next generation of mines

Background

There is general consensus that demand for copper will continue to increase, based on a combination of population growth plus increase in GDP in less developed countries.



Rio Tinto



Rio Tinto

But copper output is forecast to fall below demand as producers run out of reserves and new discoveries get deeper, many beyond the economic reach of open pits.



USGS

Depth to Top of Mineralisation (Base Metal Discoveries > 0.1% Copper Equivalent)

So where is the copper going to come from? One source is a new generation of large scale underground mines using a technique called block caving.

Although block caving has been in use for over a century it has seen greater use in the past 20 years, such that both experience and the production base has now been built up

to create confidence in establishing the next generation of 'super-sized' mines.

Its use is based on:

- Lowest operating cost of any underground mining method;
- A safe, highly productive method;
- Ideally suited to automation.

However, though conceptually simple, it is perhaps the most technically challenging of all underground methods. Its use requires a greater knowledge of the orebody and surrounding rock than any other method, and a large amount of capital expenditure is needed 'up-front' coupled with a long pre-production period. These factors mean that the method is used by mining companies such as Codelco, Freeport-McMoRan, and Rio Tinto who have built up experience and have the wherewithal to invest for the long term. The 'super-sized' mines being developed by these companies include Chuquicamata (50 Mt/y), Grasberg Deep (57 Mt/y) and Oyu Tolgoi (32 Mt/y).

Block Caving Basics

In essence the ore is fragmented by stress, rather than drilling and blasting as in all other mining methods including open pits. The stress occurs from a combination of natural (depth and regional tectonics) and induced sources. The induced stress occurs when the orebody is 'undercut', a process that removes a horizontal slice of ore over a large area, and the stress becomes greater than the inherent strength of the orebody. The greater the strength of the orebody the greater the area required (more than, say, a football pitch). Very weak rock may fragment over a small area (say, a squash court) without much stress being induced. The fragmented ore then gravitates into funnel-like openings or 'drawbells' mined below the undercut from where it is extracted by 'load-haul-dump' (LHD) equipment. (See panel opposite)

Engineering

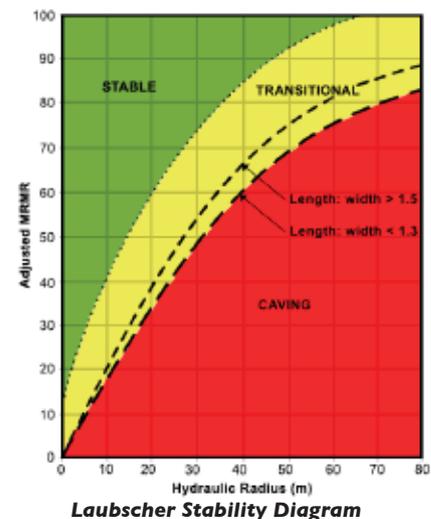
Block caving is the controlled collapse of hundreds of millions of tonnes of rock. Understanding the mechanical behaviour of rock, in both the ore-body and the surrounding waste material, is critical to the success of the method. Hence early and extensive orebody knowledge must be acquired with a scope well beyond the standard studies associated with open pits and other mining methods.

This knowledge is used to answer three questions:

1. Will it cave? (*Caveability*)
2. What is the size distribution of the rock reporting to the drawpoint? (*Fragmentation*)
3. What is the optimum spacing and geometry of the drawpoints? (*Mine Design*)

Caveability is the term used to assess whether the ore-body will cave and is based on an evaluation of factors such as: rock strength, the extent and nature of fractures or discontinuities in the rock and the state of stress within the rock. Related to this is the plan area of the orebody and the span that can be created to induce the rock to cave.

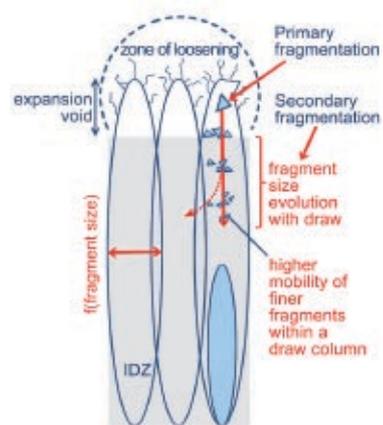
There are several methodologies used to assess caveability, ranging from empirically derived guidance such as that put forward by Laubscher and based on data from many block caving operations. In this case rock quality or modified rock mass rating (MRMR) is plotted against the hydraulic radius (HR) (area/perimeter) of the span required to initiate caving. The HR accounts for the fact that, in plan, a circular or square excavation will be more likely to induce caving than say a long tunnel of the same area.



After Laubscher 2001

In the past 15 years or so numerical modelling techniques have been developed to bring some science into what was previously a 'black art'. These techniques are constantly evolving as computing power increases and models are calibrated against actual operations.

Fragmentation is the term used to describe the size, or range of sizes, of the blocks of ore that are generated during the caving process. The estimation of fragmentation is based on similar data to that for caveability as well as the height of the cave zone (as the rock flows downwards it is subject to internal comminution, the higher the cave zone, the finer the ore will be when it reaches the drawpoint). An understanding of fragmentation is needed to determine how the ore will flow, the spacing of drawpoints (finer ore needs closer spacing than coarsely fragmented ore) and the type of secondary breaking equipment required to reduce oversize ore at, or in, the drawpoint; and hence establish the rate of mining that is possible from the drawpoint.



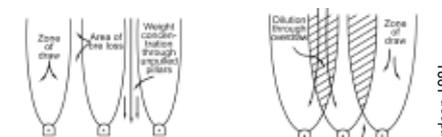
Drawzones and Fragmentation

Rio Tinto

Again, several methodologies have evolved over the years to understand both fragmentation and flow characteristics, in some cases these methods have almost become proprietary with each mine favouring a particular method for which it can then calibrate forecast against actual.

Mine Design is the process that takes caveability and fragmentation assessments and attempts to reconcile often conflicting concepts in order to produce a viable design of the block cave mine. This process primarily considers the spacing and geometry of drawpoints.

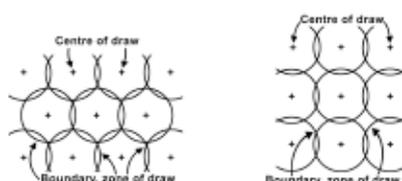
Drawpoint Spacing takes into account the fragmentation that, in turn, determines the diameter of the drawzone – a silo like volume that represents the ore that will be extracted by a drawpoint. Finely fragmented ore will have a smaller diameter, say 8 to 12 m, to that of coarser ore, say 11 to 15 m. As there is a different fragmentation profile at different stages of draw a judgement has to be made as to the optimum spacing. An over-estimation could lead to loss of ore and under-estimation to increased cost.



Negative Effects of Incorrect Drawpoint Spacing (L – too wide, R – too narrow)

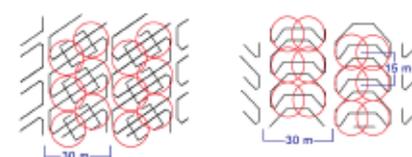
Richardson 1981

Drawpoint Geometry takes into account the need to achieve a uniform grid of drawpoints, based on optimum drawpoint spacing, while allowing LHD equipment to access the drawpoints.



Idealised Plan of Drawpoints (L- Hexagonal, R- Orthogonal)

Richardson 1981



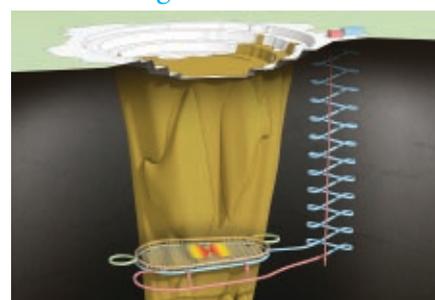
Typical Mining Plans to Fit Ideal Spacing to Practical Arrangement

Brown 2003

Stages of Block Caving

The ore-body is accessed vertically by shafts and/or declines and then horizontally through tunnels.

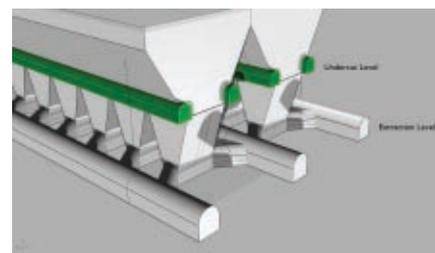
From the access tunnels a production level is constructed below the ore-body consisting of a series of parallel tunnels ('production drifts') typically 30 m apart. Along each production drift side tunnels are driven at about 15 m intervals to access the drawpoints from which ore will be collected.



Access Development and Start of Production Drift Development

Sandvik

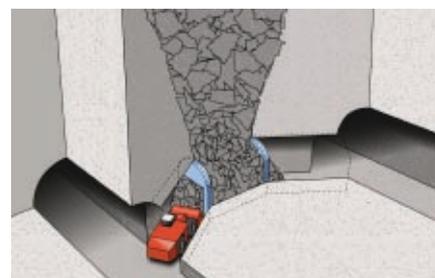
The ore-body above the production level is induced to fracture and collapse by a process called undercutting. Undercutting consists of drilling and blasting a slice of rock, approximately 15 m thick, the areal extent of which becomes beyond the point that the span of ore can support itself, inducing it to fracture and cave.



Undercut Level developed above Extraction Level

Sandvik

Fractured rock falls into the drawpoints and is extracted by Load Haul Dump (LHD) equipment and conveyed to an ore handling system to the surface.

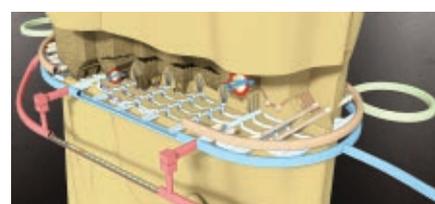


Section through Drawpoints Showing LHD at Drawpoint

Sandvik

The cave propagates as ore production continues and subsidence occurs.

Eventually all ore is extracted leaving a crater.



Caving Extends over the whole Orebody

Sandvik

With most other mining methods, the planning team has the opportunity of monitoring the outcome of their design. This provides a feedback loop that allows subsequent design to be improved. With block caves it can take many years from planning through to full production. This places a large dependence on getting the plan right in the first instance and this, in turn, requires that the input data to the design is the best that can be obtained at the time.

Beyond the drawpoint the engineering needed for ore handling is no different to other underground mines except perhaps for the scale of the operation. Typically LHD units take the ore either directly to a crusher or to an orepass that feeds a truck or train haulage system to a crusher complex. From the crusher, ore is typically conveyed via a shaft hoisting system to the surface. Because of the scale and the fixed pattern of ore flow each stage is suited to automation and many

FEATURES

mines have applied it to one or more parts of the ore handling system.

Safety

The opportunity for mechanisation and obviating the exposure of miners to unsupported ground, makes block caving a safe, if not the safest, underground mining method. However, the industry has identified some issues specific to caving that must be managed.

- Collapses and rock bursts occur when the rock is subject to stresses beyond its inherent strength.
- An air blast may occur when a large failure in the cave compresses the air and produces a rapid flow of air through exposed underground openings, resulting in a violent and damaging shock wave.
- A mud rush is a sudden inflow of saturated fine material from the drawpoint. It occurs when water builds up within caved material that contains sufficient potentially mud-producing materials.

The industry has developed guidelines for mitigating these risks. For example, advanced undercutting to minimise rock collapse on the production level, monitoring of extraction rates and the interpretation of data from micro-seismic monitoring devices, can indicate the creation of an air gap and automated or remote-controlled loaders can be used to produce from the wet areas of a mine prone to mud rushes.

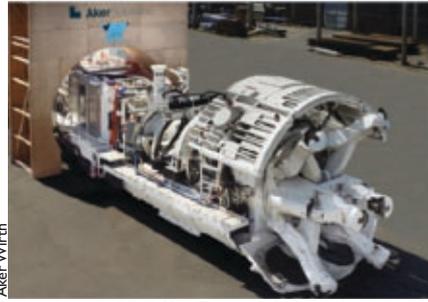
The Challenges

Despite the understanding and subsequent confidence that has been generated in the past 20 years in block caving, there remains a huge amount of research, data acquisition, numerical modelling and advances in mining techniques that are needed to mine future orebodies with decreasing grades and increasing depth. Some examples of these challenges are described below.

Rock Characterisation

This is the process by which various geotechnical features of the orebody and host rock are determined and assigned a value on a scale that relates to a quality or characteristic used in the design of a block cave; such as caveability, tunnel stability and modelling capability.

At this stage of understanding there is no single characterisation methodology that can satisfy the needs of the industry and hence the rock is characterised according to the use to



Mobile Tunnel Miner

which it will be put. For example, rock quality as assessed for caveability and assigned a rock mass rating (RMR) would have less relevance than a rock quality assigned a Barton Q number to a contractor being asked to quote for developing access tunnels.

Ore Flow

Because of the nature of block caving it is not possible to 'see' inside a mass of caved rock. The limited knowledge gained so far on how ore flows within the caved mass has come from scale experiments in the laboratory and from numerical modelling techniques that often can only be validated from these imperfect scale models.

Some good work has been achieved with the use of RFID type devices that are located within the orebody prior to the initiation of caving. However these can only give the start and end location and what is required is a means of real time monitoring of a marker generating x,y,z coordinates over time.

Mine Development

A typical block cave mine requires several deep (greater than a kilometre) large diameter shafts for access, production and ventilation. It also requires several hundreds of kilometre of tunnels to be developed before production can commence. Current industry practice is to use conventional drill blast techniques and despite improvements in the equipment and advance rates it still takes a considerable time to develop a mine. Timescales range from six years for say a 10 Mt/y operation to twelve or more years for the super-sized operations (greater than 30 Mt/y) now being developed. Because of this timescale the economics, in NPV terms, sometimes become tenuous.

The industry, and particularly Rio Tinto in its "Mine of the Future" programme, is looking at ways in which the mine development period can be reduced through the use of boring and mechanical excavation techniques.

For vertical shafts Herrenknecht are



Shaft Boring System

prototyping a shaft boring machine that will make shaft sinking safer and faster.

For horizontal tunnels Aker Wirth are prototyping a Mobile Tunnel Miner (MTM) at Northparkes Mine in Australia.

The Future

As the discovery of large resources of copper suitable for open pit becomes more infrequent (the industry needs to find the equivalent of Escondida every three years) one solution to supplying the world's demand will be the mining of deep resources using block caving.

References

- 1 Richardson, M.P., 1981. "Area of draw influence and drawpoint spacing for block caving mines", in *Design and Operation of Caving and Sublevel Stopping Mines*, pp. 149-156. Ed. D.R. Stewart. SME-AIME, New York.
- 2 Brown, ET 2003, *Block caving geomechanics (The International Caving Study I, 1997-2000)*, University of Queensland, JKMRM Monograph Series in Mining and Mineral Processing, No. 3, JKMRM, Indooroopilly, Australia.
- 3 Laubscher, D.H. 2001. "Cave mining - state of the art", Chapter 55 in *Underground Mining Methods*, ed. Hustrulid and Bullock, SME, pp. 455-463.



Frank Russell is a graduate of Camborne and Royal School of Mines (MSc Mineral Production Management, 1974-75) and has over 45 years' experience in underground hard rock mining. He was Chief Adviser Underground Mining for Rio Tinto where he led, or made a major contribution to, the application of block cave mining methods at Palabora, Argyle, Bingham, Northparkes, Resolution, DOZ and Oyu Tolgoi. Since retiring from Rio Tinto he has carried out studies and reviews of caving operations in various parts of the world for numerous clients. He is the author of several papers on mining methods and mine design. Fellow IMMM and Chartered Engineer.

Got an idea for a story?

If you have an idea for a feature article, please contact Teresa Sergot or any member of the Editorial Board (address and deadlines on page two)

Dr. Mark D. Sutton (Earth Science and Engineering), Senior Lecturer in Palaeontology

Virtual Palaeontology

Introduction

Fossils are normally three-dimensional objects – think of dinosaur bones, spiny trilobites, fossilised shells, and the like. Totally flat fossils do exist of course, such as leaves pressed into the silty layers of ancient lakes, but these are the exception. For the most part, palaeontologists deal with objects in the round, and that third dimension brings both extra information and practical problems. Fossils are normally embedded in a host rock. A flat fossil can be revealed in its entirety by simply splitting the rock open, but a three dimensional one can't – if it is to be studied fully by traditional methods it must be extracted whole, which normally involves either mechanical excavation or chemical dissolution of the rock. These approaches can damage specimens, do not reveal information that may lurk inside the specimen itself (such as hidden chambers and fossilised internal organs), and in any case are not always feasible.

A better approach to studying this sort of material is to digitise the full three-dimensional morphology, and study it on a computer: virtual palaeontology. Virtual specimens have many advantages. They are easy to work with, requiring only a computer rather than expensive and lab-bound microscopes. They can be dissected, sectioned, and split into different elements, without fear of damage. They can be fed into computer-based engineering modelling systems to better study the way in which the original animals lived; for instance finite-element analysis can be used to study stress and strain, or computational fluid dynamics systems can be used to model water flow. Finally, as virtual specimens are simply computer files, they can be easily copied and disseminated, making collaborative work easy and providing new and better ways of



A three-dimensionally preserved fossil trilobite

publishing and presenting data. For these reasons and more, virtual palaeontology is quietly ushering in a new era in the way that palaeontologists work.

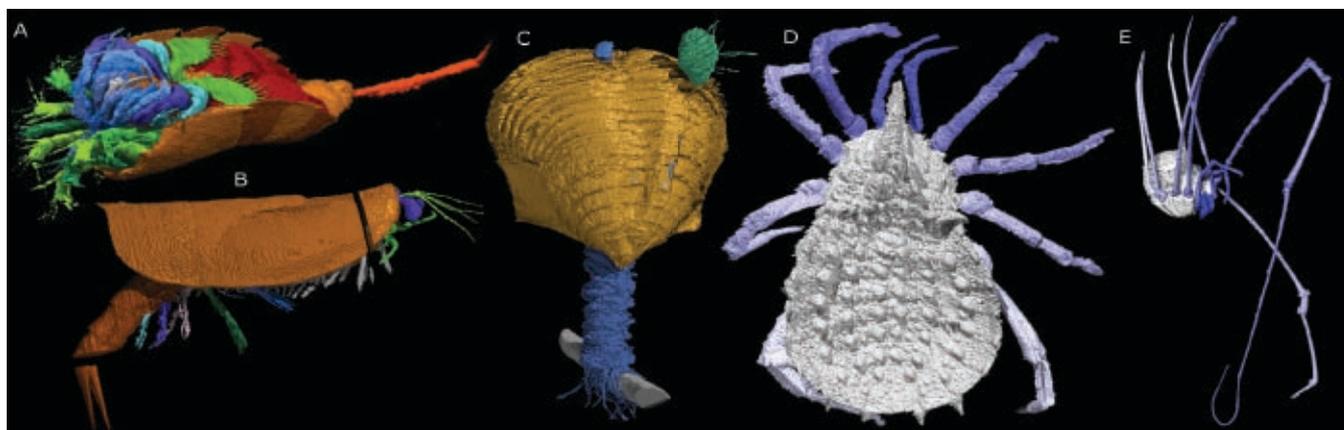
Virtual palaeontology has a surprisingly long prehistory, tracing its origins to techniques pioneered in the early 1900s by the eccentric Oxford polymath William J. Sollas. The Sollas approach used serial grinding – specimens were ground away at fine intervals (up to 30 grinds per millimetre), and each freshly exposed surface photographed. The resulting data were used to build up layered cardboard or

wax models of the original specimens. Despite being intensely laborious and worryingly destructive, serial grinding (and its relative serial sawing) were widely used throughout the 20th Century as they represented the gold-standard for data-recovery. Now married to modern computer visualisation methods rather than clumsy physical models, the approach is still in use for certain types of material – the best examples are reconstructions of the remarkable soft-bodied invertebrate fossils of the Silurian 'Herefordshire Lagerstätte' [1].

Serial grinding is a form of tomography; the visualisation or study of three dimensional objects through a series of two-dimensional parallel slices. A variety of scanning techniques now exist that can perform tomography without damaging specimens; CAT or CT scanning is the best known of these, but some of the profusion of variants and alternatives are introduced below. Tomography is not the only game in town either; 'surface-based' techniques can quickly digitise the external surface of a fossil. Where internal details are unimportant and specimens are already free from their rock matrix (many dinosaur bones for instance) this provides another route to virtual specimens.

Scanning and tomography

X-ray computed tomography or computer assisted tomography (CT or CAT) is a familiar medical technology; it uses a large number of 2-D X-ray radiographs, each taken at a different angle, to compute virtual 'slices' (tomograms) through an object and hence to reconstruct a 3-D representation. CT has been used in palaeontology for over 30 years, but medical scanners are not always optimal for scanning fossils, being designed for humans; compared to most fossils we are relatively large, absorb x-rays weakly, and are distressingly



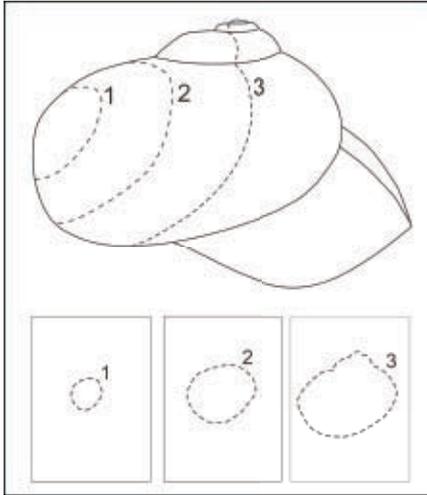
Some virtual fossils. A-C: 425 million-year-old fossils from the 'Herefordshire Lagerstätte' [1], reconstructed using serial-grinding. **D,E:** 325 million-year-old arachnid fossils from Carboniferous concretions, reconstructed using Micro-CT. Original specimens are of various sizes, but all small; *Offacolus* is only 2mm wide, while the largest specimen illustrated (*Eophrynus*) is 20mm wide.

A; the chelicerate arthropod *Offacolus* [4]
B; the shrimp-like *Cinerocharis* [5]

C; the brachiopod *Bethia* [6]
D; the trigonotarbid *Eophrynus* [7]

E; the harvestman *Macrogyon* [8]

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From Surton et al. in press [9]

Tomography is the study of an object through parallel slices; here 1, 2 and 3 are slices (or tomograms) through a hypothetical fossil snail

intolerant of high radiation doses. Due to the scales involved, early CT adoption was the province of vertebrate palaeontologists, who remain the most enthusiastic users of the technology. CT has, however, long-since expanded out of medical fields, driven by the needs of engineering and materials science. Engineering scanners can now handle the largest palaeontological specimens, and provide sufficiently powerful X-ray beams to penetrate them. At the smaller end of the scale, XMT (X-ray microtomography) has been available since the 1990s; it is now a relatively commonplace means of studying specimens in the millimetre to centimetre range, and has a resolution approaching one micron. Nano-CT scanners also exist that can resolve even finer structures. CT has also been augmented in recent years by the construction of tomography beamlines at third-generation synchrotrons. Synchrotrons are a form of particle accelerator that provide high-intensity sources of EM radiation; they can be used as an X-ray source for palaeontological tomography, and provide particularly clean and high-resolution data.

CT in its various guises acts as the mainstay of data collection for virtual palaeontology, but it is not a panacea. Some specimens are an awkward shape – CT works best on near equidimensional blocks of rock, and struggles with thin slabs. Some material also lacks sufficient X-ray density contrast between fossil and host-rock to show up on scans. Phase-contrast and holotomography techniques use refractive phase-variation rather than simple absorption to spot structures, and are able to pick out very subtle compositional variations and hence to handle otherwise intractable material. These do, however, normally require the single-wavelength X-ray sources available only at synchrotrons. Finally, certain experimental X-ray techniques such as colour tomography may eventually allow palaeontologists to map a suite of properties such as elemental composition and crystal structure in full 3-D; this would provide an even more data-rich approach to analysing specimens, and its advent is awaited

eagerly by us all!

Many other technologies exist that can perform tomography without using X-rays. Focused Ion Beam tomography, for instance, is a nano-scale destructive approach that can mill away very small increments and image the exposed surfaces using a scanning electron microscope. Optical tomography uses various methods to isolate slices in translucent fossils by tight focussing, and for the right sort of material can provide a quick and easy way to extract very high-resolution data. Neutron tomography (NT) works in an analogous way to CT, but uses a neutron rather than X-ray source; while lacking the resolution of CT, it is particularly effective for organic-rich fossils. Magnetic Resonance Imaging (MRI), another familiar medical technology, is generally not well suited to geological materials but has nonetheless found some niche applications. Other methods exist too.

Surface-based techniques

As discussed, tomography comes in a bewildering array of forms, and there are very few fossils that cannot be imaged tomographically by one means or another. Surface-based techniques further augment this formidable toolkit by providing a completely different approach to three-dimensional data capture. Instead of working with slices, virtual or otherwise, these methods digitise external surfaces.

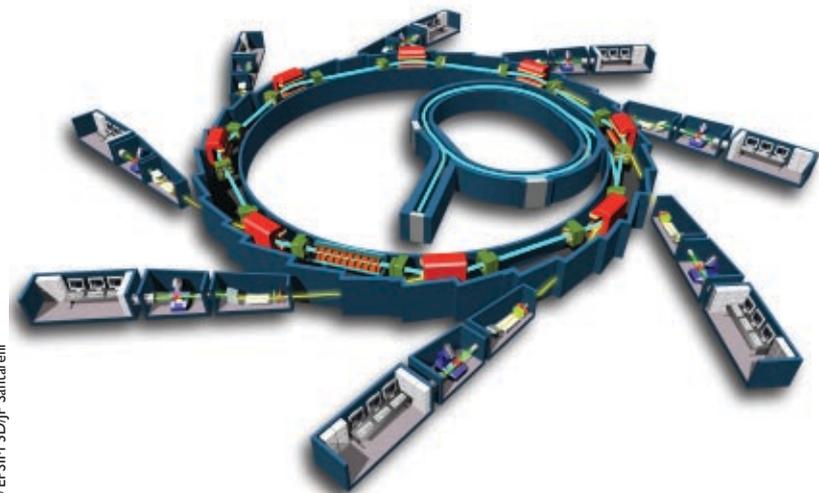
Laser scanners, which themselves come in a variety of flavours with different strengths and weaknesses, bounce laser light off specimens to generate a three-dimensional map of the surface using either triangulation, time-of-flight, or assessment of phase-shift to provide measurement of range. These devices are relatively portable, and can be taken to the specimen rather than vice versa; they have for instance been used to digitise mounted skeletons in museums, and dinosaur trackways in the field. Laser scanners can resolve structures down to 50 microns in ideal conditions, and can also record colour information. They are also quick and easy to use, and have become the technology of choice for mass curatorial digitisation of fossils; an example is the online

GB3D Type Fossils database [2].

Digital photogrammetry uses a series of two-dimensional photographs of an object taken from different positions to reconstruct a three-dimensional model of its surface. The algorithms that perform this trick are analogous to the visual processing that the human brain performs to convert stereoscopic images from our two eyes into a mental model of an object. Photogrammetry has many obvious advantages; it is scale-agnostic (if photographs can be taken at any given scale, a reconstruction can be made), requires only a camera, and (like laser-scanning) can capture colour information from a surface. Resolution and precision can be as good as that from a laser scanner under ideal conditions. Photogrammetry has seen few applications so far in palaeontology, although it has been widely used in cartography, medicine, forensics and archaeology. The method has often been considered difficult to use, but modern software is lowering this particular bar, and there is a lot of potential here for quick yet precise digitisation of fossil material.

Reconstructing and using virtual specimens

Gathering 3D data is only the first step in preparing a usable virtual specimen that can actually be studied; the data must be also be converted into a viewable three-dimensional model. With surface-based techniques this is relatively straightforward, as the raw data (in the form of a series of points in 3-D space) can either be visualised directly on-screen, or converted into a large number of 3-D triangles (a triangle mesh). Tomographic data, from any source, is more complex. One problem is that such data is often 'noisy', containing fossil structures that are indistinct in places, or geological structures such as fine cracks that may overprint the original fossil. Dealing with this 'noise' often requires human intervention, and hence there is often an interpretative step where data is cleaned and the fossil is carefully separated from other extraneous structures. This is the virtual equivalent of the manual preparation work traditionally carried out of fossils with drills, brushes and other



© EPSIM 3D/JF Santarelli

A generalised synchrotron, showing beamlines arrayed around a central storage ring

fine manual tools. Once clean enough for reconstruction, the most common approach is to treat the set of slice-images as a volume, the 3-D equivalent of a raster image made up not of 2-D pixels but 3-D voxels. Surfaces representing the original outline of the fossil specimen, again in the form of a triangle-mesh, can be computed automatically from such a volume.

Once converted to a triangle-mesh, virtual fossils can easily be visualised using the powerful graphics hardware ubiquitous to modern computers. Virtual photographs can be taken from any angle or lighting conditions desired. Even more usefully, the specimen can be manipulated on-screen as a 3-D object, and sliced, dissected, zoomed in or otherwise played with as much as the researcher desires. Recreation of the fossil in physical form is also increasingly practical with the advent of modern 3-D printers; these devices can take a triangle-mesh virtual fossil and reproduce it as a physical model, ideal for display or further study.

Virtual fossils also enable palaeontologists to share information in new ways. Traditionally, when we published a new species, we accompanied it with photographs, but these could not document the full form; other scientists who wanted to check or continue our work had to borrow the original specimens from a museum. Virtual fossils are different; they can be published electronically, enabling other workers to instantly download and examine the full data. This sort of data-sharing may sound like a mere convenience, but it is actually one of the key advantages to the whole approach, and has the potential to completely change the way we work. It does not yet happen quite as much as it could or should, one problem being technical issues with file-formats and availability of free software. Providing solutions to these problems is one of the areas with which the author of this article is involved [3].

Conclusions and summary

Palaeontology is an old science, and many aspects of the way in which palaeontologists work have remained much the same for well over a hundred years. The advent of virtual palaeontology however, borrowing techniques from engineering, medicine, and other areas besides, is changing things. With tomographic and surface-based virtual techniques, three-dimensionally preserved fossils no longer present a challenge; instead they are now an opportunity for new types of research and new types of collaboration. All sciences, no matter how deep their historical roots, evolve in their methods and in the mind-set of their practitioners – and as palaeontologists are particularly well aware, no type of evolution occurs at a constant rate. The virtual palaeontology revolution, for revolution it is, represents an evolutionary burst within our science. Palaeontology will never be quite the same again, and I, for one, firmly believe that it will be greatly enhanced.



3D-printed model of the trigonotarbid arachnid Eophrynus

References

- [1] Briggs, D.E.G., Siveter, D.J., Siveter, D.J. and Sutton, M.D. 2008. Virtual fossils from a 425 million-year-old volcanic ash. *American Scientist* 96, 474-481.
- [2] <http://www.3d-fossils.ac.uk/>
- [3] Sutton, M.D., Garwood, R.J., Siveter, David J. and Siveter, Derek J. 2012. SPIERS and VAXML: A software toolkit for tomographic visualisation and a format for virtual specimen interchange. *Palaeontologia Electronica* 15, <http://palaeo-electronica.org/content/issue-2-2012-technical-articles/226-virtual-palaeontology-toolkit>
- [4] Sutton, M.D., Briggs, D.E.G., Siveter, David J., Siveter, Derek J. and Orr, P.J. 2002. The arthropod *Offacolus kingi* (Chelicerata) from the Silurian of Herefordshire, England: computer based morphological reconstructions and phylogenetic affinities. *Proceedings of the Royal Society, London B* 269, 1195-1203.
- [5] Briggs, D.E.G., Sutton, M.D., Siveter, David J. and Siveter, Derek J. 2004. A new phyllocarid (Crustacea: Phyllocarida) from the Silurian Fossil-Lagerstätte of Herefordshire, England. *Proceedings of the Royal Society, London B* 271, 131-138.
- [6] Sutton, M.D., Briggs, D.E.G., Siveter, David J. and Siveter, Derek J. 2005. Silurian brachiopods with soft tissue preservation. *Nature* 436, 1013-1015.
- [7] Garwood, R.J., Dunlop, J.A. and Sutton, M.D. 2009. High-fidelity X-ray microtomography reconstruction of siderite-hosted Carboniferous arachnids. *Biology Letters* 5, 841-844.
- [8] Garwood, R.J., Dunlop, J.A., Giribet, G. and Sutton, M.D. 2011. Anatomically modern Carboniferous harvestmen demonstrate early cladogenesis and stasis in Opiliones. *Nature Communications* 2, 444.
- [9] Sutton, M.D., Rahman, I.A. and Garwood, R.J. 2013. *Techniques for Virtual Palaeontology*. Wiley-Blackwell, 224pp.



Mark Sutton is a Senior Lecturer in Palaeontology in the Department of Earth Science and Engineering, in the Imperial College Engineering Faculty, where he has worked since 2005 following a series of postdoctoral appointments in Oxford. Mark works on the early evolutionary history of molluscs, arthropods, brachiopods and other invertebrates, on 3D reconstruction techniques, and on other computer applications in palaeontology.

Colleen Richardson

The Face Behind the Name

Many of you will have met Colleen Richardson when she was editor of *Imperial College Engineer*[†]. She filled the role with energy and enthusiasm, chatting to everyone she saw with an easy, friendly manner. She teamed up with Adrian Winchester to re-vamp the magazine and it became a vibrant read, moving away from the traditional view of engineering as a dry-as-dust subject.

The more I've got to know Colleen, the more I've appreciated her wide experience and wicked sense of humour. When I was asked to write about the real Colleen, I knew it would be fun but had no idea how much.

Colleen was at Imperial College during a tempestuous period when young men were coming out of the armed forces and wanting to get qualified. There was huge pressure to get them through college. Unlike today, if anyone's marks were too low, they weren't allowed back the next year after re-sits. Instead, they were asked to come back in two years and meanwhile the place was filled with one of the men waiting in the backlog of entrants after the war. Colleen was in this position but when the two years were up, she'd moved on. She went to Regents Street Poly and got a City & Guilds Diploma in Photography. "They had every camera you could want and the diploma was very

good. My father financed me and I set up a Streatham photographic shop. I rented a studio and lock-up shop. I only had a bicycle so when I did weddings I would cycle there. I would then cycle back to the wedding with the proofs."

Later on, Colleen became a rep for a firm in Chesterfield, Robinsons, who made bandages and supplied pharmacists all over the country. Colleen used to travel over a huge area, living in Beckenham in Kent. She decided to join the Bromley Commercial Travellers Association, as this was what she did in her job. She was the only woman and, when pressed, Colleen admitted that women were not usually employed in this field but when it came to women's personal hygiene products, they had little choice. "When I was a Rep, I always remember going to Cambridge. I put up in a lovely old Trumpington pub. I was drinking with the other guests and we started drinking games. One game was balancing a coin on your nose while drinking. We used a copper – one of the big old pennies. We had very old dark bedrooms. I stripped off to go to bed and happened to look at myself in the mirror as I took my t-shirt off. There was an enormous black hole in my stomach and I thought something had burst leaving a big hole. Fortunately the hole disappeared when the copper



Colleen at 24

penny from the drinking game fell off. It had stuck to my flesh without me noticing." Even drunk as she was, Colleen will have had a huge laugh in her room.

Colleen met and married Harry Richardson after a whirlwind romance and they moved to Dorchester where Harry was working for the Atomic Energy Authority in Winfrith. Colleen had no job, Harry was working hard and Colleen was bored. Colleen never sits still for long and soon joined the local amateur dramatic society. There she became friendly with three other amateur actors, Bernard, Eddie and Ian. They decided to set up a 'theatre in the round' in the town. One was a café owner so that was the food angle sorted. One was an accountant so that was the finance angle sorted. The third was the son of a local businessman with many contacts so that was the clientele sorted. Finally, they decided to buy a large building in Dorchester and open a restaurant and nightclub. Colleen called all the local farmers up and asked if they wanted to invest in this new venture and they all said 'Yes'. Having got the finances sorted out, the four decided to bid for the local Women's Institute building, which was about to become vacant.

The nightclub soon took shape as they knocked the inside walls out. Colleen designed a stage and dance floor area down below with tables all round. A winding circular staircase led up past a long bar area to the top floor where there were more tables.

A friend of the businessman's son, IV (we'll stick to initials to protect the guilty), was employed as MD. He'd owned a sandwich and coffee bar, which made him well qualified to run the new outfit. The new MD organised staff, ordered table linen,

cutlery, etc and employed the all-important bar man.

Colleen engaged a chef and waitresses. She was also in charge of the cabaret and took four girls on to the payroll. Every two weeks, Colleen went to the West End and ordered new outfits for the girls. She brought in well-known cabaret acts, which changed every fortnight, booking them through a Jewish 'Mama'. I'm sure Colleen was in her element, enjoying every moment of this new adventure.

For two years the nightclub was very successful. The local farmers came in droves on Friday and Saturday nights with their folks and packed the place out. Colleen's daughter was roped in to help out behind the bar. But everything went terribly wrong when IV was found to have his hand in the till. "He'd never had so much money around before and so he just took it," recalls Colleen. "The accountant should have picked this up but he was a friend of the MD and an introvert. Everyone just trusted each other. We were devastated. It was awful. We had a meeting of all the investors and wound up the Company. It took a year trying to get rid of it and paying people's money back." The nightclub was eventually converted into a hugely successful young people's hangout. The scandal of a prosecution was too much for the gang of four so IV quietly left the area, never to be seen again.

Colleen is a delightful optimist and finished by saying, "It was a lovely experience, a good time in my life".

Colleen doesn't change and continues to have adventures. When she moved to Hemel Hempstead, she decided to have a lodger. She's had many lodgers over the years but one in particular stands out. He was a lorry driver with a huge pantechicon and, on occasion, would park his cab outside the house. Colleen was interested in this different form of transport and, when he asked if she'd like to drive the cab, naturally, said 'Yes'. She still recalls the inside of that memorable cab. "It was huge with twenty gears." Somehow, I find it easy to imagine Colleen, on a Sunday morning, driving an HGV cab around the roads in Hemel Hempstead with a huge grin on her face.

It was a chance meeting with Frank Cassidy on a train that brought Colleen back to Imperial College, where she took up the challenge of



The opening of the Maenbury restaurant and nightclub in Dorchester, Dorset in 1963. Colleen 2nd from top left. The three other partners are Bernard: next to her; Eddie, the accountant, bottom left; Ian, bottom right. Among those adding to the glamour were the Mayor and Mayoress of Dorchester.

Medal for Roderick Rhys Jones

becoming editor of *Imperial College Engineer* with her usual joie de vivre. Knowing Colleen, there will be many more adventures to come!

Alice Spain

† Colleen was editor of *Imperial College Engineer*, the CGCA Journal, from Spring 1997 until it was amalgamated with *RSMA Update* to form *Imperial ENGINEER* in October 2004. She jointly-edited the first issue of *IE* with the *Update* editor before handing over to Bill McAuley. She has remained a vital member of the Editorial Board ever since.

DIARY

Friday, November 29

RSMA

129th Annual Dinner
19:00 for 20:00

Venue: The Rembrandt Hotel,
11 Thurloe Place, Knightsbridge,
London SW7 2RS

Saturday, November 30

CGCA

2013 Decade Reunion Luncheon
12:00 for 12:30
(Open to RSMA, RCSA, & CGCA)
Venue: tbc

Thursday, December 12

CGCA

Christmas Lunch
12:00 for 12:30
Venue: 170 Queen's Gate

Friday, March 14, 2014

CGCA

Annual Dinner
18:45 to 22:45
Venue: Cutlers' Hall

Thursday, June 26 2014

RSMA

AGM / Final year BBQ
Venue: tbc

CGCA London Walks

The CGCA London Walks programme has been running since 2004. The present organiser, John Backhurst is retiring. We are looking for a volunteer to take his place.

For more details please contact the CGCA Hon. Sec. Nigel Cresswell via nigel.cresswell@hotmail.co.uk

**For more information
or booking for
any events,
contact**

Teresa Sergot
t.sergot@imperial.ac.uk
or phone
020 7594 1184



L-R : Sir John Parker (President Royal Academy of Engineering and Chair of Anglo American), Professor Stephen Richardson (Principal of the Faculty of Engineering and Deputy Rector), Sir Keith O'Nions (President & Rector), Roderick Rhys Jones (Chair, Friends of Imperial College), Professor Dame Ann Dowling (Head of the Department of Engineering, University of Cambridge).

On the 1st May, the Royal Albert Hall played host to the largest graduation event for postgraduates in the College's history, with 2,600 graduands receiving their degrees. Alongside the postgraduates, honorary doctorates were conferred on four people, including engineers Professor Dame Ann Dowling and Sir John Parker. Imperial College Medals were awarded to three people who have made an exceptional contribution to the college, one of whom was Roderick Rhys Jones (Civil Eng, 64).

Rod is a businessman, fundraiser and Chairman of Friends of Imperial College. He is also Chairman of the British Antarctic Monument Trust, which he founded to commemorate those killed in British Antarctic Territory in the pursuit of science.

He studied civil engineering at

Imperial and was Vice President of the City and Guilds College Union. After graduating in 1964, Rod joined the British Antarctic Survey as a surveyor travelling by dog sledge from Halley Bay in the Weddell Sea to map mountains in the Heimfrontfjella. He returned from Antarctica through South and North America working as a journalist and teacher before sailing across the Pacific in a small yacht. On returning to London in 1967, he worked as a journalist before going into industry with consulting engineers, Oscar Faber and GKN. In 1978 he founded a management consultancy serving the international engineering and construction community. In 1983 he co-authored a report for Imperial College which laid out a strategy for the commercialisation of its research.

In 2002 Rod set up a new department for fundraising and alumni relations at Imperial, reinvigorated Friends of Imperial College and went on to raise £7 million in new revenue for the College.

He was Committee Member of the City and Guilds College Association and editor of its biannual magazine *Imperial College Engineer* for many years. Under Rod's leadership, Friends of Imperial College has substantially increased Imperial's engagement with the public, alumni, supporters and local people as they gain access to the work, activities and facilities of the College. Rod has played a key role in a great many alumni reunions, networking and fundraising events.

When we congratulated **Rod Rhys Jones** on his Medal (see item above), he sent us this photo, with the following explanation:

"I thought you might like to see this picture of me explaining the benefits of an iPad to Robbie Robinson a past OC president who at 96/7 must be our oldest pp and possibly our oldest member. He told me at a barbecue he organised at his home in Winslow, Bucks that he's definitely going to buy an iPad."



WE WANT YOUR NEWS

Let us know your news or stories
Contact Teresa Sergot (address and deadlines on page two)

Who's doing what and where

The "Lively Year" Gathers!



Mike Warren

The cliché about the sixties is "if you can remember them, you weren't there!" During the weekend of June 14/15 twenty members of the Chemical Engineering Class of 1963 emphatically disproved this tired canard, although the accuracy of some of the recollections may be open to dispute! We and our partners came from far and wide for the gathering which was a tremendous success – so much that

it was decided unanimously to do it again in five years.

There were two highlights. On Friday afternoon Jerry Heng and his colleagues organised an excellent tour of the Department, including presentations of some of the cutting-edge research programmes. The spray-on clothing was of particular interest to the ladies and the artificial blood project is a good example of the synergies between medical

and engineering technologies being undertaken at Imperial. The visit concluded by our being hosted by members of the staff at the Union Bar, where products of a more traditional nature were consumed!

On the Saturday evening we dined at 170 Queen's Gate under the watchful gaze of past Rectors and the Prince Consort. It will be recalled that he inspired the foundation of what became the City

& Guilds College.

During the dinner, Malcolm Matthews proposed the idea of the the Class funding a scholarship. He is still working on the idea and can be contacted at malcolmmatthews@talgroup.com should readers wish to discuss this. In the meantime, it is hoped that as many members as possible can attend this year's Decade Reunion Lunch on November 30.

Bill McAuley (CTEC 60-65)

Hong Kong thrives



In the photo, from L-R, are Chris Ma, Walter Chan, Joseph Schembri (kneeling), Bob Hunt, Barry Adcock (Chairman of the Branch Committee), Ken Ho, John Latter, Peter Kee (kneeling), Ian Livingston, David Sorton (Secretary of the Branch Committee), Peter Pun and H.K. Cheng.

The Hong Kong Branch of the City & Guilds College Association continues to thrive, with a Luncheon Gathering being held on the first Tuesday of each third month, to allow Alumni to network in a comfortable social atmosphere.

The luncheon on Tuesday 4th June 2013 (photo below) was held in Civic Square above the MTR

Corporation's Kowloon Station development at the foot of the International Commerce Centre, Hong Kong's tallest building, in West Kowloon.

Ken Ho is also very active on the Committee of the Hong Kong Chapter of ICAA, which has a very large following in Hong Kong.

David Sorton (Civil Eng. 71)



Ice-Bat racing: new sport?

Alumnus Steve Ellis (BEng Mechanical Engineering 1991, MSc Aeronautics 1992), has always been a sportsman. He began rowing at eight and would row to school in Windsor instead of walking like his friends. By the time he was 18 he was a junior international rower for Great Britain. While at Imperial he improved his rowing skills with the Imperial College Boat Club. In 1992, his crew set a record at Henley that was only broken this year, at the Ladies' Challenge Plate. Steve then worked his way up to Boat Club Manager in 1995-96. In 1996 he went to the Atlanta Summer Olympics as lightweight reserve. After the Summer Olympics, he took a job with Shell International and moved to the Netherlands where he learned to skate and cycle.

In the winter of 2010 he had an idea. "I lived next to a canal in the Netherlands. In the winter, it freezes over. A few friends and I took our bikes out onto the frozen canal. Some of us made it, but one fell and broke his bike. During this experience, it crossed my mind that basically nobody has really tried to produce a serious bike for use on ice. I decided that I wanted to make one."

The Ice-Bat was born, so-called partly due to the big black carbon fibre propeller used in the bike's original design but also because it

reminded him of the Batmobile. "The engineering and materials skills I learned at Imperial as well as sporting experience in rowing, cycling, and skating all come together nicely in this project," Steve said.

Over the last 3 years he has continued to refine the Ice-Bat. It was designed to be easily ridden by everyone, including those with disabilities, and has evolved from being powered by a propeller to being powered using a bike wheel. "Touring round frozen lakes is a magnificent experience, and since these bikes are suitable for young and old, able and disabled alike, this experience is now in reach for those who cannot or choose not to skate" says Steve.

The Ice-Bat now travels at up to 28 miles per hour. Steve has also expanded his knowledge of ice formation and ice skating, applying it to improving the Ice-Bat's mechanics so riders can control the bike around 400 meter ice rinks. But Steve doesn't just want the Ice-Bat to travel in circles at high speeds. He wants the bike to inspire a new generation of sportsmen and women, by establishing a new sport of Ice-Bat racing which he hopes will become a Paralympic event in the 2022 Winter Olympics under the name of Ice Track Cycling.

More at www.icebatracing.com

BBOXX: Best UK Enterprise

In last Autumn's edition of Imperial ENGINEER we featured the work of BBOXX, a spin-out company from the e.quinox charity at Imperial that provides battery charging stations powered by renewable energy to communities not connected to a grid supply. BBOXX was established in 2010 by three of the founders of e.quinox, Elec Eng alumni Chris Baker-Brian, Mansoor Hamayun and Laurent Van Houcke. The company designs, manufactures and distributes solar powered battery packs to 14 countries across the developing world. The BBOXX system links solar panels to a battery pack into which people can plug lights, phone chargers and televisions, or power a space up to the size of a small office, depending on the size of the system. The company has now opened a joint-venture factory in China and has attracted franchises in 14 countries, including Rwanda, Ethiopia, Uganda, Kenya, DR Congo, Sierra Leone, Senegal, Sudan, Somalia, and Pakistan. BBOXX currently employs around 18 people in the UK, 130 in Africa and 50 in China.

In March this year BBOXX triumphed over stiff competition at the Lloyds TSB 2013 Enterprise Awards to be named Best Enterprise in the North West. The clean energy company was a natural contender for the awards, which unearth and foster enterprising spirit amongst students and recent UK graduates. In order to achieve this accolade, BBOXX and its competitors underwent a rigorous judging process. Shortlisted entrants were required to share great stories about their business with an expert panel. Entrants were judged on their business concept, market research and financial performance.

Chairman of the judges, John Leake, revealed the reasons for their decision: "BBOXX has identified a clear market for their products and has already made remarkable progress in developing their business in some of the most challenging markets on the planet."

Winning the North West heat brought BBOXX £5,000 of business investment and numerous business and networking opportunities. With their ambitious target to provide electricity to 20 million people by 2020, such investment is much appreciated.

Chris Baker-Brian, BBOXX's Executive Partner and Director of Research and Technology, expressed his pride: "This award represents the exceptional work of an entire team. Over the past three years we have worked phenomenally hard to maintain our 100% year-on-year growth rate and continued expansion into new markets; what keeps us going is the real difference our products make to people's lives."

In April they went on to win the Grand Final, being named the Best Enterprise in the UK. BBOXX co-founder Laurent Van Houcke and CFO Robin Claessens were on hand to collect the award from Lloyds TSB CEO Antonio Horta-Osorio together with a prize of £50,000, plus mentoring and support from senior Lloyds TSB advisors. Commenting on the award, Laurent said "This is a fantastic recognition of all the hard work that the BBOXX team has been putting in over the last three years to grow our business into over fourteen countries across Africa and Asia, as well as develop and build a global supply chain."



BBOXX

Provided water and electricity for millions

RONALD TILBROOK GERRARD (Civil Eng 37) was born on 23rd April 1918. He oversaw the construction of huge hydroelectric dams, providing drinking water and electricity for millions of people. He was a life member of CGCA.

In an era when British consulting engineers dominated the world market for vast infrastructure projects, he was a key adviser to the World Bank which was funding major infrastructure schemes in Malaysia, Pakistan and Lesotho. He advised on the feasibility and engineering design of what were hugely challenging schemes in remote areas, where there were no established construction industries.

Born in Southampton, Ronald attended Dartford Grammar School, then studied civil engineering and surveying at City & Guilds College, graduating in 1937. After two years designing sea defences, he was commissioned into the Royal Engineers in 1939, at Bangalore. Soon promoted to lieutenant in charge of No 1 Bridging Section, he spent 18 months in Iraq and returned to India in 1942 for service in Assam and Burma. He was promoted to Captain and to Major in charge of 422 Field Company, building forward landing strips, roads and bridges.

Demobilised in 1945, he worked on the expansion of RAF Northolt. This was followed by two years on coastal defence work. In 1948

he joined Sir William Halcrow & Partners and worked on the design and construction of hydroelectric schemes. From 1951 to 1954 he worked for the Montreal Engineering Company, returning to Britain three years later to join the civil engineering consultancy that became Binnie & Partners, where he would remain for the rest of his career. He was made partner in 1959 and senior partner in 1974.

His projects included the Cameron Highland and Batang Padang hydroelectric schemes in Malaysia, the Mangla hydro-electric scheme in Pakistan (for which, in 1968, he was awarded the Telford Silver Medal), the Maseru water supply project in Lesotho, and flood defences for the north bank of the tidal river Thames. He was a council member of the ICE 1974-77; Chairman of the Association of Consulting Engineers 1969-70; and Chairman of the MAFF Flood Protection Committee 1979-82. He was elected a Fellow of the ICE in 1957, of the City and Guilds of London Institute in 1975 and of the Royal Academy of Engineering in 1979. He retired in 1983, having served as senior partner for nearly 10 years. In retirement, he pursued his life-long interest in water colour painting.

Ronald died on 10th February 2013, aged 94, mourned by his wife Cecilia, whom he married in 1950, and family.

Long Service in Scouting

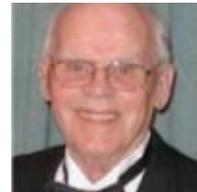
DOUGLAS WILSON HAIGH (Chem Eng 40) was born in Barnsley, on 7th January, 1919. A veteran of WWII, he lived in England, India, Australia, Sri Lanka and Canada, was a Chemical Engineer by profession and spent many years in the Boy Scout Movement.

Douglas studied Chemical Technology at Imperial College, 1937-40. He was on the first XV Rugby Team, served as Hon Secretary of the Guilds Rugby Club and of the Guilds Athletics Club, and was one of the first four graduates in Chemical Engineering.

He trained with the Royal Engineers, joined the 79th Armoured Tank Regiment and, as a Second Lieutenant, landed with the Canadians on Juno Beach on D-Day, staying with them through Holland and into Germany. In 1994, he was again at Juno Beach, for the 50th anniversary of D-Day.

Returning to England, Douglas met Anne Sager. They married in August 1947. Douglas was the Scoutmaster of 1st Davyhulme Scout Troop.

In 1952, Douglas found work at a Pulp and Paper Mill in Tasmania,



built his own home there and continued his involvement in Scouts, Rovers and the Church Choir.

In 1963, the family moved to Canada, Douglas accepting a

job with a consulting engineering practice. He learned soon after that the company wanted him to spend two years in Ceylon (Sri Lanka).

In 1966 the family returned to Vancouver. Douglas was again involved in the Boy Scouts, becoming a District Commissioner, and over the years was an officer in various clubs. He was awarded the 35 year Service Medal and Long Service & Good Conduct Medal in Scouting.

After his retirement in 1982, Douglas travelled extensively, enjoyed many hobbies, read widely and kept up to date on world politics. He founded and attended various local societies and sang in Church Choirs.

Douglas and his dear wife Anne celebrated their Golden Wedding in August 1997.

Douglas died on 5th March, 2012, leaving a son, daughter, 3 grandsons and 2 great grandchildren. *

OBITUARIES

UK representative on standards bodies

(From an Obituary in the Institution of Engineering & Technology Members' News, March 2013)

DAVID GOWER ('DAI') JONES (Elec Eng 38) was born on 4th March, 1918, in Streatham, London.

He graduated from City & Guilds College and became a life-long member of CGCA. After a brief spell with Marconi Wireless Telegraph, David joined the Post Office as an assistant engineer in 1939. He was engaged by the Post Office Radio Group at Dollis Hill Research Station in the 'design of circuits and apparatus for telephone, telegraph and radio plant'.

In 1941, he was commissioned into the Royal Signals, eventually spending much of the war at the Military College of Science in Bury as a lecturer in radio principles and equipment, reaching the rank of Captain.

After the war, and back in the Post Office at Castleton, he oversaw technical developments in relay circuits and aerial performance of the new London-Bristol-Cardiff FM Band Radio Relay system for telephony.

During 1958, David became responsible for planning and managing development of a new national microwave link network

for telephony and television, a major technological leap forward from the then largely coaxial cable-based trunk networks. This included the microwave link equipment in the relay towers of which the Post Office Tower in London was the principal node.

His work also included chairing the UK's national panel of the International Radio Consultative Committee, Study Group IX, responsible for international agreements on standards for international radio relay systems, and he often represented the United Kingdom at the International Telecommunication Union. His final ten years were spent as a senior staff engineer, overseeing Post Office technical and procurement development projects.

David retired in 1980, was widowed shortly afterwards, but remained active. A keen singer, he spent 53 years with the London Bach Choir.

David died peacefully on 3rd February 2013, in his 95th year, leaving four children and six grandchildren.

"The best boss I ever had"

ERNEST LOW, (Civil Eng 54 DIC) died 15 April 2013.

Born on 19 January, 1927, in Hankow, China, Ernest studied Civil Engineering at the University of Hong Kong. After working in Borneo, as site engineer for railway reconstruction, and in design of reinforced concrete structures, he came to City & Guilds College in 1953 to study for his DIC in soil mechanics and foundation engineering. From 1954 to 1959 he worked as a senior engineer and, from 1959 and 1969, as Manager, Site investigation.

From 1969 to 1978 he was a partner in Low and Parsons Brown, specialising in geotechnical works and offshore engineering. In 1976 he also set up a partnership in Hong Kong, but from 1988 onwards he acted as an independent consultant, based in London.

The following is taken from a tribute given by his son-in-law:

"After a nomadic childhood, some of Ernest's happiest times were spent at University, and working in Borneo. The fact that he remained in touch with so many people from these times is testament to his sociable nature. He had a wide range of knowledge and, with his wry sense of humour, he was extremely good



company.

"Ernest worked as a civil engineer before moving into consulting, specialising in geotechnical engineering. He has been described by many of his former employees as 'the best boss I ever had'. They remember how he helped build their confidence and launch their careers. Ernest also worked as an arbitrator, for which he was much respected, and he was the first Chinese man to be admitted into a Livery Company in the City of London.

"Ernest gave of his time to many groups over his lifetime, from the City & Guilds College Association to church working parties and Freemasonry.

"Ernest enjoyed family life, teaching his children to swim, building dens in the garden and the normal pursuits of a normal family." *

"A gem of a human being"

WILLIAM GEORGE (BILL) LOVELL (Elec Eng 75) died on 13 March 2013, at the age of 58. While studying Electrical Engineering at City & Guilds College from 1972 to 1975 he met his wife Deborah, through the university chaplaincy. Bill went on to become very well known, worldwide, in the fields of television cinematography and digital video photography.

Bill joined the BBC at Ealing Studios, progressing to be Sound Operations Manager and, later, Head of Technical Services. The following is from a tribute given by Nigel Walters:

"It was my good fortune to meet Bill when he joined the BBC, 37 years ago. He radiated enthusiasm and inspired confidence. A colleague wrote: "Often...when I had a problem, Bill popped out of his office to assist, in that inimitable way of his; at once humble and authoritative, gentle and positive – and ALWAYS helpful."

In 1996, Bill took voluntary redundancy and moved to Arri Media, becoming involved in the emerging digital side of the industry.

He became the Head of Digital and 3D, involved in the development and promotion of several of their industry-leading digital video cameras.

"At Arri Media, Bill showed the same generosity and kindness which had made him so popular at Ealing. MD, Franz Kraus, said Bill's calm, respectful personality and sense of humour made him friends around the Globe. Bill was trusted by everyone.

"Bill Lovell – you brought your ethics to the work place by quiet example – always full of hope and infectious optimism. Even in the darker days, exploring new technology, you had faith in your colleagues, and believed that a team effort would succeed. Above all you loved people; your greatest pleasure in life appeared to be helping everyone. You were truly a man of Faith, Hope and Love, a Christian gentleman."

Bill is sorely missed by his wife Deborah, son Simon, daughters Beth & Ruth, and by a young grandson.*

A Friend, Colleague and Mentor

Provided by his friend and colleague Jörg Imberger, Center for Water Research

TONY MAXWORTHY (Mech Eng 54), a great experimentalist in geophysical fluid dynamics who held the Smith International Professorship in Mechanical Engineering at the University of Southern California (USC) Viterbi School of Engineering, died on 8th March 2013.

Engaged in some experiments in his lab, Tony collapsed and passed away almost immediately, as he was about to enter the building to do what he loved most: discover new things about fluid motions and teach students, not just about fluid mechanics, but to instil in them his passion for research.

Born on 21st May 1933 in London, Tony became a naturalised US citizen on 17th March 1961 in Los Angeles. He received his BSc(Eng) (1st Class Honours), and ACGI from Imperial College in 1954, an M.S. degree from Princeton University in 1955, and a PhD from Harvard University in 1960, all in Mechanical Engineering. His primary research interests were in environmental and geophysical fluid mechanics, aerodynamics, turbulence, solidification, convection and bio-fluid mechanics. He was a member of the National Academy of Engineering, and a Fellow of the American Physical Society and the American Academy of Arts and



Sciences and a Life Fellow of Clare Hall, Cambridge University. He received the G.I. Taylor Award of the Society of Engineering Science, a von Humboldt Senior Scientist Award and the Otto Laporte Award of the American Physical Society.

Tony and Anne visited CWR many times, starting in 1985 when we all went down to Margaret River for the Environmental Fluid Dynamics meeting (photo above). I am greatly indebted to Tony for the advice he offered and the example he provided, a world leader in experimental fluid dynamics, devastating in his ability to see the answer before the question was even finished and a wonderful friend who loved life and adventure.

Tony you shall be missed. Anna please accept our sincerest condolences.

More complete versions of obituaries marked with an asterisk * can be found on our website (see page 2)

His drive and perception will be missed

E. R. (ROGER) PLACE (Chem Eng 59-66) died on 19 May 2013.

In 1964, Roger married Jacky, who survives him, as do his 4 children and 8 grandchildren.

After graduating in 1962, Roger joined Professor Weinberg's research team on the formation and control of carbon particles in rich ethylene/air flames using opposed flow porous disc burners. He was also one of the postgraduates who ran the steam plant to extend the Callendar Steam Tables to higher temperatures and pressures. An enthusiastic member of the IC Rugby Team, he was a veteran of encounters with bruising opponents including the Metropolitan Police Team. He maintained links with the City and Guilds College and the Department of Chemical Engineering throughout his life.

In 1967 he joined British Titan Products Ltd (now Huntsman Pigments) and worked in the Central Research Laboratories. There, using very similar technology to the porous disc burners, he was part of the team investigating the kinetics of the oxidation of titanium tetrachloride and the factors affecting the particle growth of

titanium dioxide pigment. He played a major role in the development of a mathematical model of these processes and its integration into fluid dynamic models of production scale reactors. He was to remain heavily involved in the development of Huntsman's unique process for the production of titanium dioxide pigments via the oxidation of titanium tetrachloride for the whole of his career at Huntsman Tioxide.

Roger left Tioxide in 1994, continuing his interest in particle technology as an independent consultant. As Vice President (Technical) of the International Fine Particle Research Institute, his responsibilities included servicing the members of the Technical Committee and ensuring their decisions were made effective by liaising with and providing direction to university personnel, worldwide, contracted to do the IFPRI sponsored work.

He always provoked the alternative view and made his colleagues question common conventional thinking and assumptions. He had a real love for the science and his drive and perception will be missed.

Always fascinated by steam railways

ROBERT HUGH DE WARDT (Elec Eng 45) was born on 17th May 1925. He studied Electrical Power Engineering between 1942 and 1945, and was a winner of the Sir William Siemens Medal. He pursued a distinguished engineering career in the chemical industry, whilst contributing generously of his spare time to the renaissance of steam railways in North Wales.

After 11-years at the GPO in telecoms R&D and managing telephone exchange maintenance, Robert joined Imperial Chemical Industries in 1957. He ran ICI's Wilton Power Station for 4 years, then moved on to manage the carbonylation alcohol plant. From 1969 to 1978 he managed construction activity at ICI Wilton, overseeing a major expansion in olefines processing plant. ICI moved him to northern Germany in 1978 to manage the construction of two major new plants at Wilhelmshaven. This was a period during which ICI was beginning to go through major changes which eventually led to its being broken up and, on his return to Britain in 1981, Robert took the decision to move to Fluor (GB) as Manager of Construction, a post that he held for two years up to his 'official' retirement in December 1983. He remained active as a consultant for many years thereafter.



Always fascinated by steam railways, Robert contributed his considerable engineering and organisational skills (and much of his holidays) to helping with the restoration of the Ffestiniog narrow gauge railway and the Welsh Highland Railway. In particular he worked on the construction of "the Deviation" around the Llyn Ystradau reservoir, the creation of which had flooded the route of the original line. Robert and his wife Mary celebrated their diamond wedding on the Welsh Highland Railway on the 5th July 2012, along with a large group of family and friends.

Robert took a keen interest in industrial archaeology. He was also an enthusiastic hiker and cross-country skier.

Robert died on 17th July 2012, aged 87, and is survived by Mary and his children Susan, John and Robert.

Never missed Henley Regatta!

(Obituary provided by Jan's long-term friend Tom Gilbert, Chem Eng 1948-53, and by those who spoke at Jan's funeral on 2nd July 2013)

JOHANNES FRANCISCUS (JAN) SMULDERS, (Mech Eng 49 & 50) died aged 86 on June 14, 2013, after a short illness. He was a life-long member of the Old Centralians (now CGCA), and a member of the Links Club.

Jan's family came to England from Holland in 1940. After boarding at Ampleforth, Jan studied engineering at City & Guilds College and, when he completed his studies in 1950, he decided to stay in England, marrying Brenda. He worked for UK-based companies for the whole of his career, albeit never relinquishing his Dutch nationality.

At Imperial College he took to rowing, winning Morphy races for Guilds, rowing in the IC 1st boat at Henley, and gaining his IC full colours in the process. After graduation, whilst working in London, he coached the IC First Eights.

Jan's house boasted a very small - but essential - river frontage. From here he could embark in his sculling boat. He also kept a motor boat for family outings.

Jan rowed for Thames Rowing Club from 1960-67 and then for Maidenhead. Throughout his life he never missed Henley Regatta, even when this meant contriving to return to London from overseas postings for conveniently-timed meetings taking place just before Henley was due to start!

Jan loved to meet people and to talk. His other loves were of walking, art, and music, especially jazz.

Jan's professional occupation, in sales, engineering and project management, mainly in connection with machinery for the chemical



industry and for oil and gas pipelines, involved travelling widely in Europe, the Middle East and North America. After Clarke and Ingersoll Rand (both now part of Halliburton) he was Engineering Manager at Bechtel. He worked briefly for Air Products, WH Allen and finally for Coopers and Cooper-Rolls.

In retirement Jan enjoyed rowing and boating. He also found pleasure in volunteering at the Stanley Spencer gallery in Cookham.

Jan was a loyal 'Old Centralian', a true friend both of the Imperial College Boat Club and of Imperial College itself. He will be sorely missed by Brenda, after more than 50 years of marriage, by his family and by his many friends. *

Genuine Renaissance man

Provided by his son, Mr John Wills.

GERALD MICHAEL BERKELEY WILLS (Elec Eng 37) died June 27th, 2013 in his 98th year.

Born in Wolmer Cottage, Marlow in 1915, he graduated from City & Guilds College in 1937 and served with the army from 1939 until demobilisation, with the rank of Major.

In 1946 he met, and later married, his beloved Kay during a 7-year tour in Brazil and emigrated to Canada in 1953. Before his retirement in 1980, Michael travelled widely, including a 2½ year posting to England in 1963.

Michael is remembered as a loving and supportive husband, an exemplary father, granddad, and uncle, and genuine Renaissance man. As a dedicated family man and cinematographer, he documented six decades of family history on 70



reels of film. As an adventurer and sportsman, Michael conquered the Himalayan mountains, and later co-founded the Lorne Park (Whiteoaks) Tennis Club. His Racing Demon skills were legendary.

Sorely missed by Kay, John, Susan, David, Peter, Rob, Gabriele, Lee, Julie, Vally, Anne, Melanie, Jamie, Michael, Andy, Kristy, Stephanie, Melissa, Nicolas, Annie, Shirley, Crystal, Tim, and cousin Jimmy. Loving brother of Ken and Margaret, predeceased, with fond memories of Tippy and Pan.

