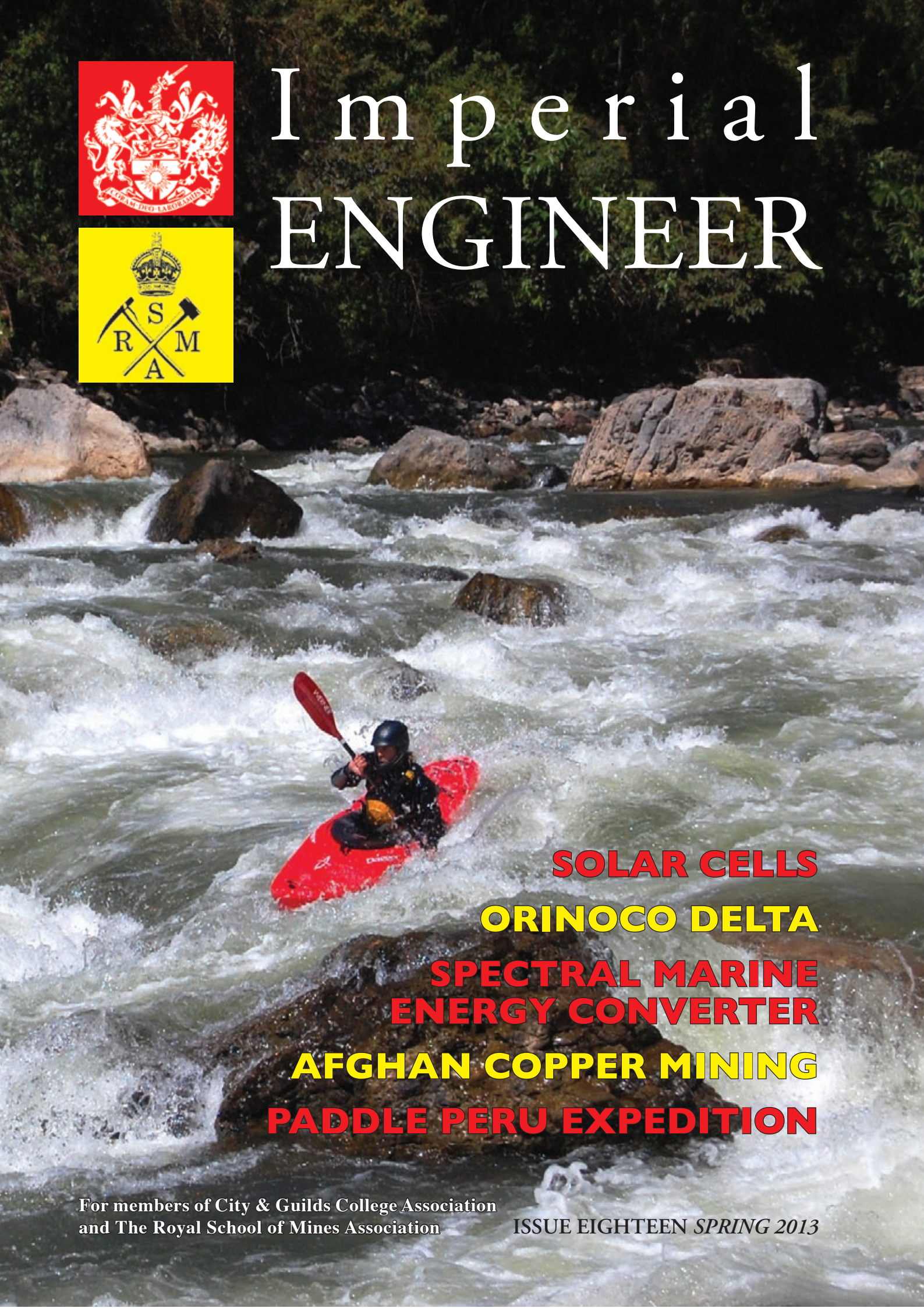
Imperial ENGINEER



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SPECTRAL MARINE ENERGY CONVERTER

AFGHAN COPPER MINING

PADDLE PERU EXPEDITION

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

ISSUE EIGHTEEN *SPRING 2013*

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Imperial ENGINEER

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David Nethercot

Previous Presidents would probably have used this piece to reflect on the success (it is always a success) of our Annual Dinner. This year, however, I can still write in anticipation; in case you have forgotten, we celebrate our One Hundredth Annual Dinner on May 17. Because it is a larger and more ambitious affair, we moved it into a more welcoming month in terms of weather and opted for a Friday evening so as to encourage members living outside London to attend as part of a visit to our capital city. City is the appropriate term as the venue will be the Mansion House, where our Principal Guest, Sir John Parker, will be joined by the Lord and Lady Mayoress, the Chair of Imperial's Council, the Baroness Eliza Manningham-Buller and several Masters of City Livery Companies. It won't simply be a success, it will be a tremendous success. Tempted? Well, I'm afraid it's too late. Not only will you be reading this after applications for tickets close, at the time of writing (March 6) we have only about 20 unsold. I promise a full report in the next issue plus photos on the web site.

In preparation for a previous presidency, the best piece of advice I received was also the first: Make time for it and don't be surprised at anything. I am finding that this is universal, i.e. applies just as much to CGCA as it did to IStructE. Being (partly) retired and a little older this time, I am finding it easier to observe both principles. One of the Presidential roles I can always find time for, is engaging in activities that bring the Association closer to the Imperial Engineering students. They certainly appreciate opportunities to mingle with those with experience of the world beyond College – particularly in terms of career choices – and we benefit by reminding them that they will soon be alumni and being part of CGCA is their best way of retaining a secure link with those parts of the College where, I am sure, they spent many happy hours at a formative time of their lives.

After the Dinner, our next major event is the President's Evening and AGM in early June. The speaker (not me again), date and venue are all fixed and we will have an important Agenda item concerning membership of the CGCA General Committee. A major reason for the suggested change is to enhance opportunities for engagement with alumni and students by associating Committee members more obviously with the Engineering Departments in the College. The idea is explained more fully elsewhere in this issue. Study the material and if you feel minded to contribute to the discussion at the AGM do please come along.

PRESIDENTS REPORT

Mark Burridge

The last year has been quite a significant one for the Royal School of Mines. The RSM as a constituent college has been re-recognised by College and the crossed hammer and pick emblem is once again prominent in the entrance of the building. The RSMU (student union) has also been again recognised as an independent student body.

On the social front, last year saw an overcapacity Annual Dinner. It was great to see so many alumni turn up for the event, clearly enjoying themselves in true RSM style. In particular I would like to thank Teresa and her helpers for their usual efforts in organising and the organisers and contributors to the raffle (which raised £613). We also managed to break the recent trend of just having "mining" centric speakers and we had Steve Patterson as our guest speaker. Steve is Head of Materials at Shell, thus we killed three birds with one stone by having RSM materials representative, an oil industry representative and an entertaining speech. A full report with a photos of some of the diners is included in this issue on page 5.

This year's dinner will be held on November 29th so please make a note in your diary. We are also reviewing options for a larger venue.

Outside of the UK, I am pleased to report that formal social events are still a regular occurrence in Toronto, Perth and Sydney and informal get togethers occur in various other jurisdictions.

You will be pleased to know that we once again thrashed Camborne at the annual bottle match at Harlington (see Lewis Ryan's report on page 7). Many alumni turned up to the match this year and we are now planning to make this event a regular alumni get together.

As my and other committee members' tenure comes to an end this year, we will be electing new committee members and officers at the AGM. Nominations/volunteers have been received for the committee and once again this is oversubscribed. The key nomination is for John O'Reilly to succeed me as President, a choice that I know many alumni will happily support. Details for the elections and nominations will be included in the circular to be mailed out ahead of the AGM which will be held on 27th June 2013.

The AGM will be followed by the final year student barbecue. The booking form for the AGM and Barbecue is included with this issue of Imperial ENGINEER. It would be great to see alumni there to encourage graduating students in their career ahead.

While we have a strong alumni platform, graduating students are the lifeblood of the association. So we are making a drive to devote increased resources to funding vocational student experience and involvement of the association. In the short term, we are establishing plans to increase funding support for students in gaining field and practical experience; developing mentoring and career day support; and looking to add a third formal social event to the annual calendar around the bottle match. In the longer term, the ambition is to support the College in providing more vocational education and dialogue has been opened with the current RSM faculty regarding this initiative.

To fund this in the long term, the plan is to launch the 1851 funding drive which I have discussed in previous editions. In the short term however, we are pushing ahead with a membership drive. Our goal is to encourage non-member alumni to join and to encourage those members who are not currently paying the £15/year annual subscription to voluntarily do so. We are in the process of finalising online payment and joining mechanisms to make this process easier. In the meanwhile, the current membership/payment form is available for those who wish to revise their contribution or make a voluntary donation. I should note that many more of you will be reading this issue of Imperial ENGINEER via electronic means as we have made the decision to divert the costs of printing and mailing this magazine towards association activities. So only those who are paying the full annual membership fee will receive the magazine in hard copy. Of course everyone is still entitled to the electronic copy and for those who really want a hard copy, just ask and we will send you one as we will have a few extras printed up to cover this eventuality.

In case of any questions, please don't hesitate to contact the association via t.sergot@imperial.ac.uk. I look forward to seeing many of you this year.

Imperial College Alaska Expedition

Supported in part by a grant of £2000 from the OC Trust, four climbers from Imperial headed off to Alaska.

On the 5th of June 2012 they boarded a DHC-3 Otter plane which landed them on the Jeffries Glacier, in the St. Elias Range area, Alaska (60° 38.1N, 141°08.735W). Over the course of the following 30 days, the expedition explored the sorrounding area, which included the Baldwin glacier and the Fraser glacier, and climbed 13 peaks of which 6 were first ascents. Moreover, 2 of the peaks were climbed via 2 different routes. Alpine climbing and ski mountaineering were the techniques used. In general the rock was of a poor quality. The team therefore made the decision to choose the routes based on the quality of ice and snow on a particular line. The team spent most of the time climbing in pairs, thus achieving a high number of climbs. The grade of climbing ranged from Facile to Difficile. The highest peak climbed was Siris peak, 12050ft (3673 m) and the highest 1st ascent was peak M-79 with a height of 11350ft (3460m), (60°40.443N, 141°10.392W). The main basecamp was established next to where the plane landed, (60° 38.1N, 141°08.735W), on the Jefferies glacier, the pick-up location was set to be the same as this was a safe place for the plane to land.

The weather conditions were extremely mixed. Out of the 31 days we spent there, 15 had good weather and 15 were very poor. On the good days, temperatures rose considerably during the afternoon getting to above freezing on many ocasions, especially in the lower areas of the Fraser glacier. On the other hand, on the poor weather days, snow storms, high winds, zero visibility, and cold temperatures were commonplace.

Arnaud Sors, Finance Officer; Sam Thompson, Medical and Communications Officer; Boris Korzh, Training and Equipment Officer; Sara Arbós-Torrent, Expedition Leader.

Accepting the torch

Taking on responsibility for Imperial ENGINEER is an exciting challenge, especially following in the footsteps of Bill McAuley and Lynn Penfold. However Alison and I have an experienced and talented Editorial Board to guide and support us; they will help ensure that the transition is as seamless as possible.

Although many of the features were already chosen and underway before we took the reins, I am pleased that we have such a diverse collection of articles to offer you in our first issue. It helps to emphasise not only the range and reach of Engineering but also of Imperial College. Across the globe, Imperial students and alumni are there, helping one way or another with practical support, innovative approaches and leading-edge research. Something of which we can all be proud.

Members of the alumni associations are aware of activities and events organised for their benefit, and Imperial ENGINEER helps to inform everyone about the breadth of those activities. On which subject, I would like to draw your attention to the Alumni Reunion during the Imperial Festival (see left). Last year's was very entertaining!

We include alumni news, and for many of our readers this may be their main source of such information. So, if you think others would like to know what you're doing, let us know.

As Imperial ENGINEER is only published every six months, it is difficult to include up-to-date news about the Engineering Faculty or College as a whole, so I heartily recommend that those with access to the Internet regularly visit the new Imperial News website for instant gratification!

Peter Buck (Computing 79)
Editor, Imperial ENGINEER

Correction

We regret that in the obituary for Joe Knevitt (Mech Eng 38) in IE16, Joe's surname was spelt incorrectly and some other gremlins clearly got control of the typewriter! There is now a recently-obtained and very interesting obituary for Joe on the website.

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 IE18 bundle at:
http://bit.ly/IE18links

Imperial News

Keep up to date with news from Imperial on the newly transformed Imperial News website. With theme pages for health, science, engineering, business and college & campus, the site is designed to be just as slick on mobiles and tablets as it is on desktops.

http://imperial.ac.uk/news

RSMA Annual Dinner 2012

The unquenchable spirit of the RSM lived on among the 111 alumni, students and guests who attended the 128th annual dinner at The Polish Club, last November.

In toasting the RSMA, president Mark Burridge stressed the importance of the current membership drive, adding that it was a little remiss for committee members not to be up-to-date with their subs! He also thanked Teresa Sergot for organising the event.

Vice president John Sykes welcomed the strengthening ties between RSMA, the CGCA under its new president David Nethercot and RSMU and CGCU. He also thanked another guest, Lynn Penfold, who was retiring after 20 years producing a magazine for RSMA. RSMU president, Lewis Ryan, responded for the guests, thanking once again RSMA members who had sponsored tickets for students attending the dinner.

Other presentations during the dinner were made to Materials PhD student Stephen Tay for his winning essay in the annual competition. His subject was the use of solar cells in reducing fossil fuel dependence (Ed: see page 17).

A lively table of mostly 60s graduates, a few more recent, plus guests. From left: Andrew Bell, Mike Nott, Pete Bridges, Jim Crawford, George Lock, From front right: John Ballard, John Horsburgh, John O'Reilly, Pete Hoddinott, John Mortimer and Chris Webborn, Geoff Parsons and Bernie Pryor

Unfortunately, Ron Butler, winner of the Peter Harding Medal, was at home in Sydney although present by letter. His dedication to RSM traditions, through the running of a strong alumni group, was felt to be in the spirit of the Medal's originator (Ed: see page 6).

Another highlight of the evening was the amusing and thought-provoking speech by Steve Paterson, head of materials for Shell UK. It took the audience back to the oil boom of 1981, comparing it to today when oil is once again at around £110 a barrel. He stressed the necessity for new methods (like shale gas), especially now that India and China are driving the economy, whatever one is selling.

After formalities it was, of course, back to the Union Bar.

Lynn Penfold

CGCA Christmas lunch–an Olympian feast

The customary delight that is the annual CGCA Christmas lunch took place on 10th December 2012 at 170 Queen's Gate. A good turn-out was not only able to enjoy a sumptuous three course lunch, but was also able to hear a fascinating address by president David Nethercot's guest, Sir John Armitt.

Sir John headed the Olympic Delivery Authority and is widely acclaimed as the guy who "made it happen" for London 2012. The purpose of his talk was to share some lessons learned from delivering the infrastructure, venues and transportation needs of the games. This article gives a flavour of some of the points he covered.

With responsibility for the budget of £9.3 Billion ($14B, €10.7B) agreed with the UK government, Sir John oversaw the two year planning exercise, four years of venue construction and associated delivery activities, and final year of testing. This 2-4-1 pattern was, he reckoned, a good template for most large projects. He cited a couple of notable examples (London Heathrow terminal 5 and the newer Hong Kong airport) where the testing phase had not been done properly, with disastrous consequences in the early stages of live operation.

The most fundamental thing Sir John gave as the reason for successful delivery – of the London games or indeed any large project – was to align the interests, incentives and motivations of all parties concerned – notably suppliers as well as client bodies. It's about people, not technology, he said. In the case of the games, they quickly decided that time (given the fixed deadline), cost (given the budget's size and that it was public money) and safety (not one person died working on the entire 2012 programme) were to be their top three themes. These should be, and were, made common to all activities, with key decisions oriented towards them. This applied to everything, whether big or small, high or low level. The three main themes were complemented by others such as sustainability, diversity and impact on the local population. Sir John was clear that aligning everyone – influencing behaviour and essentially defining success – around these themes was key.

Being the leader of the whole 2012 Programme, Sir John was kept busy with a lot of stakeholder management. He mentioned how honesty was always the best policy, and that he had applied this to his dealings with the government opposition party – until 2010 the UK Conservative party. It was important to talk to them, not only in case they came to power (as they subsequently did) but also because opposition parties can often cause quite a bit of trouble when talking from a position of considerable ignorance! When, after the 2010 General Election, the Conservatives did form the present coalition government, they found themselves not being told any "new news". This they found pleasantly surprising, Sir John said – but then that perhaps speaks volumes about trust levels amongst politicians!

Another aspect of delivery that Sir John raised was the beneficial role played by the Programme Assurance function. In particular, carrying out frequent, in-depth risk reviews, plus good auditing of project data, led directly – he said – to safer, more confident delivery. Risk management has come a long way in the last decade, and it was interesting to hear Sir John single it out as an important aspect of influencing project delivery. The results speak for themselves, of course.

All in all, those present were privileged to hear Sir John speak. He summed things up by saying that the important thing when leading delivery of projects, no matter what scale or complexity, is to keep asking why you should do things, as well as how. London 2012 was challenging, and not everything went right of course. But the end result was widely acclaimed to have resulted in a brilliant 30th Olympiad, showcasing that the UK can safely deliver large projects, on time and within budget. And that's without taking into consideration, but not forgetting for a moment, that UK athletes went on to win a shockingly large number of gold medals!

The work to deliver the London 2012 legacy commitments continues, with Sir John remaining very much involved. It is reassuring to think that the considerable work yet to be done, predominantly in the Stratford area of east London, will benefit from his tremendous skill and experience.

Peter Chase

RSMA EGM

An Extraordinary General Meeting of the Royal School of Mines Association will take place at the start of the Annual General Meeting in June.

The purpose of the EGM is to consult members on a change to the RSMA's constitution. It is proposed that the committee structure will be modified and two new positions introduced.

- Membership Secretary
- Vice President International

Ron Butler receiving his PH medal, taken at the Customs House Bar in Sydney, in December. From L to R: John Horsburgh, Peter Lewis, Ron Butler, Ray Dudgeon, Sue Barker, Mike Noakes

Ron Butler awarded PH Medal

Ron Butler studied at RSM from 1949-52, and says the combination of Metallurgy with Geology as a subsidiary fitted him well for his later career, managing broad-based mineral consulting projects. Since graduating he worked in the UK and Canada before moving to Australia. He told John Sykes, International Vice President, "On arrival in 1961 in Sydney, we received a very warm welcome from the RSMA rep, Brigadier Dicky Foot (1910-14, 1919 Mining) and we became good friends. When he died suddenly in 1969, I took up the reins and have held them ever since!"

He was a metallurgist with Consolidated Tin Smelters from '61; from '67-69 he was Project Manager at the Cape Flattery Silica Sand Mine: "I saw this operation through from detailed exploration to initial export production. It is gratifying to see that it is still in operation, exporting 2-3 million tons of high grade glass sand per year to Japan." He moved to Macdonald Constructions in '69 and then in '71 to become Chief Metallurgist with Robertson Research Australia, where he stayed to become MD in '79 and Chairman in '87. As a self-confessed "soft touch when volunteers are required", Ron has spent his time not just helping RSM and Imperial alumni, but has also been involved in a variety of activities, ranging from the JORC Committee (about 15 years), Mineral Industry Consultant Association (Founding Member, 1981, Chairman 1990), to providing computer activities to nursing home residents ("I'm not one yet!" he adds).

The Peter Harding medal was set up in recognition of the contribution that Peter made over many decades to the RSM and IC communities as a student and an alumnus. The prize is awarded annually to a person who has demonstrated sustained commitment and outstanding contribution to the Royal School of Mines and/or Faculty of Engineering.

RSMA AGM & Final Year BBQ

The Annual General Meeting of the Royal School of Mines Association will take place on Thursday, 27th June 2013, starting at 18:30 in the College Room, Level 5, 58 Prince's Gate / Prince's Gardens, London. The meeting will include the election of officers for the 2013 / 2014 academic year.

Following the AGM, at 19:00 our President, Mark Burridge will host a BBQ for alumni and the Final Year students of the RSM who have just completed their academic studies. The BBQ will be held in the Garden Room and Terrace at 58 Prince's Gate.

We look forward to welcoming as many RSMA alumni as possible to the AGM and joining in with the celebrations for the final year students and welcoming them into the association. Please see the enclosed flyer or contact Teresa Sergot for more details and bookings.

A Constitutional Change?

Part of the City & Guilds College Association constitution lays out a structure of Group Representatives with the aim of ensuring all age ranges of members are represented within the General Committee. Each group has up to two representatives and these are elected at the AGM.

At the General Committee meeting held on 5th March 2013 at Imperial College a proposal was made, and unanimously accepted, to present an alternative structure for approval at the 2013 AGM (4th June 2013). The proposed structure would align representatives with College departments. At present we have 8 year ranged groups, e.g. Group IV is 1990–1995 and each group has two posts on the General Committee representing alumni of all departments graduating in that year range. In the proposed structure there would be two posts for each department in which an ACGI is awarded and these would represent all graduates from that department as well as taking a 'college wide' view.

The alignment with Departments was thought beneficial as it was felt that people tend to relate more with their class and department and then tend to work in the same industry for a large part of their lives. It would also give a focus in CGCA for relationships with the Departments, staff and structures like Department Societies and student Departmental Representatives. In order to keep a spread of age ranges within the Committee one CGCA Departmental Representative would be preferred to be over 40 and the other under that age. Also the CGCA Departmental Representatives would be tasked with taking a College / Association wide view in all their activities.

This proposal will be presented at the AGM. It is unanimously commended by the General Committee. If accepted 2013 / 2014 would be a transition year where members elected to be (age) Group Representative would be tasked with realigning to a Departmental structure. If the proposal is accepted a reworded constitution will also be proposed at the meeting for its approval.

Your comments are welcome at and before the AGM.

CGCA AGM & President's Evening

The Annual General Meeting of the City & Guilds College Association will take place on Tuesday, 4th June 2013, starting at 17:30 in the Read Theatre, Level 5, Sherfield Building, Imperial College. The meeting will include the election of officers for the 2013 / 2014 academic year and a proposed change to the structure of Committee.

At 18:00 Professor Anthony Bull, Professor of Musculoskeletal Mechanics at Imperial will present a talk entitled, "Surgery – made by Bioengineers" and this will be followed by supper in the Queens Tower Rooms, Level 1 of the Sherfield Building for those that want to attend.

Refreshments will be available from 17:00 on the Level 5 Concourse area just outside the theatre.

Please note that the AGM and presentation are free to all Association Members however a charge will be made for those wishing to stay for Supper. See the enclosed flyer or contact Teresa Sergot for more details and bookings.

CGCA on-line!

The CGCA website has had a revamp over the winter, with updated content, event calendar and pictures. A new section specifically for students has been added (see Student Centre) and this includes the facility for students to apply for free membership on-line. For all alumni and staff there is now an on-line form to apply for annual membership. Take a look and let us know what you think!

http://cgca.org.uk

The CGCA LinkedIn group – 'City & Guilds College Association' continues to grow as well, with 772 registered members as of mid March. The group is used for discussions and to announce forthcoming events. Joining LinkedIn is free, as is joining the CGCA group.

http://linkedin.com

RSMU is a Constituent Union once again

by RSMU President – Lewis Ryan

The Royal School of Mines has had yet another fantastic year, which begun with Imperial College Council passing the new constitution stating that the RSMU is once again a full constituent union within the university. Our renewed status encouraged a warm cheer at the RSMA dinner at the end of the Autumn term, which was well attended by both students and alumni.

RSM also hosted the Bottle Match this year, and won four trophies in total, including the Bottle after a 24-8 victory over Camborne School of Mines. The weekend was a fantastic success, with over 300 supporters making it to Harlington – the most we have ever seen. Chief groundsman at Harlington, Mick Reynolds, has been at Harlington for 24 home Bottle Matches, and retires before next year. The RSM would like to thank Mick for his on-going hard work and support.

The Spring Term was capped off with a brand new event – The RSM Spring Dinner – which was an awards dinner recognising staff, alumni and students who have made outstanding contributions to the RSM. With 140 in attendance, the evening was very well-received by all, and will hopefully become an annual event at the end of each academic year.

The RSM continues to grow within Imperial College, and the students are showing increasing support to the RSMU's events. I look forward to seeing next year's committee taking the Union to an even greater level.

4th year students at the RSM Spring Dinner

CGCU keeps up with tradition and history

by CGCU President – Temi Ladega

CGCU has been keeping up with its traditions this year, having one of its strongest years in terms of academia, sports and other recreational activities.

Links with our alumni association were kept strong, starting the year off with the annual *Meet the Union* event at the Polish Club. All the Chairs, Treasurers and CGCU Executive Committee had the pleasure of meeting members of both the CGCA and OC Trust Committees, over drinks and canapés.

This year we went back to the origin of the Guilds and held a welcome reception for all new undergraduates in the Mechanical Engineering Foyer overshadowed by the CGCU shield and the shields of the founding livery companies. It was a great event attended by many, and the keynote speech was given by the CGCA's Commodore Barry Brooks, Deputy President of the IET.

As tradition and history dictates, the annual London to Brighton run was carried out, with the Bo team carrying guests of the college with few mechanical mishaps!

Carrying on with the success of last year, we put together another extremely popular dinner with industry in which companies from all industries, with a strong inclination to engineering, were invited to mix with over 100 bright and motivated students.

The autumn term ended with the fantastic CGCU & RCSU Winterball, with well over 600 students in attendance at the highly rated Loop Bar on Oxford Street. It was a great end to the year and helped students get into the Christmas spirit.

The CGCU & RCSU Committee enjoying themselves at the Winterball

The spring term was as eventful as the last, beginning with the CGCA Careers Lecture where we were honoured to have CGCA President David Nethercot chair a panel that included: CGCA Treasurer, Peter Chase; The President of the IChemE, Judith Hackitt; and a leader in the finance industry Atula Abeysekera of Cazenove Capital. Students in attendance took away great life stories that will surely prove beneficial to them in the coming years and we look forward to this type of joint event continuing in years to come.

One of the key things we wanted to do this year was to bring back inter-departmental competition and some more inter-faculty rivalry and we did this to great success. This year we held the CGCU Inter-departmental Football Championship where Chemical Engineering took first place, followed by Bioengineering and Civil Engineering. Alongside this, we have brought back the Sparkes Cup (a rugby competition between the CGCU, RCSU and RSM).

We are so grateful to the CGCA and the OC Trust for their great support this year. We know that without them we would not have been able to do many of these wonderful events, and we are very much looking forward to the wine tasting and CGCA 100th Annual Dinner.

Imperial : "greatest scientific institution in the world" – Boris

On 6th March, leaders from business, research and Government joined Imperial staff for the launch of the vision for Imperial West, the new 7-acre campus in White City, which will become London's first major research and translation quarter. President & Rector Sir Keith O'Nions showcased the centrepiece of the new campus, a £150 million Research and Translation Hub, and laid out the College's vision for a £1 billion innovation eco-system where 3,000 researchers will work to solve the scientific challenges of the future. Boris Johnson, Mayor of London, delivered a wide-ranging and entertaining speech, observing that London has been a source of scientific inspiration for centuries. He said: "Here at Imperial you've got the right answer, which is to capture the *flash* of inspiration, harness the *bang* and convert it into *wallop* for the London and UK economy - and that is what you're doing at Imperial West. You'll be following in the footsteps of all the innovators at Imperial that have made it the greatest scientific institution in the world."

http://bit.ly/IE18ImperialWest
http://bit.ly/IE18IWVideo

Electric car challenge

At the Institution of Engineering and Technology Christmas Lecture in December, a team of Imperial engineers discussed some of the challenges they faced in designing an electric car fit for one of the toughest motoring challenges – travelling 26,000 kilometres down the Pan-American Highway, from Alaska to Tierra del Fuego.

Instead of a combustion engine the team's creation, the SRZero, features two motors designed by Evo Electrics (a company founded by Imperial researchers in 2006) and a 550kg battery pack with a capacity of 54kWh. This dealt with the problem of range – at present, even the best electric cars must recharge their batteries, on average, every 150km.

Clemens Lorf, one of the Racing Green Endurance team members, believes that the project has improved the image of electric cars: "Adventures like this excite people, and give them a real feel for electric vehicles. It's not about talk, it's about action and showing what technology is actually capable of doing."

More from the Guardian:
http://bit.ly/IE18SRZero

Head of the River Race

Imperial's Women's 'A' Crew beat over 300 other boats to take victory in the Women's Eights Head of the River Race, London's premier rowing event, on 9th March. "I'm over the moon about the result," coach Stuart Whitelaw said. "It's an incredible race to take part in, and to come home with a win is just fantastic – though this has not happened by chance. The win is the result of more than six months' preparation, so all credit to the girls' fantastic effort." A combined student and open crew, it included PhD student Michelle Vezie (Physics), undergraduates Mel Wilson (Medicine) and Myriam Goudet (Life Sciences) with alumnus Seb Pearce (Mech Eng 05) serving as cox.

http://bit.ly/IE18Rowing

www.racinggreenendurance.com

Clemens Lorf in the Racing Green Endurance team's SRZero electric car in the Atacama desert in Chile, just next to the European Southern Observatory (where several IC Alumni are based)

ICURFC USA Tour 2012

Supported in part by a £1500 grant from the OC Trust, ICURFC had a successful US tour. Some of the younger players tell us what happened...

Meeting at Heathrow on an early Thursday morning, all dressed in garish blue tour blazers, there was a high expectation for a once in a lifetime tour to the US. After a good luck message from the pilot, we stepped onto American soil in Boston with no problems, apart from the so called 'random' searches of some of our players.

The first 9 days we stayed in Boston, allowing us to settle in and scout local bars and pubs in the area. We were also in a motivated mood to train, using the local park, on the first few days, making use of our tour vests in the blazing heat. This motivation was somewhat whittled away as we got further on into our tour. Our first game was against MIT, with our 2nds up against their 1sts, this would have been a good victory to kick off our tour. After a well fought game IC came out on top, in a good stride to start celebrations early. Putting our tour blazers to use, we attended a bar for a sing-song with the locals, and then we went on to the infamous frat parties. It was an eventful night for all, and a good way to top off our first game day.

Our next was near the end of our Boston stop, up against Harvard. After turning up to an artificial pitch, and a pair of posts which the referee deemed unsafe, we were thirsty for another two wins. Proving too strong in both games, IC walked over the locals in two convincing victories. The evening couldn't quite live up to that of the MIT game – the opposing players leaving early to revise for next year's exams, we were left to our own devices. Due to the size of our group we all went our separate ways, searching for places to show off our English accents and loud blazers. Unfortunately all we could achieve were the local bars, which were still able to cater for our celebrations.

Finally we left Boston and travelled south to Washington. After a 10 hour journey in 4 minibuses, including a lot of dubious song choices, we arrived worn out. An early night was had by all, before a long day of being tourists. We managed to view a lot of America's most well known monuments, including the Capitol Building, Washington Monument, White House and a range of Smithsonian Museums. This was by far our most cultural stop of the tour.

Only in Washington for a day, the next morning we left early to head to Philadelphia for our 3rd team of the tour, Princeton. This ended up being our closest game, only winning by a measly 20 points. Princeton were a good opponent, as well as the best hosts so far. Putting all the players up in their club houses, the blazers were out again, this time for a different set up of celebrations, including pre-game, game, and post-game stages of the night. The next day was more sightseeing: the US Constitution, Liberty Bell and most importantly, the steps from the Rocky films.

Leaving for our final stop in New York, we knew our tour was coming to an end. The first couple of days were unplanned, so the majority of us went to Manhattan to see the obvious attractions, such as the Empire State Building, Central Perk and the Statue of Liberty. However a group favourite seemed to be Ground Zero, this really was a must-see memorial. Our final game arrived: against Columbia, and wanting to head home unbeaten, IC were up for our Swan Song. However, it wasn't the best start. Turning up late due to transport issues and finding out the referee had left, we were faced with one of our own players having to referee. Unfazed, we went into the game at a high intensity, too much for Columbia. After a long day and due to injuries a lot of players forced to play two games, we came out with two wins, making a great conclusion to our tour. Again, we were hosted well, attending the rugby frat house to be taught a few lessons at one of their own sports, beer pong. Some argue this was the main competition of the day.

Finally we headed back to JFK for our flight home, after 17 days of unbelievable fun and experiences; we'd like to thank everyone who contributed to the organisation, and also our sponsors for making this trip possible.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Carbon Capture & Storage

Three projects based on Imperial research will share almost half of £20 million new funding from the UK Government to reduce the cost of low carbon energy. Carbon Capture and Storage (CCS) technologies, if developed on a large scale, could reduce the contribution that coal and gas power plants make to national carbon emissions. In the future, this could include strategies to store greenhouse gases underground or convert them to commercially useful products.

Thirteen projects run by scientists in universities and energy companies were given a financial boost by the Department of Energy and Climate Change (DECC), who hope to advance technology for CCS and make it more attractive to investors in the UK.

Dr Paul Fennell, from the Department of Chemical Engineering, is working with the Millenium Generation project that aims to build a prototype power plant in Doncaster in the north of England, incorporating a combination of low carbon technologies that could reduce the costs of implementing CCS by 20%. Dr. Fennell is working with chemical technology company Calix and energy engineers at HEL-East to develop a plant to generate up to three megawatts of electricity while capturing 90% of the carbon waste and creating agricultural lime – a product that farmers use to improve soil conditions for their crops – using a byproduct of this process. The project will receive £5.8 million towards demonstrating that these ideas could make it economically attractive to decarbonise electricity generation on a large scale in the UK.

Dr Daryl Williams, from the Department of Chemical Engineering, is working to reduce the amount of energy required to carry out carbon capture after the combustion process has occurred. His team hopes to do this by improving the efficiency of fluids called amines, which are used to capture carbon dioxide. The team are designing equipment that can be retrofitted to existing power plant designs and avoids problems with corrosion that affects current designs. Dr Williams and colleagues are working with an Imperial spinout called Process Systems Enterprise Limited and the technology company Clean Carbon Solutions. Their project has received £3.35 million funding.

A third project will receive £100 thousand to make commercially valuable organic plastics from the waste carbon dioxide emitted by power stations and industrial plants. Led by Professor Charlotte Williams, from the Department of Chemistry, scientists at start-up company Econic Technologies hope to perfect a technique to help CCS pay for itself by creating substitutes for expensive oil-based hard plastics such as those used to make protective mobile phone casings, foam for furniture stuffing, or insulation and flexible plastic coating used for electric cables.

http://bit.ly/IE18CCStech

Models help predict flood, drought and nitrate levels

Predicting floods, droughts and contamination to the chalk aquifer, which provides up to 20 percent of the UK's water supply, will be easier thanks to models developed by researchers from Imperial.

Dr Adrian Butler, Reader in Subsurface Hydrology in the Department of Civil and Environmental Engineering, and his fellow researchers, teamed up with hydrogeologists and modellers from the British Geological Survey (BGS) to develop a range of models including one that more accurately predicts the time and location of groundwater flooding in southern England, which is the main location of the chalk aquifer. These models could mitigate millions of pounds in flood damages.

Dr Butler and his colleagues, in collaboration with Thames Water, are developing models to assess the effect of drought on water availability in the chalk aquifer.

The researchers are also using their models to understand more about how nitrates seep into the chalk aquifer. Nitrates are the remains of excess fertilizers that farmers put on fields to compensate for the lack of nutrients in chalk.

European directives require the nitrate level in drinking water to be below 50 milligrams per litre in order to prevent health issues such as methaemoglobinaemia, or 'Blue Baby Syndrome', an illness that deprives infants of oxygen in their body tissue and causes digestive and respiratory problems.

When nitrate levels are above 50 milligrams per litre, water companies must treat the drinking water, which is a very expensive process. Dr Butler and his team have, therefore, also created models that predict the amount of nitrates making their way into the groundwater supply.

http://bit.ly/IE18FloodRisk

Quake-proof homes

Researchers at Imperial are developing techniques for improving traditional construction methods used in rural communities in Central and South America, so that homes are more able to withstand earthquakes. Many people in these communities have to build their own homes from limited available materials. The new project aims to show them how they can build homes more robustly using traditional materials. "These unskilled labourers have a poor grasp of the engineering behind their homes, and when this is combined with poor maintenance and inappropriate construction methods, these places are prone to collapse in an earthquake," said Dr Christian Málaga Chuquitaype (Department of Civil and Environmental Engineering), one of the lead researchers. "We hope our research will lead to the construction of robust, sustainable low cost homes."

http://bit.ly/IE18Quakeproof

Printing electronic circuits like stamps

Researchers at Imperial are being backed by government to put the UK at the forefront of a growing global high-tech electronics industry.

Using low cost and high efficiency printing techniques, components such as simple displays, power sources, sensors and electronic circuits could be printed in large numbers onto a single giant sheet, in a similar way to that by which postage stamps are produced.

In the future such technologies could be used to make engaging electronic greetings cards, toys and games, smart packaging and anti-counterfeit devices. They could also be integrated with current medical devices, electronic displays, low-energy LED lighting and electricity-generating solar panels.

New public funding will help to develop economically viable processes for manufacturing these future components and integrated electronic systems on an industrial scale.

Imperial researchers – Dr Natalie Stingelin (Materials), and Dr Paul Stavrinou, Professor Thomas Anthopoulos and Professor Donal Bradley (all Physics) – from the Centre for Plastic Electronics are part of a consortium of four universities that will contribute to the Engineering and Physical Sciences Research Council (EPSRC) Centre for Innovative Manufacturing in Large Area Electronics, one of four new centres funded under the scheme.

http://bit.ly/IE18Electronics

Jolly Angelina

It might not compete with the blockbusters at the top of the video game charts, but *A Puzzling Present* was certanly unique: it wasn't designed by a human, but by a computer program.

In the game, which had the added advantage of being available to download for free in time for Christmas, Santa Claus must use a range of superpowers to navigate through snowy worlds, avoiding prickly holly and collecting presents. The levels and superpowers were designed by ANGELINA, an artificially intelligent program created by Michael Cook, a PhD student in the Department of Computing. "In many ways she is like Photoshop or Microsoft Word but when ANGELINA starts running, instead of waiting for me to do stuff, she works on her own," said Michael. "Through the development of a quirky Christmas-themed computer game, ANGELINA demonstrates just how creative computers can be."

http://bit.ly/IE18Angelina

Regius Professor

Imperial has been awarded a prestigious Regius Professorship, recognising the highest standard of research and teaching in the Faculty of Engineering. This honour is bestowed on the College by HM The Queen as part of her sixtieth anniversary celebrations, to recognise the work of the Faculty of Engineering and its many technological breakthroughs.

Imperial will confer the title on Professor Chris Toumazou FRS and FREng, from the Department of Electrical and Electronic Engineering. Among his many achievements, Professor Toumazou developed one of the world's first cochlear implants to enable deaf people to hear. He has also created a digital plaster, which can remotely monitor a patient's vital signs in the comfort of their own home and a hand-held device that can analyse DNA to determine if a patient is allergic to specific types of medication.

Professor Jeff Magee, Principal of the Faculty of Engineering, said: "This award recognises the world renowned excellence of the Faculty of Engineering, which Professor Toumazou exemplifies."

http://bit.ly/IE18Regius

SpR Exchange

The Orinoco Delta, Venezuela

Dr Farhad Cooper (Aero 2001), Specialist Registrar – Chelsea and Westminster Hospital

Graduates from Imperial certainly do go places, however when I was filling in my UCAS form way back in 1996, for a place on the Aeronautical Engineering course, little did I know that ten years later I would not only be a qualified Engineer, but also a medical doctor working in far flung places around the world.

I was fortunate to have undertaken my first degree at Imperial when I did, as it was the first year that medical students were integrated onto the main campus in South Kensington, and it would be fair to say that they had something to do with me thinking about a career in medicine after my degree. I had always been a practical person but felt that I really wanted to make a connection between my love of engineering and that of the human body, which equally intrigued me. It wasn't until we designed and made a centrifugal pump in our second year that I started reading manuals by RedR, the "Register of Engineers for Disaster Relief" and then attended a course run by them about becoming a humanitarian aid worker. One thing led to another, and I decided that whilst I could do a lot of good as an engineer, I wanted to have a more direct and practical role in alleviating human suffering, and that I would be a lot more use as a doctor as well!

Having graduated, and worked for Airbus for a period in their environment office, I then went on to undertake my medical studies, and was fortunate enough to be able to spend time in Ghana, and Azerbaijan in refugee camps. One of my memories of putting my engineering skills to use wasn't building a centrifugal pump, sadly, but a simple, locally sourced rechargeable lamp for a *Snellen chart* (the charts with decreasingly small letters on it, that opticians use to test your vision). Our concern was that a number of refugees who had poor vision were coming back with

The Orinoco Delta, Venezuela

headaches despite being prescribed what we thought were the right spectacles. The problem was that we had no electricity and the hut was too dark. The challenge was that we needed a way to measure their vision in appropriate light, which didn't rely on electricity, and that was sustainable, so that spares don't need to be expensively shipped in. Hence came our solution – modifying a rechargeable hurricane lamp to be used with a special light box that illuminated a Snellen chart. The result was a device that was bought cheaply and freely available locally, which could charge off a generator overnight and work all day, and which could be replaced or repaired without trouble when need be. And most importantly, patients who no longer had headaches, who were getting the right spectacles, whose lives had been improved, if only slightly compared to the other losses they had suffered.

Following on from this experience, I went to Azerbaijan to another camp for displaced peoples, and then to Harvard, to study under Dr Paul Farmer, a respected medical anthropologist, who has spent a large part of his life trying to alleviate inequalities between people. The motto of his organisation, Partners in Health, was not just equal healthcare for the poor, but "a preferential option for the poor", and this has remained with me ever since.

I have since been fortunate to have completed my house jobs and core medical and specialty training with Imperial College's hospitals and have chosen to specialise in a career in HIV medicine. Having completed my Diploma in Tropical Medicine last year, I am also now a clinical tutor for the course, run in Africa, by the London School of Hygiene and Tropical Medicine.

Below is a taster of my latest expedition, which took me to a remote part of South America. I am most grateful to the St Stephen's AIDS Trust, at Chelsea and Westminster Hospital, and to my consultants and colleagues, for making this happen.

The Orinoco Delta, Venezuela

In May 2012, I was privileged to be able to visit Venezuela as part of the St Stephen's AIDS Trust SpR exchange programme.

A nation that is geographically in South America, but has the largest Caribbean coast of any country in the region, Venezuela also has an extremely diverse population. Translating as "Little Venice", this nation of approximately 27 million inhabitants was populated by indigenous peoples until it was colonised in 1522 by the Spanish. The indigenous people have long been a minority who live on the fringes of Venezuelan society, and it was this group that I was fortunate enough to visit and learn about during my two week trip.

On arrival in Caracas, I took an internal flight of 1 hour to a city called Maturin, in the north of the country, close to the Caribbean coast and the islands of Margarita and the nation of Trinidad and Tobago. Maturin is mainly known for the petroleum industry, which is the main source of Venezuela's vast wealth.

This is relevant because, whilst the country is an extremely wealthy nation in terms of its GDP (almost $12,000 per capita), it also has

one of the highest rates of inflation in the world and is known for its violent crime. The Revolutionary Bolivarian government, led (until his recent demise) by President Hugo Chavez has invested heavily in a state-run system which is able to provide healthcare to all, irrespective of means. For example, there are approximately 20 drugs suitable for the treatment of HIV, all of which are available free of charge to every Venezuelan.

Unfortunately, despite the presence of a healthcare system that is well sourced, there is a significant private sector, of which many middle class Venezuelans take advantage, and the cost of this is comparable to that in any developed nation, often accounting for a significant part of a citizen's monthly salary. Due to inflation, the cost of living is very expensive for most Venezuelans. The only product that is heavily subsidised by the government is petroleum, and a car costs approximately $2 to fill up. Most other costs for the average citizen are comparable to the developed world, if not more expensive.

So what is the relevance of this to the healthcare of Venezuelans, and in particular to that of a minority group such as the indigenous tribes that originally inhabited this land?

Arriving by speedboat at a settlement prior to a storm

Healthcare challenges to the Warao Ethnic Indians

Maturin is the gateway to the most inaccessible parts of Venezuela, known as the Delta Amacuro in the local language of Warao (better known as the Orinoco Delta). The Warao are a tribe who form less than 1% of the population of the country, and who also live on probably less than a dollar a day, if they earn money at all. Most do not speak any Spanish (the national language) and their lifestyle mainly consists of living off the land.

On arrival in Maturin, after a day at the local hospital which is a tertiary referral centre for the whole state of Monagas, we prepared for our trip the following day to the delta. Our objective was to assess the prevalence of infections such as HIV, Hepatitis B and HTLV amongst this very isolated community, who have hardly any contact with the world outside their own settlements and certainly not with any healthcare providers. We also aimed to provide childhood and adult immunisations to every person we came into contact with, and perform a "health needs assessment" using a local translator.

To get to the first settlement, we needed to take a 2 hour ride in a 4x4 vehicle, to the start of the delta, and then spent approximately 6 hours in a speedboat, carrying all our supplies for the following 48 hours including water, food, medical equipment and mosquito nets. There is no electricity or clean water in most of these settlements and so ice and suitable insulating containers were a vital supply to ensure that any blood samples can be preserved until they are transported back.

They live in Palafitos, which are crude structures built out of trees, elevated on "stilt" like platforms, on the edges of the Orinoco River. As a result, they are largely open to the elements and vulnerable. Most Warao live off the land and eat tuberous plants, fish and occasionally creatures from the jungle that surrounds them. They are monogamous and enter unions with the opposite sex after puberty. A minority of males fish for a living and try to sell their catch in the nearby town of Tucupita, but the costs of oil required to run their speedboats is too exorbitant (even though the cost of petroleum is minimal) and as a result, many struggle to make any profit at all.

On arrival and after introducing ourselves to the community chief, we started to collect blood samples, and vaccinate. Most of the community had had no immunisations whatsoever, and from speaking to them via our translator (who is also a fellow doctor) we realised that physical access was the main barrier to them receiving any healthcare. A common theme was that they were delighted when doctors made it to their settlements and they wished we could make more frequent visits. I learned that finding a Venezuelan team who are willing to spend a prolonged period in the Delta was the main challenge given the isolated nature of the job and the lack of access to basic amenities such as clean water, electricity and telephone signals.

This sense of being isolated was most palpable to us, when we found ourselves stranded in the middle of a delta almost 500m wide, filled with brown water that is used for washing, toileting and drinking, waiting for the tide to rise or our motor to kick back into gear. Sadly the delta is too vast for anyone to be able to keep it clear of reeds and overgrowth of vegetation, which often makes any transport impossible. The rivers are also frequented at night by drug traffickers and so it is a somewhat double-edged sword for the police who want to prevent illegitimate use of the waterways.

Several unplanned motor failures and one rain storm later, we reached our base for the night which was spent, with a Warao chief, in a Palafito, a further 2 hours away from the first settlement, in an open air hammock. This was certainly an experience that I will never forget.

On our second day we paid a visit to the military station of Pedernales which is another 100 miles or so from the night base, where we registered our presence with the stationed officers. Despite a sizeable population, this station only has a small medical facility which is staffed not by Venezuelan doctors, but Cubans.

Once again I learned that providing healthcare in one of the isolated communities of the Delta is heavily dependent on attracting and retaining a skilled workforce, and not just funds.

We immunised a further community and collected more blood samples, making a total of 72, which are currently being processed. The results are eagerly awaited.

The city experience

On my return from the delta, apart from recovering from the terrible sun and windburn one gets from being in a speedboat in a tropical country for 8 hours a day, life continued as normal the following day, with a 7am ward round.

The hospital in Maturin is a training hospital for local doctors, and has approximately 500 beds. The majority of the inpatients seen by the infectious diseases team (who look after HIV inpatients) were HIV positive and on treatment, which was fully funded by the state. We did also see a number of conditions that are particular to the tropics such as Myiasis, Chagas and of course Malaria.

Conclusion

Whilst the availability of treatment is not an issue in Maturin and this is a credit to the nationalised system of healthcare in Venezuela, my experience showed me that it takes a considerable amount of willpower and resources to provide healthcare of a similar standard for the isolated indigenous communities who live in the country's less accessible areas. Coupled with the lack of infrastructure, and of caregivers who are able to speak the scores of languages that are spoken by the local communities, it is not an insignificant challenge.

The partnership that has been formed between the hospital in Maturin and the indigenous groups in the delta is a remarkable one, and will hopefully continue to grow and lead to better healthcare for these communities.

My sincere thanks go to my host, Dr Douglas Arias, and all his colleagues at the Hospital Manuel Tovar in Maturin, and Ms Mara Fani who hosted me in Caracas, as well as the St Stephen's AIDS Trust, Dr Mark Nelson and Linda Connor at Chelsea and Westminster Hospital, and of course our funders from Bristol Myers Squibb, who made this all possible.

Spectral Marine Energy Converter ("SMEC")

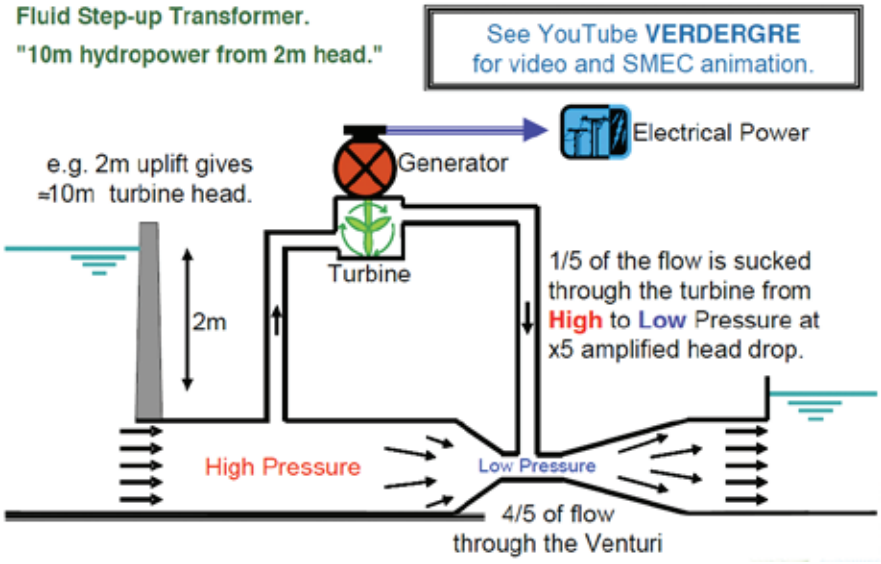
Peter Roberts (Civil Eng 66), Managing Director of VerdErg Renewable Energy Ltd.

When Daniel Bernoulli looked over the bridge nearly 300 years ago he saw that when the river water accelerated through the gap between the massive stone piers, it lost pressure. We know this because his famous theorem, from which modern Fluid Mechanics grew, was published shortly afterwards, in 1738. But we can only speculate whether Bernoulli would have been surprised to learn that it would take until 2006 to first patent the Spectral Marine Energy Converter, which his theorem defines.

SMEC technology is now set to re-commercialise the vast, dormant, sub 3-metre head hydropower market. There are 26,000 existing sites in the UK alone that are potentially suitable, with several times as many possible new sites. Water wheels and Archimedes screws once dominated this market, during the early part of the Industrial Revolution – before fossil fuels replaced them, first coal, then oil and gas. Bernoulli would have known these large, heavy, slow-moving installations as ancient legacy devices, even in the 18th century. But, unlike the steam engines that mostly replaced them, they are still sometimes used in environmentally sensitive locations. As with some other renewable energy technologies, however, their carbon emission benefits come with corresponding drawbacks, including poor economics, noise, and visual intrusion; or detrimental impact on sedimentation patterns, flood risk and wildlife amenity (particularly regarding bird and fish habitats).

Diagrams and photographs: VerdErg Renewable Energy Ltd

SMEC Prototype at Ellers Mill, Cumbria



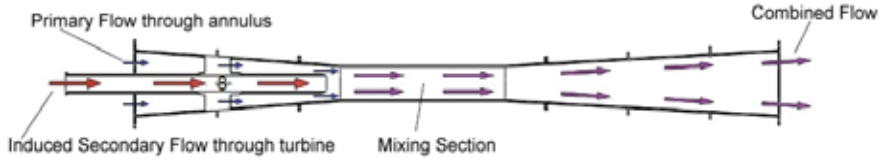
SMEC Basic Principles

SMEC addresses these drawbacks in one simple no-moving-parts device inspired by Bernoulli's Theorem. Eighty per cent of a water flow under – say – a 2-metre high weir, is accelerated through a narrowing gap where its pressure drops, as Bernoulli told us it would back in 1738. The other twenty per cent passes through a modern high-speed turbine which backs onto this low pressure zone so that instead of only experiencing a 2-metre head drop it sees maybe an 8-metre head drop. Small modern high-speed turbines don't work at all well at a 2-metre head drop but are highly effective when they experience an 8-metre head. So instead of a large slow "turbine" like a waterwheel passing 100% of the flow at 2-metres, SMEC has a fifth of the flow at four times that head passing through a very much smaller, cheaper, neater, quieter modern turbine.

Apart from being cheaper and quieter, a SMEC installation can also be completely concealed below ground level to preserve visual amenity. Perhaps its most compelling advantage in onshore rivers, however, in complete contrast with any other form of hydropower, is that because 80% of the flow passes straight through a SMEC without impediment, any fish present in the river can also pass through safely. Tests on live fish will be undertaken over the coming few months, to prove this somewhat counter-intuitive claim beyond reasonable doubt.

SMEC has been developed by a team of engineers whose combined hands-on experience of several hundred years was gained in the offshore oil & gas industry where 'what *can* go wrong, *will* go wrong, usually in foul weather at 2 a.m. on a Bank Holiday'. In developing SMEC, low capital cost, robustness and reliability were prioritised above hydrodynamic efficiency, although that has also turned out to be quite acceptable. A view was taken from the outset that many of the "wet renewable energy" concepts emerging from academia, and elsewhere, had the reverse development priority. They sought competitive advantage through converting incrementally more of the available hydraulic power of a given flow into electro-mechanical power, at the expense of capital cost and reliability.

In the development of SMEC, an engineer's view, rather than a scientist's view, was taken that because the hydraulic power was effectively



Annular SMEC

SMEC across the Upper Solway Firth (artist's impression)

limitless and free at source it was far more important and productive to firstly reduce the cost rather than slightly increase the power conversion efficiency. Cost-effectiveness, not hydrodynamic efficiency, was believed to be the true criterion of success. If highly cost-effective renewable electrical power was to be obtained on an industrial scale, it must come from lower cost not higher "effectiveness".

In the event, a fully-developed SMEC in a river with a reasonably consistent annual flow is now expected to produce electrical power at 3p/kWh, competitive with fossil fuel, without tax incentive. This meets the ultimate challenge for renewable energy and will surely help to secure its popular adoption. It is believed that around 1.5GW of SMEC generating capacity can be installed quite rapidly on rivers in the UK alone without undue collateral impact.

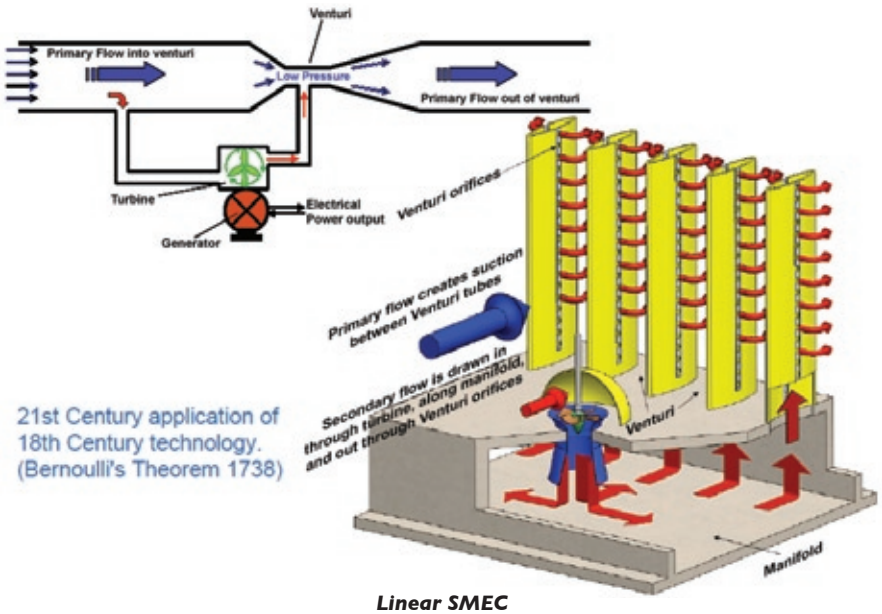
SMEC is also targeted at tidal estuaries where maybe around 3.5GW capacity can be foreseen in the UK over a more extended timescale. SMEC is already selected for a planned crossing of the Upper Solway Firth. Tidal flows stop and reverse twice a day of course, giving tidal energy a less favourable load factor than river power, although it is still attractive. SMEC was one of the three "Embryonic Technologies" selected by the UK Government in 2009/10 for comparison in the context of a Severn Estuary crossing. Compared to a conventional ebb-flow Severn Estuary Barrage said to cost over £30bn, a barrage fitted with SMEC-enabled turbines was shown to produce 80% of the power at less than one third of the capital cost. Using unit cost data supplied by the Department of Energy and Climate Change, a SMEC barrage costing £9.8bn was shown to produce power at 6.8p/kWh at an annualised average output of over 1.3GW.

Critically, because SMEC is porous and works in a very different way to an ebb-flow barrage, the tidal signal in the upstream lagoon side of the barrage is preserved. A conventional barrage is said to permanently inundate over 70% of the upstream wetlands on which migratory birds feed whereas a SMEC barrage inundates less than 10% of this vital habitat.

There are two main SMEC configurations, Annular and Linear. Both are patented. The Annular SMEC is best suited to installations in the 2kW to 500kW range. The Linear SMEC configuration lends itself to larger sites although there is no formal transition point. Both work in the same way, with the primary flow maintaining a reduced pressure on the back face of a turbine located in the induced secondary flow. Sketches of both are shown.

A prototype SMEC was successfully installed with financial support from the Technology Strategy Board at an old weir on a river in Cumbria during late 2012. The purpose was to prove that the results previously obtained in the laboratory could be reproduced in the field. Lloyds Register was retained to witness and certify this achievement. A site photograph is shown opposite.

The first truly commercial SMEC project is now under way and although further development will undoubtedly continue for many years, a very bright worldwide future is anticipated for this curiously "new-old" but nevertheless truly revolutionary renewable energy technology.



Linear SMEC

Peter Roberts was President of the City & Guilds Union, before graduating in 1966. After entry to the Royal Corps of Naval Constructors in the first intake to take a Naval Architecture Masters at University College, Peter joined Brown & Root in the early development of North Sea Oil & Gas. Later, as a Director of JP Kenny, which he joined shortly after its incorporation, Peter moved to Houston as a specialist in ultra-deepwater marine pipelines. Following a few years running an offshore commercial bank, Peter returned to the UK at the Millennium and founded INTEC Engineering's Europe-Africa presence where he was able to lead a management buyout of its subsea connector unit, which was renamed VerdErg Connectors Ltd. Several other specialist technology companies are now being spun out of this core business, including VerdErg Renewable Energy Ltd.

Paddle Peru 2012

Over the summer of 2012, a group of students explored some of the whitewater rivers of Peru, supported in part by the Imperial College Exploration Board and the Old Centralians' Trust

In terms of whitewater kayaking, Peru is relatively unexplored and unknown to the European community. The main aim of the Paddle Peru 2012 expedition was to explore some of the whitewater rivers of Peru and relay our findings to the British and European paddling communities, whilst enjoying some incredible exploratory kayaking.

Outline Aims

- To enjoy independent and self-supported exploratory whitewater kayaking in remote parts of the Peruvian Andes;
- To work with local whitewater rafting companies to explore the potential of new rivers or sections;
- To increase awareness of Peru as a suitable whitewater kayaking destination and report our findings to the UK (and worldwide) paddling community;
- To collect scientific samples of river diatoms on behalf of Adventurers and Scientists for Conservation (ASC).

The primary aim of the expedition was to explore whitewater rivers in Peru independently. The team enjoyed 12 weeks of whitewater kayaking and in total paddled 19 sections of river of which we believe 2 were first descents.

There is limited information on the nature of rivers suitable for kayaking in Peru and as such it remains a largely unexplored destination, especially by British expeditions. Whilst we were there we were successful in uploading many photos and river notes on the rivers we paddled to our online blog, a resource which we hope will be used to help plan further expeditions in the future (http://paddleperu2012.blogspot.co.uk/).

The river diatom study was postponed by ASC, however we were put in touch with the Pacific Biodiversity Institute for whom we collected cultural, land use and environmental observations.

Country Profile

Peru is located on the North West coast of South America and borders Ecuador and Colombia to the North, Brazil and Bolivia to the East and Chile to the South. The Andes mountain range runs the length of the country from North to South and is the source of the majority of Peru's whitewater rivers.

Terrain, Geography and Climate

Peru has 3 distinct terrains – *la costa* (coastal desert), *la sierra* (highlands) and *la selva* (jungle). Whitewater rivers are found in each of the terrain types and we were successful in experiencing whitewater kayaking in each.

The country's dry season runs from April to October and is the most pleasant time to visit Peru, predictably coinciding with the peak tourist season. In these winter months there is less likelihood of weather-related logistics problems (mud slides, floods, etc.) and the level of the rivers is usually more predictable due to the lack of changeable conditions (they are fed through these winter months with the summer rains and snowmelt which collects in the Andes). Generally the volume of the rivers follows the rain pattern and is highest between January and March, and drops off until October when they are at their lowest points. Many rivers can be run year round, however the levels are generally preferable between June and October.

Tim Lamb

Traversing scree slopes with precariously balanced kayaks on the back of tired donkeys, above an almost sheer 400m drop into the whitewater below was a testing experience.

Language

The national language of Peru is Spanish, however in rural and highland areas Quechua is also spoken. With little Spanish experience in the team Tom underwent intensive language classes for 6 weeks before the expedition whilst the rest of the team learnt basic Spanish in their own time. By the end of the expedition we were all competent in communicating in Spanish.

The paddleable section of Rio Urubamba begins on the left of the picture, with Machu Picchu to the right

Adam Holland

Alby paddles 'Purgatory'

Peruvian Whitewater

Most of our knowledge about the rivers in Peru came from Kurt Casey's website www.peruwhitewater.com which provides good guides as to how to reach some of the best rivers and any hazards of which one should be aware.

Due to the remoteness of most rivers, many runs were completed as multi-day trips, taking food and camping supplies with us in our kayaks.

As expected from Kurt Casey's guides, Peruvian whitewater is characterised by high volume rapids formed by boulders which have fallen into the river from often deep cut canyon walls. This creates powerful yet technical rapids, where moves must be made to avoid large recirculating stoppers or siphons created by boulder chokes. The majority of the rapids were read-and-run style. Some rapids required definite inspection from the bank before being run, to identify hazards and to be sure that one could make the line safely. It was sometimes necessary to protect rapids (e.g. with throwlines), often, however, throwlines were of limited use since the width of the river meant that any swimmers or equipment would be carried downstream rapidly, requiring pursuit by kayak.

A number of whitewater rafting companies operate in Peru, particularly on the Rio Apurimac. Kayaking with the safety kayakers of these raft companies was very useful for us as they are well-experienced and knowledgeable about the rivers in their area.

First Descents

One of the aims of our expedition was to investigate the possibility of achieving first descents – navigation of previously unpaddled rivers. Whilst it is very difficult to categorically say that a river has never successfully been navigated by kayak before, we took the following signs to reach that conclusion:

- No previous record, either published online, written in the South American Explorers notes or knowledge from local rafting and kayaking guides of a previous descent by any group;
- No local knowledge, within living memory, of kayakers having travelled to the region or paddled the river before;
- General confusion over what a kayak is and what we were doing there, often accompanied by numerous hand gestures indicating "very bouncy water, big waves, danger" and looks of terror. These were all good signs.

As the specific rivers we attempted required the use of local accommodation and transport or were situated in remote areas where unusual traffic would be noted, it is unlikely that a previous descent occurred within living memory without being noticed by local people. Prior to living memory, boat design would have seriously hindered attempts to navigate this type of water by kayak. All of the first descents we attempted were in the context of multi-days, where we carried food and shelter for several days on the river and intended to make camp at various points along the way.

Itinerary

Our expedition paddling was split into 3 main regions:

Pozuzo	North East of Lima on the edge of the jungle
Cusco	In the heart of the Andes at high altitude
Arequipa	Towards the coast in the South of Peru

Large maps showing the areas in more detail can be found on the 'Maps' page of our blog.

The Team

Alby Roseveare – Joint Leader (Logistics)
4th Year Mechanical Engineering.
President of IC Canoe Club.

Adam Holland – Joint Leader (Sponsorship)
Graduate Architect (2011),
University College London.

Alex Robinson – Webmaster
2nd Year Physics.
Joined IC Canoe Club in 2010.

Derfogail Delcassian – First Aid
2nd Year PhD (Biomimetic Nanomaterials),
Materials Department.
Past President of IC Canoe Club.

Tim Lamb – Media
1st Year Adult Nursing,
Buckingham New University.

Tom Leeman – Treasurer/Food
3rd Year Civil and Environmental Engineering.

Adam Holland

The development of non-toxic and earth-abundant solar cells to reduce fossil fuel dependence

Materials PhD student Stephen En Rong Tay's article won the RSMA essay prize

Current electricity producers that rely on fossil fuels are faced with a dilemma. On the one hand, there is an increase in global demand for electricity as the world population increases. On the other hand, to meet increasing electricity demand by burning fossil fuels would emit greenhouse gases, which contribute to global warming. Hence electricity producers are hard-pressed between increasing supply from fossil fuels and reducing carbon emissions. Furthermore, the finite amount of oil has to be considered by electricity producers when forecasting future electricity generation. In view of these considerations, what is necessary to meet future electricity demands is a gradual reduction in fossil fuel reliance and a shift towards clean alternative sources of energy.

As the world seeks to reduce dependency on fossil fuels, four potential alternative energy sources are typically discussed – wind, hydro, biomass and solar. In terms of efficiency, wind turbines and water turbines have efficiencies of around 60% and 85% respectively, while biomass and inorganic solar panels (solar cells that are not based on conducting polymers) have lower efficiencies of around 1% and 15% respectively. Despite the lower efficiency of inorganic solar cells, solar energy has several significant advantages. Firstly, unlike wind power, solar panels do not create any noise when generating current from sunlight, while wind turbines generate considerable noise from turbine blade rotation and moving parts in the gearbox. Secondly, unlike hydropower, the installation of solar panels does not require large areas; they can be installed anywhere in places where there is solar radiation. On the other hand, installation of hydropower plants requires large areas and water bodies. This heavy dependence on geological landscape confines the use of hydropower to certain locations, such as the Yangtze River in China. Thirdly, solar panels are suitable for providing electricity to rural areas that are isolated from the national grid system as the panels operate independently from the grid. Also, solar panels allow point-of-use power generation, which avoids transmission losses along electrical distribution lines, a feature that the other three alternatives do not have. Finally, the modularity of solar panels offers users flexibility of installation to scale up or down depending on their energy usage. In view of these advantages, solar energy shines as a promising candidate for environmentally-friendly electricity production.

For long-term production of solar cells, there are several criteria which have to be met by the material used. The first criterion for an efficient solar cell is *suitability* in light absorption. A material that absorbs light effectively generates increased watts per square metre. Next, the *toxicity* of the material has to be considered. This is especially important when issues such as waste management and recycling of toxic compounds are considered. For industries, adopting a non-toxic material would result in fewer complications with environmental legislations. Finally, the *availability* of the material should be evaluated for possible long-term use. To meet the growing global electricity demand, an abundant material should be adopted for solar cells. Furthermore, solar cells based on abundant materials would be less sensitive to price volatility.

Through the years, materials scientists and engineers have developed compounds from the Periodic Table that eventually cover the three criteria for long-term solar cell production. In the same way that creative toddlers build toy models using building blocks, researchers develop solar cell materials for practical applications by using elements from the Periodic Table. Figure 1 shows an overview of the evolution of materials used for solar cell applications.

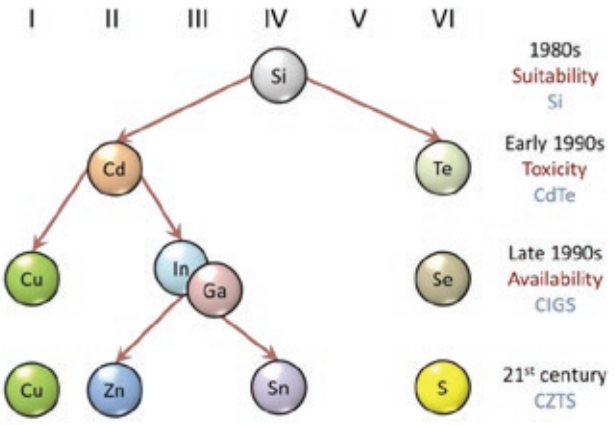


Figure 1: Evolution of materials for inorganic solar cells. Red arrows represent the replacement of elements along the groups in the Periodic Table. The evolution has been driven by three criteria: suitability, toxicity and availability.

Silicon (Si) received much research attention as a semiconductor material during the growth of the semiconductor industry in the 1980s. Si is one of the most abundant elements in the Earth's crust, and its natural abundance further makes it attractive as a semiconductor material for long-term production. Before a semiconductor becomes useful, it has to be doped with impurities. If the impurities introduce electrons into the material (such as phosphorus doping in Si), the semiconductor becomes n-type. On the other hand, if the impurities introduce holes (such as boron doping in Si), the semiconductor becomes p-type. When p-type and n-type semiconductors are joined together, a p-n junction is formed. The p-n junction is responsible for the separation of electrons and holes in a solar cell to generate electricity. The development of the Si p-n junction in the 1980s facilitated the migration of Si to the solar cell industry.

However, one disadvantage of Si is that it does not absorb light effectively. The ideal band gap (the energy required to extract electrons for useful work) for solar cell applications would be around 1.5 eV. However, Si has a non-ideal band gap of 1.12 eV. Furthermore, Si is an *indirect* band gap material, meaning that for electrons to be excited, it requires both a phonon (a unit of lattice vibration) and a photon (a unit of light) for electrons to be extracted for useful work. The need in Si for both phonon and photon for electron excitation results in less efficient light absorption as compared to a material that requires only a photon. To overcome the suitability problem of Si as a solar cell material, alternative materials have been developed.

In the early 1990s cadmium (Cd) and tellurium (Te) were used to form cadmium telluride (CdTe). The compound is used as an alternative to Si due to its direct band gap. Being a *direct* band gap material, CdTe does not require a phonon but only a photon for electron excitation. Furthermore, CdTe has a band gap of 1.44 eV, which is close to the optimum of 1.5 eV. These properties allow CdTe to absorb light more efficiently than Si. The success of the CdTe solar cell was welcomed by experts in the solar cell industry when First Solar announced in February 2009 that their manufacturing costs was US$0.98/Watt, which is below the industry benchmark of US$1/Watt. The exciting development by First Solar demonstrated that grid parity (when the cost of electricity from alternative sources of energy is equal to or lower than the grid) is possible with solar cells.

Despite the success of CdTe, the use of toxic Cd in CdTe production remains an

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environmental concern. Long-term exposure to Cd leads to itai-itai disease which may result in kidney failure and bone softening. The toxicity of Cd has identified it as a restricted substance in the European Union Directive 2002/95/EC Restriction of Hazardous Substances (RoHS). Even though Cd is currently allowed in solar cells, it may one day face the same fate as its close cousin, lead (Pb), which was replaced by Pb-free alternatives to comply with environmental standards. Furthermore, the idea of using a toxic element for an environmentally-friendly source of solar energy seems to be counter-intuitive. In order to overcome the toxicity problem, copper (Cu), indium (In), and gallium (Ga) were used to substitute for Cd, while Te was substituted with selenium (Se). This resulted in the development of the $CuIn_{1-x}Ga_xSe_2$ (CIGS) solar cell in the late 1990s.

The CIGS solar cell has the advantage of a tuneable band gap that can be tailored from 1.0 eV ($CuInSe_2$, when x=0) to 1.7 eV ($CuGaSe_2$, when x=1) by adjusting the ratio of In to Ga. However, the scarcity of In and Se remains an area of concern for long-term solar cell fabrication. In addition, the use of the rare metal In to meet growing global energy demands will not be feasible in the long term. This problem is aggravated by the use of limited In for the growing liquid crystal display and light-emitting diode industries. In order to overcome the availability problem of In, zinc (Zn) and tin (Sn) have been used to substitute for In. This has resulted in the Cu_2ZnSnS_4 (CZTS) solar cell which has emerged as a promising solar cell material in the 21st century.

The advantage of the CZTS solar cell is that it uses elements that are non-toxic and earth-abundant. It is also a direct band gap material with a band gap of 1.5 eV. The potential of CZTS as a solar cell material has attracted much research effort. According to the science database, Web of Science, the number of research publications in CZTS research has increased by more than three times from 2010 to 2011. The suitability, non-toxic nature, and availability of CZTS solar cells position it as a viable alternative to current CIGS and CdTe technology. It is interesting that the modern CZTS material consists of materials used long before the Digital Age such as brass (Cu+Zn), bronze (Cu+Sn), and S.

In November 2011, Guha and his team from the IBM T. J. Watson Research Center reported a CZTS solar cell efficiency of 8.4%, which at the end of 2011 was the highest achieved. In their report, they used a thermal evaporation process to deposit Cu, Zn, Sn and S onto a substrate. Interestingly, Deligianni's group, also from the same research center, reported an efficiency of 7.3% for electrodeposited CZTS. Unlike thermal evaporation, electrodeposition obviates the need for high vacuum and temperature, which reduces fabrication costs. This will be attractive when translating laboratory-level research to industry-level fabrication. Despite this interesting development, CZTS as a new entrant in the area of solar cell materials still faces some challenges. One main challenge is the stoichiometric control of the compound. An excess of metals may lead to the formation of metal sulphides, which degrades solar cell performance. Another challenge is the formation of defects and pinholes that are detrimental to charge transport. In view of these challenges, continued research efforts in CZTS solar cells are necessary to develop it as a non-toxic and earth-abundant solar cell material.

Thomas Edison in a conversation with Henry Ford and Harvey Firestone said "I'd put my money on the Sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out, before we tackle that." To overlook the vast potential of solar energy would be unsound as humanity simply does not have the luxury of time while the earth warms up as limited barrels of oil are being consumed. If Thomas Edison – at a time when solar cells were unheard of – could see the potential of solar energy, it is the author's hope that the world will one day be able to appreciate and develop solar energy, in particular non-toxic and earth-abundant CZTS solar cells, as an alternative to fossil fuel.

Stephen Tay graduated with a first class honours in BEng (Hons) Materials Engineering from Nanyang Technological University, Singapore. During his undergraduate study, his interest in solar energy motivated him to gain valuable practical working experience in both industry (Robert Bosch Research and Technology Center-Asia Pacific, Singapore) and research institutes (Energy Research Institute @ NTU and the Institute of Materials Research and Engineering). Currently, Stephen is pursuing a PhD in the Department of Materials at Imperial. His research is focused on green solution-processing of CZTS solar cells.

Afghanistan's economic future – Copper mining?

Bill Bradford (MinTech 57)

Introduction

About a year ago I was asked to give a talk on mining to a group of retired RAF engineers. Several of them had service experience in Central Asia. This is, in part, an abbreviated version of that talk. It is pleasing to see that the public image of Afghanistan has improved significantly in recent months. A great deal of unpublicised constructive work has been done in the northern part of the country. Sadly it has not produced the headlines that terrorist action in Helmand or Kabul does. Hopefully the perception is changing.

With the winding down of Western military intervention, trade is inevitably following the flag. The country has few options to move it out of its tribal/feudal past, and copper mining appears to be the best immediate choice to boost its export economy significantly and to support an effective government. At the moment China is making the running and has been accused of piggy-backing on Western military involvement.

The illustration below is a summary of the suggested mineral potential of the country based on an essentially geological appraisal. It is not clear exactly how the US$ values of the various commodities were arrived at, but they are probably a reliable indicator of their relative economic importance. The implication is that copper represents about a quarter of the country's mineral wealth (in situ).

Refined copper is a high value material (currently around US$ 8.50 per kg) and hence a remote location is not a negative. Mine sites are relatively well contained and security should be a bearable cost. Product transport would not be a major problem, compared to a low value bulk product like iron ore.

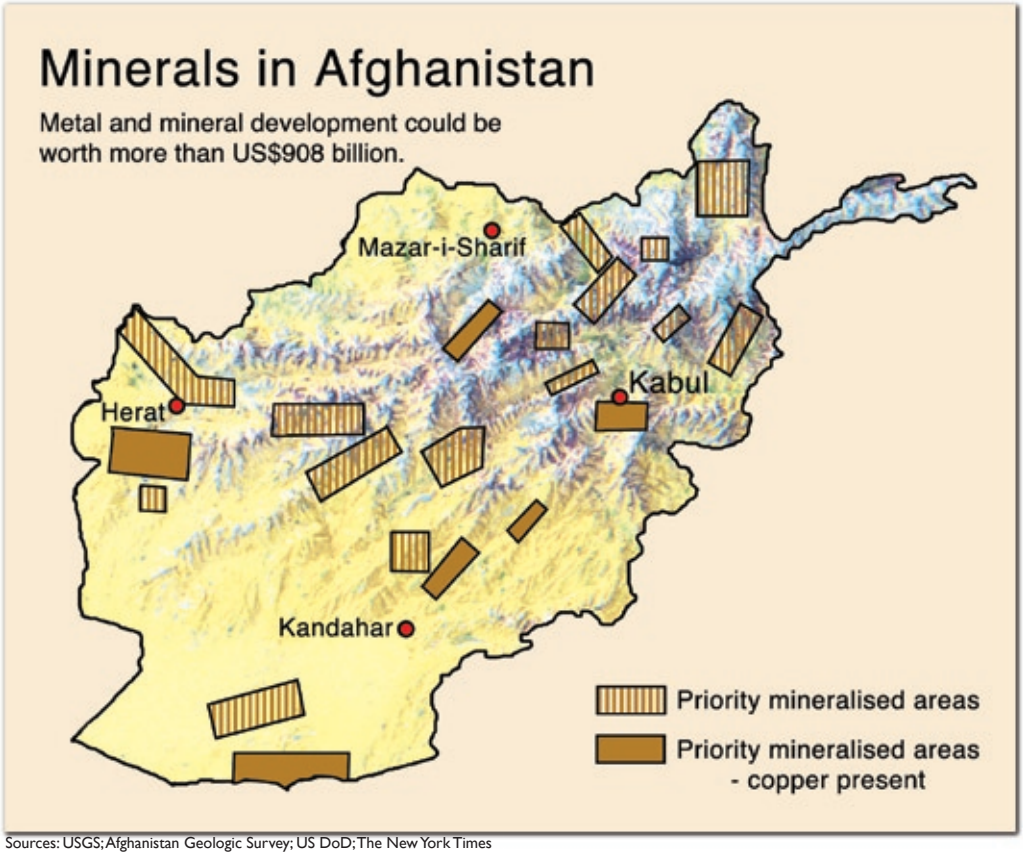
There are a number of other recognised copper prospects in the country, listed on the British Geological Survey website (http://www.bgs.ac.uk/afghanminerals/docs/copper_A4.pdf)

The country also has significant oil and gas potential, but installing pipelines seems to be really tempting fate, quite apart from the general political sensitivity of energy production. This article tries to put Afghan copper in a regional and global context both technically and economically.

Afghan Copper

There are a number of prospects and it is early days to rank them. Aynak in Logar Province, south of Kabul, is a complex but potentially good tonnage, high grade deposit which will probably be worked part open pit, part underground and will probably be the first prospect to start up. The Chinese have successfully bid for it, against American, British and Canadian interests. The politics of this are convoluted, and the Afghan government appears to currently favour the Chinese, at inter-government level. Again – early days.

The best guide to cost is probably the Oyu Tolgoi or Turquoise Hill project in the Gobi Desert in Mongolia. It is a joint venture between a British company, a Canadian company and the Mongolian government. It is the largest financial undertaking in Mongolia's history. It was discovered in 2001 and will be part open pit and part underground. The estimated cost for bringing Oyu Tolgoi mine into production is US$ 4.6 billion and it is scheduled to come into production in 2013. The mine could account for 30% of Mongolian GDP. Production is expected to reach 450,000 tons of copper a year.



Sources: USGS; Afghanistan Geologic Survey; US DoD; The New York Times

Potential value
of known and estimated resources in current prices

	(US$Bil)
Iron	420.9
Copper	274.0
Niobium	81.2
Cobalt	50.8
Gold	25.0
Molybdenum	23.9
Rare earth elements	7.4
Asbestos	6.3
Silver	5.3
Potash	5.1
Aluminium	4.4
Graphite	0.7
Lapis lazuli	0.7
Flourite	0.6
Phosphorus	0.6
Lead and zinc	0.5
Mercury	0.5
Strontium	0.4
Sulphur	0.2
Talc	0.2
Magnesite	0.2
Kaolin	0.1

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A new mine in Afghanistan would look similar to this open pit mine with water recovery and ore processing plant.

Global context

Around forty years ago primary copper production was to an extent controlled by a 'cartel' known as CIPEC. It was dominated by four producing countries; Chile, Peru, Zaire and Zambia. Australia, Indonesia, Papua New Guinea and Yugoslavia were also involved. There had been previous attempts at creating a production controlling body, dating back almost a century. The cartel effectively broke up in the late 1980s, when Chile took advantage of its domination in terms of high grade undeveloped ore reserves.

The current world primary copper production league table (top 12) has Chile, Peru and the US in the first three places. Kazakhstan is 11th and if Mongolia fulfils its promise it could match it in a few years. Iran is close to entering the table. Zambia is eighth but Zaire has fallen away.

It may help further to put Afghanistan copper in a global context by doing a bit of educated guesswork.

I have always had a sneaking admiration for metal traders. They require a short-term mindset that is the complete opposite of the mining business, which requires a clear strategic view to stand a chance of being successful. The proposed merger of Glencore and Xstrata brings the two mindsets together – intriguing. At the really sharp end of the metal trade is your friendly local scrap dealer. Judging by the press, his (her?) 'hot' current stock-in-trade is copper. How soon before the heavy money moves in?

The World Copper Study 2010 includes statistics on copper secondary (scrap) as well as primary (mine) production. It states that in 2008 primary production was around 15 million tons, and secondary was around 8 million tons. In round figures 35% of world copper production was recycled metal.

Let me assume that scrappage becomes more assiduous and possibly faster, and that we could be looking at a percentage recycle rate in the higher 30s in ten years time Taking a figure of 23 million tons total usage in 2008, it seems reasonable to postulate a world copper consumption of 30 million tons by 2020 including over 11 million tons of scrap. This means a primary demand of around 19 million tons compared to today's 15 million. A shortfall of around 4 million tons a year? Mines being a wasting asset, output drops over the years and a major closure could easily boost the need for further primary investment.

The new Turquoise Hill copper mine in Mongolia mentioned above has a price tag of around US$ 4.5 billion to produce 450,000 tons a year of copper in concentrate. A budget cost figure is therefore US$10,000 per annual ton of new mine and concentrator capacity.

To create 4 million tons of new capacity will therefore need of the order of US$40 billion (current prices) spent over the next decade or so to create the necessary mines and concentrators, even assuming no old mine closures. If we lose perhaps a million tons per year of uneconomic production capacity, then we could need as much as US$50 billion (again current prices).

This figure does not include expansion in primary smelter and refinery capacity, not to mention scrap processing, which will add several billion more US$. General infrastructure costs for transport, electricity, water etc. can only add to this.

We could be looking at a total of perhaps US$ 60 billion of new global investment at current prices. As I said before I freely admit that my estimates are guesswork. I believe however that they are both educated and conservative. I am confident however that the order of magnitude is right, although the time scale could stretch.

I am not suggesting that Imperial move into the scrap metal business, but with so much money being invested over the next decade or two, we should look carefully at what the College can offer for all aspects of this spending. Links with southern hemisphere Schools of Mines seem an obvious avenue to explore, supplemented by the College's geological and environmental expertise.

The author of this article, Bill Bradford, worked on site in the early stages of development of the Sar Cheshmeh (Iran) copper mine and the Saindak (Baluchistan) copper project, while employed by Selection Trust and Seltrust Engineering. He was involved in the very early stages of what became the BP Minerals feasibility study on Bajo de la Alumbrera (Argentina) gold-copper deposit and on process design for copper projects in Chile and Peru. He also authored an in-house pre-feasibility study for rationalising copper scrap processing in Europe.

Acceptable Risks from Natural Disasters

Dr Don Higson (Chem Eng 54)

Introduction

Engineers may sometimes need to design structures for loads imposed by natural occurrences such as earthquakes and meteorological events of various kinds. A common way of doing this, giving a misleading sense of certainty, is to determine the worst event considered credible and design accordingly. If something worse then occurs and the structure fails, the best defence that designers can have is that they complied with the practice of their peers, *viz*: the standard. Such an event has sometimes been called an "Act of God".

One of the most famous "Acts of God" in history was the destruction of the city of Sodom during the third millennium BC. Recently reported scientific evidence points to Sodom's destruction as having been the consequence of an earthquake and tsunami [1].

An alternative approach to design is to accept that anything that is physically possible has a finite probability of occurring, and to place a design limit on the risk that this will happen. Unfortunately, this opens the possibility (after the event) that a newspaper journalist could write – or a lawyer could stand up in court and say – "they knew it was going to happen".

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Some existing risk criteria

In the design of large dams, the division between "credible" and "incredible" for such events is 10^{-5} per year (once in a hundred thousand years but it could be this year). The design base used to be events with a probability of 10^{-4} per year (e.g. the "ten thousand year flood") but the risk of failure on this basis came to be considered too high.

A risk limit of 10^{-6} per year has been quoted for nuclear plant design. For seismic design, however, criteria are generally deterministic and are divided into two levels, as follows:

- What was once called the "maximum credible earthquake" is now the S2 or "safe shutdown earthquake" (SSE), which is the design base for equipment that is essential for safety.

- The S1 event is a smaller and more likely earthquake, which is the design base for equipment that is important operationally but is not essential for safe shutdown of the plant.

Thus, failure of equipment that has only operational significance is recognised as being a more acceptable risk than failure of equipment that has safety significance.

In civil engineering, it would not be practical – and would certainly not be justified economically – to design every building to survive (say) a Magnitude 7 earthquake beneath its foundations, even though that could conceivably happen; its probability being around 10^{-2} per year in some parts of San Francisco and less than 10^{-7} per year in many other parts of the world, but never zero. As Charles Bubb (Chairman of the Australian National Committee on Earthquake Engineering, 1971-6) put it: "Every building will be destroyed by an earthquake eventually, unless something else destroys it first."

Acceptable to whom

No matter what natural event is specified as a design base, something worse is always physically possible. Hence, the basis of design generally incorporates a risk of failure due to large but unlikely external natural events. How big a risk is acceptable? And is it possible to estimate the probability of such rare events reliably?

But first: The question to be asked is "acceptable to whom?" To individuals, groups or communities who are exposed to the risk, to authorities who are responsible for public safety or to some remote bureaucracy?

For individuals, average risks of death due to external natural events in Australia are small, *viz*:

- 10^{-9} per person-year from a meteorite strike [2]
- less than 10^{-7} per person-year from earthquakes and tsunamis
- 10^{-7} per person-year from being struck by lightning [2]
- 2×10^{-7} per person-year due to storms and floods [2]

I have actually not found any record of deaths attributed to a tsunami in Australia or to a meteorite anywhere in the world, but both are physically possible. I understand that there is geological evidence that large tsunamis have struck the coast of Australia, although perhaps not within the time of human habitation. I estimated the risk from a meteorite strike, using reports of the frequencies with which meteorites of various sizes reach the earth's surface and estimates (made by others) of the consequences of a large one. By far the majority of this risk is due to the possibility that a city could be destroyed by a large meteorite, causing many deaths.

More familiar risks of death from "unnatural" causes are:

- 8×10^{-5} per person-year from road traffic accidents [3]
- 1.8×10^{-3} per person-year from cancer (all causes) [3]
- 5×10^{-3} per person-year from smoking 20 cigarettes per day [2]

These last three risks are largely accepted by those exposed to them, but the authorities and/or relevant professional and lobby groups continually try to reduce them. Risks from road traffic accidents have decreased over the past 40 years, partly because of improved engineering of roads and cars. Two of the most effective reasons for reduction of the road toll – the mandatory use of seat belts (1974/6) and random breath testing (1982 in New South Wales) – were opposed by many motorists when they were first introduced.

The main concern about the effects of natural events is when they might lead to many casualties and major damage from one event, such as the Newcastle, NSW, earthquake in 1989 which caused 13 deaths, more than 160 injuries and extensive damage. Consider also:

- Cyclone Tracey (71 deaths): Before the devastation caused by Cyclone Tracey in 1974, building standards in Darwin were generally considered acceptable by most stake-holders, even though the city had been severely damaged by cyclones several times during its history. After Tracey, standards were upgraded to the extent that some people considered the additional cost to be excessive.

- Christchurch: Before the series of earthquakes that commenced in 2010, building standards were accepted. Standards for repairs and new construction are being upgraded substantially.

- Fukushima: Before 11th March 2011, risks from earthquakes and tsunamis were accepted in North-Eastern Japan. Some risks to housing of the general population from tsunamis will presumably have to be accepted in the future, because it is difficult to see how they could be eliminated in practice, even by building a high sea wall all along the coast or moving residential areas to higher ground. It is not yet clear how the acceptability of risks to and from nuclear power stations will be affected by the disaster at Fukushima Daiichi. Although the risk of flooding of emergency power supplies (the cause of the nuclear accident) can be substantially reduced in new designs, the Japanese government has pledged to give more emphasis to "renewables" in future and not to rely so much on nuclear power. However, the implications of such a policy for power supplies in Japan may themselves prove to be unacceptable.

The Fukushima disaster illustrates yet again the problem that the acceptability of a risk depends more strongly on the source of the risk than the size of the risk. "The earthquake and tsunami on March 11, 2011, left 25,000 dead, injured or missing. In contrast, there was probably minimal or no health effect from radiation from the damaged reactors. However, the ensuing evacuation disrupted more than 150,000 lives and has led to 13 suicides, along with 50 deaths of elderly evacuees" [4]. No member of the public was exposed to radiation at a rate outside the range of variation of natural background radiation around the world. There is no direct evidence that natural radiation is harming anyone anywhere, except in some cases of α-radiation from elevated radon levels in enclosed spaces. The average estimated risk from natural radiation is about $2x10^{-4}$ per person-year, based on the recommendations of the ICRP [5], but the true value is probably much lower than this and may be zero.

Nevertheless, far greater concern has been expressed about the nuclear accident than about the other aspects of the catastrophe. Our news media have concentrated their attention on the former. They have largely ignored the latter except in the immediate aftermath of the disaster. Some countries where tsunami risk is not normally an issue, such as Germany, have reacted by backing away from the use of nuclear power.

Tsunami risk for Australia

The risk of a tsunami is less around the coast of Australia than it is around the coast of Japan but it is not zero. Apart from seismic considerations, tsunamis can be caused by large meteorites, which have a random probability of striking any point on the earth's surface. This probability is extremely small at any particular point but, with three quarters of the earth's surface covered by water, the probability of a large meteorite landing in the ocean is not negligible. To cause a significant tsunami, the meteorite would have to be a fairly big one, perhaps of the size that reaches the earth's surface every thousand to a million years (between 10^{-3} and 10^{-6} per year), depending where it splashed down. The larger the meteorite the lower the probability.

It would not have to be of the size that is said to have killed off the dinosaurs. Our only real protection against such an event is its low probability of occurrence. Astronomers might see it coming but it is questionable whether anything could be done to stop or divert it.

Conclusions

Current engineering standards relating to earthquakes, floods and storms incorporate acceptable risks of failure and will no doubt be reviewed if (or when) design base events are exceeded.

The risk from tsunamis needs to be assessed, not only for nuclear power stations and other industries but also for coastal towns and cities anywhere in the world. My expectation is that few people in Australia will want to think about this unless it is in the context of nuclear power.

Risks from meteorites are very small and will probably have to be accepted.

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[1] Harris, G., "Sodom's fate result of surrounding minerals?" Imperial ENGINEER, *Spring* 2012, p.26.

[2] Higson, D.J., "Risks to Individuals in NSW and in Australia as a Whole". ANSTO Nuclear Safety Bureau Report NSB2/1989, July 1989. (Some of the figures presented in this report were cited in the OPAL reactor safety case as the basis for comparative risk assessments used by the NSW Department of Planning.)

[3] Risks from reference [2], updated in accordance with Australian Bureau of Statistics (ABS), "Yearbook Australia, 2007" and "Causes of Death, Australia, 2008" (Risks are recorded as the number of deaths each calendar year per 100,000 of the population. Eight deaths per 100,000 per year is a risk of $8x10^{-5}$ per person-year.)

[4] From a statement by Kazuaki Matsui, Executive Director, Institute of Applied Energy, Japan, to "The President's Special Session on Low Level Radiation and its Implications for Fukushima Recovery" at the American Nuclear Society's Annual Meeting in Chicago, June 24-28, 2012.

[5] Valentin, J. (Editor), "The 2007 Recommendations Of the International Commission on Radiological Protection". *Annals of the ICRP: Publication 103*, Elsevier (2007).

bruno ismael da silva alves/shutterstock.com

Reducing the effects of Natural Hazards

Louis Solway (Civil Eng 58)

The Problem

The thousands of people affected by the 2011 Japanese earthquake and tsunami all know what a natural hazard event is, and how it can seriously disrupt society and cause a disaster. Recent history is littered with many huge devastating events including the 1976 Tangshen earthquake that destroyed a city. Further back in history, the 1883 Krakatoa volcanic eruption covered the World's atmosphere with dust for months, not just a small area of Europe.

For recent events several western countries sent rescue teams which perhaps rescued one person but did little more than slightly raise the morale of the local people. It is the indigenous population who substantially carry out the real rescue work. Some countries always send a fully staffed and equipped field hospital, which make more positive contributions. The Department for International Development (DFID) are now considering this for future hazard events, not just a busload of firemen.

But there is an increasing requirement for cities and nations to protect their human and economic assets from hazards which present a risk in urban areas, particularly in developing countries with their often random urban expansion. This can be done by developing strategies of mitigation rather than the existing practice of simply responding to a hazard event. The United Nations designated the decade from 1990-2000 as the International Decade for Natural Disaster Reduction (IDNDR) during which all countries were encouraged to raise interest, develop research projects and promote international co-operation. Did it work?

The Solution

Disaster Management can be represented by a 'Cycle of six activities' (See diagram) The obvious place to start is with the disaster event but the argument is that communities should not wait for the event but invest now in Protection.

1. **Mitigation** – Measures that minimise the effect of disasters on a community.
2. **Preparedness** – Plans for response by national and regional governments, communities and individuals.
3. **Disaster event**
4. **Response** – Saving life, protecting properties and dealing with immediate disruption.
5. **Recovery** – Assisting communities to return to a normal level of functioning. Including restoration and rehabilitation.
6. **Reconstruction** – Long term replacement of destroyed buildings and infrastructure.

Response and Recovery are where most National and International effort is put in. Reconstruction can be over a 5, 10, 30 year period, but as time goes on and no additional hazard event occurs, money given and allocated often disappears or gets spent on alternative programmes. Preparedness is not high budget but is very important for allocating responsibilities, establishing warning systems and upgrading equipment. Trying to persuade authorities to spend money to minimise the effects of a natural hazard event, which may never occur, makes mitigation fragile, but money spent on mitigation of a water supply system could apply to war, sabotage or strike events in addition to natural hazard. Many mitigation measures are generic in that they apply to physical infrastructure in general, and an understanding of the principles involved will enable specific measures to be adapted to local circumstances. Mitigation has five subheadings:

- *Preventive measures*; which aim to minimise the physical damage created by hazard events – e.g. raise sensitive plant above flood level.
- *Spread the risk*; avoid dependence on single facilities and transport routes – e.g. provide alternative source of electricity supply (New York Oct 2012)
- *Spread the responsibility*; widen ownership – e.g. help informal communities to install and manage local systems.
- *Cover or minimise the impact*; provide insurance for physical losses, particularly plant; regularly test standby power generation equipment.
- *Plan to minimise the time taken to return to normality*; – e.g. promote hazard awareness.

Summary

The Author was the Project Leader for the Institution of Civil Engineers IDNDR study and report "*Megacities - reducing the vulnerability to natural hazards*". After completion, he presented papers at conferences in the UK and overseas but by the end of the decade it was clear that the subject was slipping into being an interesting academic topic again rather than one screaming for action. An example of how little the world has learnt since the United Nations IDNDR decade was when the 2008 Haiti earthquake destroyed and killed many in the very building occupied by the United Nations staff – if they don't check their own buildings, how can we hope for other building tenants to check?

In the future, instead of DFID spending the money on 59 firemen to go across the world for photo opportunities, they should fund qualified Engineers to visit developing countries where they have not been for over 10 years to check:

- that the countries' design code of practice is satisfactory for the predicted level of earthquakes and wind forces;
- that the individual structures are designed correctly; and
- the potential effects of other natural hazards, e.g. flood routing, are considered. To mitigate for the next Krakatoa explosion, planes will need to be designed to fly through volcanic dust.

More property and more lives would be saved when an event does occur.

Louis Solway, a Consultant Infrastructure & Environmental Engineer and a Fellow of the Institution of Civil Engineers, played hockey & the violin while at Imperial and captained Guilds Hockey Club 1957-8. He has carried out assignments in Europe, Ghana, Libya, PRC, Syria, Pakistan and Iran. He tries not to compromise where environmental issues are involved.

ON THE BEACH

Jolyon Nove (Civil Eng 60) asks if this is Australia's future

Australia has been inhabited over approximately the last 50,000 years.

200 years ago modern civilisation arrived in Australia. In the next 200 years Australia's task is to withstand the global impact of increasing world population, increasing global standards of living and increasing destruction of the global environment. The code word for this impact is 'Climate Change'.

How is Australia doing? Australia is increasing farming production and mining of minerals and fuel, and exporting these to the rest of the world. Australians are holidaying overseas more, and fewer overseas visitors arrive in Australia. The rest of the world is increasingly competitive in undertaking the manufacture of goods and services to meet the needs of Australians. The rest of the world is increasingly carrying the burden of Australia's pollution now and for a long time to come.

Australia will have some short downturns in the next 200 years, no doubt. The growth in China and India, as their large populations gain modern standards of living, will underwrite Australia's very long term prosperity.

Australia is a very large island continent with a small population. The length of coast per head of population is probably only exceeded by the Antarctic. Where would we like Australians to live and have the best chance of surviving 'Climate Change'?

The Australian answer is "On the beach". That is where the temperature is moderated by sea breezes. "On the beach" is where gravity provides an abundance of water in the rivers at no energy expenditure.

This move to "On the beach" is naturally happening as five or more major cities grow or are retrofitted to meet the needs of future Australians. What is left over will be most useful as Fly-In Fly-Out (FIFO) mining, and perhaps FIFO farming, communities. An example of growth in FIFO is in Australia's current mining practices. The limit of any community's existence is water supply.

The battle over water rages in Australia and particularly in the great Murray Darling Basin and the Artesian Basin. The battlelines are mining, farming, people and the environment. Over the last 60 years the Snowy Mountains Hydro-electric Scheme has provided more water to the Murray Darling Basin than nature actually intended. Farming has expanded to use all that water. Farming now cries out for more water. It is not the water that will change direction. It is the farmers. The farmers will have to adapt to farming where the water is. The farmers will have to move North to where the water is deposited in 'The Wet'. They will have to move to the Ord River Scheme Stages 2 and 3 and other such schemes.

Ord River Dam and Lake Argyle

So Australia's long term environmental advantage as a place to live and work is increasing and it will continue to increase into the foreseeable future. Australia's rough Colonial legal past is well and truly past. Australia has both a sound Government and a sound Opposition. A sound legal system and banking system exist. Australia's long term global financial advantage increases as we pay off our small amount of Government debt.

Oh yes, I nearly forgot to mention Australians play cricket "On the beach".

Jolyon E. Nove was president of C&G Union 1959-60. After graduating he gained experience in the design of Power Stations and Dams working for the Snowy Mountains Hydro-Electric Authority and for the Electricity Commission of New South Wales. He is the inventor and owner of Civil Engineering Patents "Thermal power plant" and "Greenhouse gas emission disposal from thermal power stations" relating to Climate Change.

LETTER TO THE EDITOR

From Atula Abeysekera

Educating engineering and science students on the basics of risk management during periods of uncertainty

Following the recent economic meltdown, organisations have to adapt to survive in these uncertain times by refocusing their energies on challenges faced by current issues such as social media, big data sets, emerging markets, innovation and sustainability. One such challenge that is receiving significant Board and Executive level attention is the role of risk management. Risk management is increasingly being seen as an enabler of long-term profitability and a competitive advantage. Those organisations that have an enterprise wide approach to risk management are likely to be successful in these uncertain times.

Engineers and scientists are at the 'heart' of this process: their innovative technical and numerical ability can help an organisation to achieve long-term strategic goals and improve business performance. For example, engineers who are responsible for major infrastructure construction (HS2, Cross Rail etc) and design projects, have to base their daily decisions by balancing the practical risks against the public perception of risks. Despite the importance of this topic, risk management is not formally taught to undergraduate and postgraduate students, and Imperial College's course designers for engineering and science faculties should take note of this in designing curricula. A risk management course should de-mystify the process and present the subject in practical terms with case studies and input from senior risk professionals from the industry and the government; risk can be taught in a holistic way to students.

This course should have three broad aims. Firstly, it has to teach students the basic concepts of enterprise risk management. Secondly, the course has to simulate practical examples through case studies, with the help of industry experts. Finally, the course should lead to research on quantitative and qualitative aspects of risk management. All final year students should demonstrate awareness of the risks involved in their projects. As a result, future engineers and scientists can be educated on business aspects of risk management, which would be instrumental in their careers in the industry in this uncertain economic climate.

The author would be grateful for feedback from Imperial College alumni on the ideas discussed in this letter. The author would be able to offer help to design this course for Imperial.

Atula Abeysekera
atula.abeysekera@hotmail.com

Atula Abeysekera (Civil Eng 81) has 25 years' corporate governance and risk management experience and holds a MSc. in Civil Engineering from Imperial. He has extensive experience in setting up and running internal corporate governance and enterprise risk management functions. His career has included holding senior positions in governance and risk management at KPMG, Morgan Stanley, Fidelity Investments and Lazard. Atula is currently Deputy Chairman of the Risk Forum Committee of the Chartered Institute of Securities and Investments. He recently published a paper for the UK Cabinet Office on a commercial approach to managing Civil and National Security.

DIARY

May 3-4
Imperial Festival
See notice on page 4

Saturday May 4
Imperial College / Chapter
Annual Alumni Reunion as part of Imperial Festival
Alumni Hub: Senior Common Room, from 10:00

Friday May 17
CGCA
100th Annual Dinner
The Mansion House
19:00 to 22:45

Tuesday June 4
CGCA
AGM/President's Evening
Read Lecture Theatre, 17:30
(refreshments from 17:00)
Supper: Queens Tower Rooms, approx 19:00 (Booking form on the back of address carrier)

Saturday June 8
CGCA London Walk
Chiswick & Hogarth's House
All welcome. Please email johnsheilabackhurst@tiscali.co.uk for further details

Tuesday June 11
Faculty of Engineering
Teaching Awards Ceremony and Reception
Venue: tbc, 16:00

Thursday June 27
RSMA
EGM, AGM & Final Year BBQ
58 Prince's Gate
EGM/AGM 18:30, BBQ 19:00
(Booking form on the back of address carrier)

Friday November 29
RSMA
129th Annual Dinner
Venue: tbc

Saturday November 30
CGCA Decade Reunion 2013
(Open to RSMA, RCSA, & CGCA)
Polish Club (Ognisko,) 55 Exhibition Road, 12:00 for 12:30
(See enclosed booking form or email christopher.lumb58@imperial.ac.uk for further details)

For more information or booking for any events, contact Teresa Sergot t.sergot@imperial.ac.uk or phone 020 7594 1184

ALUMNI NEWS & VIEWS

Who's doing what and where

Chem Eng 57-60 Reunion

Tony Davis reports on "our annual reunion at IC in February with group photo. 10 attendees this year being - from photo left, Tony Davis, Graham Yorke, Paul Gallagher, Don Latimer, Malcolm Cross, Richard Lee, Barry Daniels, Dave Martin, Jim Friend, Roger Thomson. Suggested venue for a group outing late summer is the Weald and Downland Museum near Chichester."

Kingsbury Scholarships

More Imperial engineering students will benefit from industry experience thanks to the expansion of the Kingsbury Scholarship programme. The Kingsbury Scholarships, which have been established through the generous support of alumnus Derek Kingsbury CBE FREng (Electrical Engineering 1947), offers scholarships to UK undergraduates in financial need who have a firm offer from the College to study an engineering course. Eligible students are required to spend a year working in UK industry before they start studying at Imperial.

Derek Kingsbury enjoyed a notable career in UK industry with Associated Electrical Industries, Thorn Electrical Industries, Dowty Group, Pearson and Fairey Group. Commenting on why he decided to found the Scholarship at Imperial, he said: "I want to encourage more students to consider industrial and technical careers in the UK. I believe that investing in academic success and encouraging ambition and excellence in engineering students is vital to UK industry."

The Kingsbury Scholarship programme aims to support gifted students who may not otherwise have been able to study. This support is combined with a year spent in industry to gain a valuable insight into the sector.

The first Kingsbury Scholar, Catherine Stevenson, who joined Imperial last October, said "My placement was invaluable in helping me to understand how engineering and technology are practically applied to industrial solutions."

Mr Kingsbury has recently expanded the Scholarship programme, enabling the College to offer a Kingsbury Scholarship to one outstanding student each year. Successful students receive a full scholarship for the duration of their course, which includes a tuition fee waiver and a grant towards living costs.

http://bit.ly/IE18Kingsbury

Ralph Benjamin

Some present or past "Guildsmen" may recall Ralph Benjamin, who graduated in "Electrical Engineering with Communications" in 1944 under the wartime Hankey scheme. He had his 90th birthday last November, but is still active, both physically and professionally, being a part-time visiting professor of Electronic Engineering at both University College London and Bristol University, an industrial consultant and a personal contributor to professional journals etc.

Now Professor Ralph Benjamin, CB, FREng, PhD, DSc, DEng, FIET, FCGI, he had started his career as an electrician's mate, before getting a private scholarship to C&G where, as an undergraduate, he invented the single-sideband mixer. Joining the Royal Naval Scientific Service, in 1946 he patented digital data nets and the computer "mouse" two-way interface between a display and digital data, (both as parts of the world's first electronic command-and-control information system). This was followed by a meteoric rise in the RN Scientific Service, Ministry of Defence, Intelligence Services, NATO and finally Academe. Recent distinctions include an honorary Doctor of Engineering, the IET Achievement Award for Innovation in Electronics and the Oliver Lodge Medal for contributions to Information Technology.

His 1996 autobiography *Five Lives in One* was republished in paperback form in 2009 and covers:

- Self-education in a refugee camp
- The start of IT
- The origins of modern Command-and-Control Information Systems
- The workings and intrigues of the Defence World
- The way Whitehall works (or doesn't)
- The real story of GCHQ
- Anglo-US co-operation
- The war of wits with the IRA
- Adventures in mountains, in the air and under the sea

"A fascinating glimpse into the Defence and Intelligence Services, liberally spiced with amusing anecdotes and quirky insides", it is available from www.parapress.co.uk/military.php for £12.00 (incl. p&p). – of course there is also quite a lot that he could not write about!

Maybe some literally and metaphorically "old" boys can remember Ralph?

WE WANT YOUR NEWS

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

42nd Triode Meeting, Jan 2013

There were 14 of us on 4th January.

Peter and *Paul Cheung* are both still in academia. Paul is now Associate Vice President at the University of Hong Kong and as busy as usual. Peter, who has been Head of EEE at Imperial for the past four years, has been asked to stay on until 2015. His offer of "free lunch" for any Triode visiting Imperial will be extended to at least 2015!

Alice Spain became a member of the U3A this year and joined a number of their study groups including Engineering Heritage. She's just returned from a trip to Antarctica, where the weather was fantastic and the penguins were amazingly photogenic. She swam in the Antarctic Ocean (which was freezing!) and sent postcards from the world's most southerly post office at Port Lockroy.

Geoff Banks took early retirement in May 2009 and has (by choice) not been gainfully employed since! He now has four grandsons, aged 2, 3, 3.5 and 7.

Peter Wright has finally taken an Early Leaver's Package, after being with BT for nearly 18 years. He's not sure what his next step will be. He remains involved with the Scouts which keeps him surprisingly busy.

Phil Harris was carrying out a key role during the Olympics making sure the world's media could cover the event smoothly. Although the weather during the Olympics was great, he was trapped in his office.

Rear row from left to right: Alice Spain, Geoff Banks, Phil Harris, Sid Seth, Pete Marlow, Hari Singh, Rut Patel, John Harding, Richard Lewis. Middle row: Pete Wright, Dave Mansfield, Pat Mason, Peter Cheung and reduced to his knees – Martyn Hart!

John Harding left Comptel and is now working for CACI as a Managing Consultant. He has been getting back into shape and has completed both the Maidenhead and Windsor half marathons in the last few months.

Dave Mansfield said that unfortunately he and his wife are spending most of their time looking after his 93 year old father. However, Dave and his wife did manage to go on a luxury Baltic cruise to celebrate his wife's 60th, that left them so impressed they're destined to become regular cruisers.

Hari Singh made a welcome return. After working for GEC Computers, DEC, Compaq and HP, he took early retirement in April 2008. He has a daughter and a son, both married now, and became a grandfather in February 2011.

Richard Lewis retired from PA in September 2011 and almost immediately started on a PGCE course in mathematics at St Mary's University College. On becoming a newly-qualified teacher the following summer, he took up a maternity cover post at a grammar school in Sidcup, teaching maths to Years 7-11.

Rut Patel seemed to enjoy his first visit! He is still working, currently for an NHS trust, in IT of course.

Peter Marlow is still running his own business (Softcopy Limited) and is mainly occupied managing IT projects for Government. He's also building smartphone apps for events such as music festivals.

Sid Seth is very active with new innovations. Currently starting up a new business to do with the identification of assets, he'll let us know all about it soon, perhaps in November!

After 28 years in the IT industry (IBM, EDS) *Pat Mason* helped out with a company rescue in the payments sector, which led to co-founding an internet start-up (globalwebpay.com) to give consumers a cheaper and easier way to transfer money to bank accounts around the world.

Martyn Hart works for Gartner, the US research company, mainly in the public sector and is also the Chairman of the UK's National Outsourcing Association - he must be going to retire soon!

The next Triode reunion will be on Friday 3rd January 2014 at The George, Fleet Street, from 7 pm-ish.

Before that, CGCA's Decade Reunion for 'our' decade will be held in the Polish Club on Saturday 30th November 2013, starting at about midday (see p24).

Martyn Hart
Arch Triode

Contact Martyn for a fuller report at martyn.hart@blueyonder.co.uk

New Delhi still feels close to Imperial College

Jag Mohan Puri OBE (Mech Eng 58) talks to Colleen Shilstone

FIFTY-FIVE years ago, a young man from Calcutta obtained an engineering degree in mechanics at the City & Guilds College, Imperial College. He tells me that his son, Ranvir, is the sixth member of the Puri family to have graduated from Imperial. He obtained an MBA from the Business School. The first member graduated in 1929.

Mohan was the founder and first President (1993 – 2006) of the Imperial College Alumni Association of India.

Colleen: I believe you started your university career in 1954. Did you live in Hall where the old stone steps led up to the students' bedrooms?

Mohan: *I was fortunate to live in Beit Hall during my second and third year. We were five of us on the fourth floor with a kitchenette and laundry. I have fond memories of coffee meets after dinner when we would discuss and debate a wide range of subjects.*

C: Did you study quite hard or did you spend a lot of time fraternising with other students?

M: *No I didn't study too hard and spent a fair amount of time in the bar downstairs! I played Badminton for the College and was a member of the Horse Riding Club. In 1958 I started the Hedonists Dinner Club with the support of the IC Union and invited Nubar Gulbenkian to be the first patron. He was a known gourmet and was quoted as saying:"the best number for a dinner party is two – myself and a damn good Head Waiter!"*

C: Weren't you involved with the charismatic C&G mascot Boanerges, the 1902 James and Browne car? It is still going well and doing the London to Brighton run every year.

M: *Very much so. Delighted to learn it is still doing the London to Brighton run. I have a lovely photograph of Bo and a London Bobby chasing us.*

C: Did you return to Calcutta after graduating?

M: *I joined ICI in London and moved to Calcutta as a Project Engineer. My first project was an in-house expansion of the Company's Caustic Soda plant. This was a great hands-on experience as it brought me in close contact with various aspects of engineering disciplines – design, purchase and execution. This was followed by four years with Simon Engineering of Stockport and sixteen years with Shell Oil. After nationalisation of the oil industry in India, I joined the Assam Company – a Group Company of Inchcape plc. I left them in 1997 after fifteen years, as their whole time India Director. In 1986 the Company asked me to attend a four week Senior Management course at Ashridge Management College before being invited to join the Board of Directors of the Company.*

C. I believe that the Earl of Inchcape was a major shareholder of the Assam Tea Company until 1991 when they divested their tea interests in India.

M: *Yes, and our closest friends for the past twenty years are the Inchcape family. In 1998 I left the Company as I had been encouraged by the British Commissioner to India, Sir Nicholas Fenn, to make students from India aware of the advantages of an education at British Universities. I set up my own company therefore and called it 'The Combine Company International Education Counselors'. The Company is a leading Overseas Education Consultant/Agent offering options of various studies abroad in the UK. In 2006 I was awarded the OBE on 27th September for running the best consultancy in India for various aspects of education in the UK and my contribution in furthering Indo-British relations in Education. My family and I are very proud of this award by Her Majesty, Queen Elizabeth II .*

My wife, Nalini, is an accomplished portait painter and has held a few exhibitions. Our elder daughter is a senior opthalmologist consultant in Melbourne, our second daughter is a graphic designer and operates from Delhi and Goa. Our son, Ranvir, is now the CEO of our family business. To complete the family, we have two Golden Retrievers: one called Chikh and her daughter Ailsa.

From Cambridge Classicist to Imperial Engineer

TERENCE HASLETT (Civil Eng 63) who died on 7th December 2012, is remembered by his nephew Philip Hughes and ex-colleague Robin Whittle

Born in 1936 in London, Terence was evacuated to Canada from 1940-1944 and attended Bryanston school. He gained a major scholarship in Classics to Kings College Cambridge but, having graduated, decided to change to Engineering and went to Imperial College. Finishing the degree, he travelled to India in a camper van; this period gave him his lifelong interest in cooking and eating Indian food. He went on to Australia to visit his sister and stayed there for 3 years, working for the Queensland Department of Harbours and Marines, designing Caboolture lighthouse, and on a hydro-electric scheme in Tasmania. Returning to London, he worked at Arup's from 1970 to 1996.

In the 1970s, Alistair Day was developing his dynamic relaxation program to design fabric shapes. There was pressure from project engineers to have a system which Engineers could use directly. John Thornton, keen to develop a program as part of the OASYS Suite, arranged the funding for Terence to write new software for it. During this period, Terence was involved with prestigious jobs, such as assisting in the design of the roof structure at Lords cricket ground.

Terence's degrees in Classics and Engineering epitomise his wide intellectual interests. He was a good crossword solver, and occasionally set puzzles for Arup's magazine. He had a wide knowledge of music and a great interest in languages. He learnt Czech, building up strong bonds with a group of Czech friends, was learning Persian for fun, and one of his last outings was to a Danish class. In retirement he completed several half marathons. A quiet, caring man, loyal and committed to his friends, he will be missed by them and by his family. *

He built a dinghy ... in the attic

DAVID JOHN WALDER (Mech Eng 57) was born on 6 July 1936 and attended Bancrofts School.

In 1954 he came up to Imperial College to read mechanical engineering (working as a locomotive fireman in the vacation). He continued his interest in railway engineering and added rowing, acting as cox to one of the College crews.

He went as a graduate to British Railways, where he spent five years. During this time he married.

In 1962, he went to the former Belgian Congo to work for Unilever as the resident engineer at a palm oil plantation.

David later found work with Tate & Lyle. The family, with two children, moved into a Victorian House. Restoring the house, he also found time to build a dinghy... in an attic. Its most difficult voyage was via a long rope from attic to garden.

His marriage ended and he changed function at Tate & Lyle, travelling extensively. He remarried and, in 1978, went to run the Zambia Sugar Company.

In 1982 the family settled in Sussex, his final position being a job he could do from home. He resumed his interests in sailing and model engineering.

He took his Inshore Master's Certificate and bought a boat. It had seen better days, but over time he brought her back to first class condition. Each summer we cruised, once as far as Brittany.

David sailing (or motoring) his beloved Andorran on the River Tamar just below Calstock (railway viaduct just visible – he was a lifelong fan of GWR)

David suffered a slight stroke. Fortunately he remained alert, never ceasing to give his trenchant views of the follies of the world. He died on September 12th 2012.

David will be much missed by both family and friends. *

David Nicholas (Physics 57)

More complete versions of obituaries marked with an asterisk * can be found on our website

Old-boy racer

NIGEL KENNETH BENSON (Aero 53) was born on 31 May 1932 and brought up in Barking. Gifted academically, particularly at maths, he rose from a modest schooling. After a start with Handley Page, he entered Guilds in 1950 and gained a first class degree in Aeronautical Engineering, top of his year.

Nigel joined the Royal Aeronautical Society, becoming a Chartered Engineer. Returning to Handley Page, he worked on the design of the Victor bomber. He was immensely proud to see it still in RAF service after 30 years, when it was used as a refuelling tanker during the Falklands Conflict.

He moved to work at Ciba-Geigy in Duxford, where he met wife, Alison. Some of his work on structural adhesives was published during this time. One of his old lecturers, John Argyris invited him to work in Germany. So in 1961, shortly after he and Alison were married, Nigel became a researcher and lecturer in Stuttgart. It was during their time in Germany that their two sons were born.

Five years later, on returning to England, Nigel began a long career with Ford. He worked in car body engineering, specialising in heavyweight computational maths to analyse vibration and structural problems, and to design bumpers and crumple zones.

Nigel had many interests outside work. He played for East Hanningfield Cricket Club. He wasn't a terribly gifted player, coming home chuffed to bits if he'd scored any runs at all. He loved motor racing and, while at Ford, had a very long string of company cars, usually choosing the go-faster models. His colleagues described him as an old-boy racer.

He loved classical music, the Goon Show and Abbot Ale. Nigel dedicated his later life to his sons. He struggled with Parkinson's for the last 10 years of his life, which progressively eroded his once brilliant memory and robbed him of the chance to enjoy his years as a grandparent. He died 3 Nov 2012, aged 80.

Nigel remained a member of the Old Centralians, now the CGCA, throughout his life. *

John Stoton

Nigel (left) in Barking in 1957, with John Stoton and John's fiancée, now wife, Jeanne.

Enjoyed corresponding with others

DAVID GILLARD CARPENTER (Civil Eng 53) died on 16 September 2012, aged 83. On finishing school in 1947, David was called up for national service with the Royal Engineers, and spent this time in Berlin, where his period of duty spanned the Soviet blockade and the Berlin air-lift.

After being de-mobbed in 1950, he was able to study Civil Engineering at City & Guilds College, graduating in 1953. Following graduation he spent the first four years of his career with Marples Ridgeway and Partners (of whom the Managing Director, Reginald Ridgeway, was a Guildsman - Civil Eng 1926-29), and also Alderton Construction.

In 1957 he joined Holland Hannen & Cubitts, who built a significant number of the great buildings in London. One of his colleagues here was Dudley New (Civil Eng 1929-31), who for many years organised the 'Monthly Luncheons' held by the Old Centralians. Subsequently, in 1968, David moved to work for John Mowlem & Company, and spent some twenty-one years in their employ, but he retired on health grounds in 1989, at the age of 60, at which time he was living in Banstead, Surrey.

Some nine years later he, and his second wife Jill moved to South Cornwall, where he lived until his death.

David had many interests, including model railways (he built two large model layouts) and 20th Century military history; he also enjoyed corresponding with others sharing similar interests. Regrettably, declining health in the latter years of his life greatly frustrated him, but he much enjoyed seeing his daughter Jane and living in Cornish surroundings.

Distinguished researcher, dedicated teacher and champion for women in engineering

MARIA PETROU, Professor of Signal Processing, died from cancer on 15 October 2012 at the age of 59.

"The untimely death of Maria Petrou is a great loss to her family and friends. It has also deprived the academic community of a distinguished researcher, dedicated teacher and champion for women in engineering.

Gaining a PhD in Astrophysics from Cambridge, she obtained a post at the University of Athens, before returning for a postdoctoral appointment at Oxford. Maria shifted to research, at the Rutherford Appleton Laboratory and Reading University. She took on an academic post at the University of Surrey in 1988, rising to become Professor of Image Analysis, before moving to Imperial in 1995 as Professor of Signal Processing. She accepted the position of Director of the Informatics and Telematics Institute of CERTH, Thessaloniki, Greece, in 2009 while retaining a quarter-time position at Imperial.

Honours included a Fellowship of the Royal Academy of Engineering. She was active in Women in Science and Engineering and the Women's Engineering Society. She campaigned for human rights and publicised abuses. Rationalism co-existed in her personality with warmth and a sense of fun. Uninhibited in expressing her opinions, Maria maintained a blog on which she shared her views on a wide range of topics, making her final contribution just 16 days before she died. It is extremely sad that her passionate desire to engage with the world was brought to a close so prematurely."

From Richard Vinter's tribute
http://bit.ly/IE18MariaPetrou

Nick's contributions to seismology and earthquake engineering were immense

NICHOLAS AMBRASEYS, Emeritus Professor of Engineering Seismology and Senior Research Fellow in the Department of Civil and Environmental Engineering, died peacefully at his home in Putney on 28 December 2012 at the age of 83, after a short illness.

Nick first came to Imperial to study for a PhD, awarded in 1958. He spent the first three years of his academic career as a lecturer at the College, followed by a few years in Greece and the USA, returning to Imperial in 1964, where he remained until his death. He served as Head of the Engineering Seismology Section from 1971 to 1994.

Nick's research covered earthquakes and their effects on ground, structures and populations. Perhaps his greatest contribution was in studying historical accounts of earthquakes, particularly those occurring in the eastern Mediterranean.

His approach was influenced by the knowledge gained during dozens of post-earthquake field missions in various parts of the world. These missions led to a series of reports that influenced the reconstruction of the earthquake-damaged cities. His great ability with languages was an important factor in sustaining good relations with people of many nationalities.

Nick's contributions to engineering seismology and earthquake engineering were immense, wide-ranging and covered almost 60 years. The worldwide communities in these fields owe him a debt and he will be greatly missed. He is survived by his wife, Xeni. *

Canadian space pioneer

GRAHAM HERBERT BOOTH (Elec Eng 53) died on August 21, 2012 at the age of 82. After graduating, Graham had a distinguished career as one of Canada's space pioneers. As Chief Electrical Payload Engineer for Alouette 1, Graham was part of the Defence Research Telecommunications Establishment team whose engineering achievements resulted in Canada becoming the 3rd country in the world to design and build a satellite. After several years working at Plessey Aerospace in England and ESRO (now European Space Agency) in Holland, Graham returned to Canada in 1969 and co-founded the satellite engineering division at Telesat Canada. He was subsequently involved in all major Canadian satellite projects until his retirement from the Dept. of Communications in 1990 as Chief of Satellite Programs. He also had a fulfilling three years with the Department of National Defence, including being a member of the Canadian Defence Liaison Staff in Washington DC.

Sadly missed, Graham will be fondly remembered as a man who loved to sail, valued the fellowship of others and the spirit of service evident through the professional, community and church organisations to which he belonged. He always viewed his time at Imperial as instrumental in all of his professional achievements. He is survived by his wife of 47 years Kate and son Colin.

NOTICES IN BRIEF

ASHLEY D. COLLINS (Computing 92) died on September 7 2012. Ashley attended Epsom College, Imperial College and King's College London. He worked for Logica for many years, firstly in space and defence, latterly as a CLAS consultant in the Security and Identity Management Practice. He died of cancer. He was unmarried.

JOHN ELLINGTON (Civil Eng 53) was born 20 August 1931. John worked for British Airways (and previously BOAC), and became a Captain, flying Boeing 747s. After leaving college he lived in Tewkesbury and then Hitchin, before moving to Oakwood, Berkhamsted. In retirement, he and his wife Jayne moved to Castle Village, a retirement complex located just outside Berkhamsted. Sadly, John suffered from Alzheimer's for a number of years before passing away peacefully on 27th February 2012.

PETER WALTER FOSTER (Elec Eng 48) died 6 May 2012, aged 92. Peter was president of the City & Guilds College Union in 1947-48, and also Captain of the City & Guilds College Boat Club in the same year. He entered college in 1946 at the age of 26, having served with 92 Field Regiment, Royal Artillery, during the Second World War. In 1943 he was awarded the Military Cross after he was involved in action in Sicily. Upon de-mobilisation he had achieved the rank of Colonel. By 1954 he was working with William White (Switchgear) Ltd in Brixton, which company he stayed with throughout his career, serving as Managing Director for most of this time. In November 1967, Peter was appointed to be a Deputy Lieutenant of Greater London, an office which applies for the remainder of one's life. Peter was an active member of the Old Centralians, and served as Honorary Secretary for several years, immediately following the death of Arthur Holbein in 1970. By 1974 he had become Hon. Treasurer, a post which he filled until 1990, when he had reached the age of 70. He was appointed a Commander of the British Empire (CBE), and was a Fellow of the City & Guilds of London Institute. His full list of post-nominals was: CBE, MC, TD, DL, FCGI, FIC

T D EMYR JONES (Civil Eng 48), died peacefully on Sunday April 15 2012 at Tonna Hospital, Neath. Emyr had worked in the Atomic Energy and Mining industries, before taking up his latter employment in Local Government at Swansea. He is survived by his wife Pat, sons Alun & Gareth, and by eight grand-children.

PETER JAMES HYSLOP (Civil Eng 59) died peacefully on March 2, 2011, in the Louis Brier Home, Vancouver, his daughter Caroline by his side. Peter was a highly dedicated and respected professional engineer, with roads, and particularly bridges, being his life's work and interest. His involvement with the reconstruction of the Lions Gate Bridge was the satisfying culmination of his career. An accomplished athlete, he excelled in rugby, swimming, and more recently in sailboat racing. Sailing, and his various boats, has been his passion since his teens. His crew he always thought of as `family'. Peter succumbed to a heart attack after suffering for several years with Alzheimer's Disease, which he bore with his typical stoicism and good humour. His quiet courtesy never left him, and he remained uncomplaining and good natured to the end. His was a life well lived. He leaves his dear wife, Margaret, sons Jim and Rod, daughter Caroline, and seven grandchildren.

DAVID RODNEY NANCARROW (Civil Eng 54) was born on 10 June 1933. He died peacefully at Brockville General Hospital on September 2, 2012 at the age of seventy nine. Husband of Helga his beloved wife of 48 years, he is also survived by his brother John, sister-in-law Pam and family who reside in Wales. David went to Canada in 1956 as a civil engineer and worked throughout his career for Montreal Engineering Company (Monenco). An avid sailor on Lac St. Louise and Lake Ontario, he served as commodore of the Royal St. Lawrence Yacht Club in 1986-1987. He will be remembered by his many close friends in Montreal, the Thousand Islands and St. Petersburg, Florida.

ARNOLD JAN VERSTEEGH (Elec Eng 52) was born in London in 1927 and spent his childhood in Lyminge, Kent. He graduated from the Dept. of Electrical and Electronic Engineering in 1952, after which he worked at GEC and the CEGB – the forerunner of Powergen. His hobbies included motorcycling and photography, for which he won many prizes in amateur competitions, and camping on family holidays. He was admitted to St George's Hospital in Tooting on 16th November 2011 and died on 2nd December. Mr Versteegh is survived by 4 daughters.

PETER SIMON ROSE (Elec Eng 59), beloved husband, father and grandfather 77, formerly of Belsize Court NW3 died at home in Marlow on 24 March 2012. Peter was captain of the C&G Hockey Club in 1958-59.