Imperial ENGINEER

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REVOLUTION IN OCEAN SCIENCE

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

ISSUE TWENTY *SPRING 2014*

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Now 32 Pages

In this issue...

Cover: HRH Prince Harry at the opening of the Royal British Legion Centre for Blast Injury Studies (CBIS) at Imperial. See page 11.
Photograph by Imperial College London

Imperial ENGINEER

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David Nethercot

It seems hard to believe but this will be the last occasion on which I shall be writing a Presidential Piece for Imperial ENGINEER; I hand over to my successor, Roger Venables, in the summer.

Have I enjoyed being President of CGCA? – Immensely.

Will I miss it? – Of course but other opportunities will take its place.

Was it successful? – That's for you to judge.

However, reflecting on the past (almost) 700 days, I do believe that the Association has increased its range of activities, has ensured that some established events for whom the present champion was stepping down will continue to be well looked-after, has tried (but not yet been particularly successful) to ensure that all its members pay the correct subscription and has revised aspects of its structure and method of working to better reflect current and future demands and opportunities. But my most important priority is, very much, a long term aspiration – and one that will, I trust, be continued by future presidents – to make it automatic that on graduation our students continue their membership of CGCA.

Our most recent activity was the Annual Dinner, held at the Cutler's Hall and, after last year's once in a lifetime One Hundredth, deliberately configured to be cosy and intimate. It certainly was, with a capacity attendance, an alumnus (Philip Dilley, chairman of Arup) as guest speaker and a response from Sir Keith O'Nions, attending his last CGCA dinner as the serving Rector of Imperial. We also had a spread of previous experience of CGCA dinners from those attending their first event up to an attendance for at least the 70th time. I won't make 70 but I will certainly be adding to my number as I move into being part of the history of the Association.

The previous issue of Imperial ENGINEER was the second to be produced under the charge of Peter and Alison Buck. Readers should have noticed the exceptional cover picture and the strong link with Imperial of all the features. Since many of you will have at least one interesting story to tell, don't be shy about contacting our Editor with an offer to write. I might even contribute something myself.

PRESIDENTS REPORT

John O'Reilly

It has been a busy few months since the last edition of the Imperial ENGINEER with the prime focus being on the renewed membership drive and funds appeal. In collaboration with the college alumni office approximately 5000 e-mails were sent requesting alumni to either join the RSMA, renew their membership if lapsed, or upgrade their membership, together with a funds appeal to all members. Around 60% of the letters were to potential new members. Issuing the letters in November was probably not the best time of year but the response was mildly encouraging with about 100 responses including 57 new members and many upgrading their membership to the annual subscription of £15. As a prime objective of the Association is to assist students where appropriate, all funds go to a deserving cause and the response of members is much appreciated. The RSMA is also strengthening its activity through the social media outlets, with a significant presence on LinkedIn and Facebook and it is hoped that these outlets will also lead to an increase in membership. Elly Jay continues to do an excellent job in upgrading the website and members are encouraged to send in news or items of interest to members (including births, marriages, obituaries etc.). Any regular events can be freely advertised on the website. Increased web traffic = increased RSMA chatter around the globe, which is an easy way to improve contact with former colleagues and alumni.

In November a presentation was given, by committee members, to the RSM students on the history, aims and membership benefits of the RSMA and expectations were exceeded with about 80 students attending. It was an excellent opportunity to closely interface with the current generation of students and make them aware of what the RSMA stands for. Thanks are due to Lorraine Craig, RSMU President Emily Pennington and secretary Jack Judd for their efforts in encouraging the student participation.

The annual dinner was held at the Rembrandt Hotel in Knightsbridge and a splendid evening was enjoyed by about 80 members, students and guests. Guest speaker was former double Olympian high jumper and past president of the RSMU, Geoff Parsons, who entertained the gathering with tales of his time at RSM coupled with an illustrious athletics career. The Rembrandt proved an excellent alternative venue to the Polish Club which was under refurbishment. This year the Association will celebrate its 130th anniversary dinner which will be held on Friday the 28 November again at the Rembrandt Hotel. As many members as possible are encouraged to attend.

On the sporting front RSM had a successful trip to Camborne in February and given the horrendous weather and floods in the South West it was pleasing that the matches were able to proceed. The Bottle was retained in a 6-6 draw in the Cornish mud; squash, men's and ladies' hockey were won (fortunately played on artificial surfaces) but unfortunately we went down in the football and netball. All in all a creditable performance and congratulations to all who participated and supported.

The 2014 Annual General Meeting will be held on Thursday 26 June at 58 Princes Gate and will be followed by the Final Year Bar-B-Q at the same address. All RSMA members are welcome to attend the AGM and to then interact with the students.

The Rise of the New CGCU:
it's all about Traditions, Old and New

by CGCU President – Lejon Chua

The CGCU has undergone extensive restructuring over the past year, with our refurbished office and website, reorganisation of positions, revised publicity methods, as well as the new vision of "Integrating Engineers". Moreover, we have gone the extra mile to revive many flagship traditions that were lost over the years, as well as introduce novel ones.

The Meet the Union event was held for the first time at Zetland Arms Pub to usher in the new academic year with our alumni association. Basking in a fresh new ambience, 30 esteemed Alumni and CGCU representatives relished the warm experience of engaging over good food and drink.

The Welcome Dinner, which took a break last year, was brought back with record-breaking attendance of more than 280 and concluded with a roaring Boomalaka. David (CGCA President) and Chris (OC Trust Chairman) graced the occasion and spoke to introduce the Association and the Trust to all attendees. Highlights of the night, nevertheless, were virtuoso performances from Vice-President Dominic and myself that set the audience ablaze.

We also resurrected the Mince Pies Party, which went missing from the Guild's calendar for 5 years, to celebrate Advent with everyone and raise the profile of the CGCU further. Committee members brought delight to the faces of many by giving out Mince Pies along Dalby Court.

The autumn term ended with the CGCA Careers Evening, aiming to provide engineering students with a glimpse into industry. We were very grateful to have David chair a panel with three distinguished speakers, Amish (Consulting), Jill (Software) and Atula (Finance), who shared their wealth of insight and experience from their relevant fields. The evening came to a close with a networking session over wine and snacks.

The spring term could only commence on an even higher note; our traditional CGCU bar night saw an overflowing Union Bar. To top it all off, we kick-started the inaugural City & Guilds Week (2014) - a week of exciting activities on Queen's Lawn to be held annually. The event provided the rare opportunity for more than 450 of our CGCU members to let their hair down over lunchtime fun and games. Our vintage mascot, Boanerges, was also present, giving students free tours in its inimitable style. The initiative turned out to be an unprecedented success, sparking off greater interaction between students from different departments.

Indubitably, the legacy of the 2013-14 CGCU committee will be, along the lines of our new vision, a more united engineering community and renewed C&G spirit within Imperial.

I would like to express my profound gratitude to the CGCA and the OC Trust for their generous support, without which this phenomenal year could not have taken place. We are truly privileged and honoured to be associated with you and are keen to continue with our successful partnership.

Lin Xiaoliang

The 2013-14 CGCU Committee at the CGCU Welcome Dinner (Café De Paris)

Lejon Chua / kind passerby

CGCU Vice-President Dominic and President Lejon with Boanerges during the C&G Week

Lejon Chua /Duncan Lomax

Members of the CGCU committee bouncing on Space-Hoppers during the Inaugural C&G Week

RSMU has another smashing year

By RSMU President – Emily Pennington

The 2013-2014 year has been good for the Royal School of Mines! First term saw a brilliant batch of freshers arrive and the immensely popular RSMU events run as smoothly as usual with great turnouts to every occasion. Christmas Dinner at the Royal Overseas League was well attended and the number of staff and postgraduates present confirmed that the work of the previous committees to get a varied attendance at RSMU events has paid off. The RSMA dinner saw a change in venue to the Rembrandt, South Kensington and really was a wonderful evening enjoyed by a number of students and alumni.

Bottle Match this year was hosted by Camborne so a few coachloads of RSMU travelled down to Cornwall to take part in and support at the Bottle Match Weekend. Of the Sports played, RSM won: Squash, Women's Hockey, Men's Hockey; Lost: Football, Basketball, Netball; and managed to retain the bottle with a try-less draw in the Rugby. A grand weekend was had by all, despite the bitter rivalry between RSM and CSM; friendly social interactions took place in the Stannary afterwards (see Jack's match report below).

More recently have been the Materials Alumni Dinner and RSMU Spring Dinner; both of which were very popular dinners. Spring dinner, which was introduced last year, showed ongoing popularity with a high attendance of 150 undergrads, staff, postgrads and alumni. Many awards were given on the evening alongside the announcement of the new committee; I have the greatest faith that the incoming committee can keep the Royal School of Mines at the high standard of conduct and popularity that has been shown for many years past.

4th Year students at the RSMU Spring Dinner.

The 112th Bottle Match

by RSMU Hon. Sec. – Jack Judd

This year's Bottle Match, the 112th since its conception, was an away affair, battled out in Cornwall's flooded depths. After negotiations with staff a departure time was settled, and at 1pm on Friday 21st February 150 excitable students began their arduous trek to Newquay. Despite a questionable route through central Bristol at rush hour, and some even more questionable in-coach film choices, we made good time, arriving at the campsite before 9pm.

After wrestling with the caravans' miniature cooking appliances, the athletes among us hit the hay, with the sensible supporters following soon after. At 7am the coaches to Camborne got underway, delivering the hockey players and footballers first, followed by the supporters.

The first fixture of the day was Ladies' Hockey, in which the girls fell behind early. Soon they were 2-0 down, but undeterred. After an encouraged comeback the RSM drew level, and then surpassed their opponents, eventually claiming an historic 3-2 win in what has consistently been a tough fixture in recent years.

The Football team got underway at a revised time of 10.30am, seeing a much larger crowd than they'd experienced in recent years. This year's squad are currently top of their local league and were expecting an upset against the recently dominant Camborne outfit. However, despite a number of shots and headers on goal, as well as a graze across the woodwork, RSM couldn't find the back of the net. The CSM boys were more fruitful, scoring 3 goals, though all agreed the score-line did not reflect the match.

Men's Hockey, not to be outdone by the female counterparts, chalked up a strong 3-0 victory, making it the first time (that we know of) where the RSM has won both Hockey matches.

Before leaving for the Rugby Club the two Mining Schools squared off on the netball and basketball courts. With an RSM victory in Squash (3-2) and a flooding-related cancellation in Golf, the RSM were leading 3 matches to 1 overall. Unfortunately the pressure was too great, and both sides fell to their opponents, leaving the weekend at a tie in the run up to the Rugby.

We travelled to Penryn Rugby Club for the final showdown, with all but the players looking somewhat worse for wear (and one or 2 having already fallen by the wayside). Despite amiable conditions that afternoon, the adverse weather in recent days/weeks/months had taken its toll and the pitch was heavy and sticky, making hard work for the players. In the end, the relatively inexperienced RSM team, with many representatives from the MSc cohort (and one Chilean international), battled well to hold the Camborne Miners to a 6-6 draw. This resulted in a dead tie for the weekend overall. Thanks to a strong win at home in 2013, the RSM were the current holders of the Bottle, and so retain the Bottle this year.

Following the suspense of the sport we all headed to the Rugby Club Bar for a jar or two, pending the opening of the Camborne Student Union. At 6.30pm, we made our way over for a dinner of curry, rice, and poppadoms. Basic as the meal was, it was nice of the Camborne committee to heed our request not to serve pasties, which have haunted us since 2012.

Simon Bräu

The night ended in traditional style with alcohol and a dance-floor takeover at the Sailor's Arms in Newquay, followed by a sleepy taxi ride home to the caravan site. On Sunday a brutal 8am wake-up call found us all accounted for, except one hockey player who had been waylaid at the Camborne Union by an attractive young lady, and upon his return we departed for London.

After a rare weekend, the RSM managed to bring the Bottle home once more, to sit behind the Union Bar for another year.

Simon Bräu

Simon Bräu

The victorious Hockey teams

CGCA Annual dinner

As is customary, CGCA held its annual dinner on Friday March 14th in a livery hall in the city of London. As in 2012, the venue was Cutlers' Hall. Our livery halls are astonishing tributes to the heritage of fine craftsmen and women, and Cutlers' Hall is no exception. Although there was a lot of cutlery on the tables, most of the impressive ornamentation on the walls was a mixture of fearsome swords from days of yore and shields, flags and banners. We were fortunate to be in such surroundings.

This year's dinner followed the much larger 100th annual dinner of 2013, which was held at the Mansion House. Despite the tremendous support of so many alumni last year, when some 320 people turned out in their black tie and decorations, there was still a very respectable attendance of 100 people at this year's event.

The honoured guests were led by Mr Philip Dilley, chairman of Arup, the large firm of consulting engineers. Somewhat as a complement to last year's address by Sir John Parker of the Royal Academy of Engineering on the importance of engineering to the world at large, the CGCA president David Nethercot had asked Mr Dilley to address us all on the more altruistic side of engineering. Given his career at Arup he was well-placed to do this, as many of those present heard how Arup – started in 1946 by Sir Ove Arup – had been conceived very much as a philanthropic rather than an outright commercial organisation. To this day the company's primary shareholders are trusts, its profits are shared amongst past and present employees and it directs a significant proportion of its efforts towards projects which seek to help and support, rather than profit from, those who use its services.

Gordon Lam

Philip Dilley addressed us

The other principal guest was the President and Rector of Imperial College, Sir Keith O'Nions. In what is his last year in post before handing over to James Stirling as Provost and Alice Gast as President, Sir Keith replied to Mr Dilley's address to thank him on behalf of the association and guests. We were honoured to have Sir Keith with us again, and many commented on how successfully he has steered the College since 2009. We wish him well.

I must mention two other customs of the annual dinner. Firstly, two students receive awards each year from the Association's charitable arm the OC Trust. This year Miss Victoria Solly was named sportsman (sports-person?) of the year, whilst Mr Mateusz Marcin Gocek was recognised for achieving the honoured position of official Bo driver. Both students received a cheque and an engraved tankard, and from what I could tell from talking to them afterwards were suitably awestruck by the whole experience. Also, I cannot fail to mention the exceptional job done by this year's CGCU president, Mr Lejon Chua, in leading the assembled alumni in a Boomalaka. It is always best attacked with courage, gusto and complete abandon, and in this respect Lejon goes down in my memory as one of the best!

All in all, what with the marvellous surroundings, excellent speeches, delicious food and excellent wine and port – as usual from the Association's own cellar – the dinner was a fine example of our tradition, and we can look forward confidently to many more of the same in years to come.

Peter Chase

Gordon Lam

CGCU and CGCA executive with Spanner and Bolt

CGCA Christmas Luncheon and Lecture 2013

Chris Lumb

Close on fifty guests attended the annual CGCA Christmas Luncheon and Lecture, which was held at 170 Queens Gate on 12 December 2013. After a cordial sherry reception, the CGCA President, David Nethercot, opened proceedings with a warm welcome to members and their guests, in which he light-heartedly informed the guests that the two principal activities of the association were "nostalgia and conviviality" and that the luncheon was an ideal opportunity to partake in both. He then introduced the lecturer Edward Astle, who had been Imperial College's Pro-Rector (Enterprise) until July 2013.

Mr Astle, in an engaging and informative talk titled "University / Business Interaction: Challenges and Opportunities", gave a fascinating insight into how and why industry invests in university research and how Imperial College is placed to benefit from those investments. Mr Astle first set the context with some remarkable statistics, amongst which were: industries invest about £16bn per annum in university research worldwide, less than half of that is from the US and Europe; of UK universities, Imperial College attracts the second highest such investment (the highest, if clinical trials are excluded); if Imperial College were a university in the US, it would be one of the ten highest recipients of research funding from industry; Imperial's research funding from the private sector is two to three times more than that from the funding councils. Next, Mr Astle explained some of the criteria that industries apply to universities in choosing which to partner with. Amongst them were: excellence in research; interdepartmental co-operation; the willingness and ability to collaborate long-term with other university and industry researchers; and, perhaps most pertinently for CGCA, alumni relationships. Mr Astle then finished his lecture by stating that global companies can invest their funds anywhere in the world and, as London is the one of the most expensive places to carry out research, in order to compete for such funds on merit and not on price, Imperial needs its research capabilities to stay world-class and it needs to move towards becoming a more agile, globally-networked and transnational university. A lively question and answer session then ensued, mostly around this last point.

Chris Lumb

David thanks Edward Astle

The President then thanked Edward Astle for giving the lecture and Teresa Sergot for organising the event, and invited the assembled members, students and their guests to enjoy a very good traditional, three-course, Christmas luncheon. As usual, despite the attendance of a handful of students, the average age of guests was noticeably on the older side: the welcome presence of Rogers Knight (City and Guilds College, '34 - '38) just six days after his 98th birthday increasing it only slightly. Perhaps we should encourage younger members and students to attend next year. They would surely have benefited from such an absorbing lecture and enjoyed the conviviality if not the nostalgia at the dining tables.

Charles Parry

CGCA AGM / President's Evening

The 2014 Annual General Meeting of the City & Guilds College Association will take place on Wednesday, 4th June, starting at 17:30. This year sees Professor Nethercot, our president since 2012 stand down and Roger Venables will take the reins for the next two years. The AGM will include the presentation of a revised constitution for the Association. After the AGM Roger will give a talk titled "Sustainability and Infrastructure: crucial connections and challenging contradictions" which will look at challenges faced by various engineering disciplines involved in delivering the infrastructure demanded by modern society.

The venue for the AGM and talk is the Pippard Theatre, Level 5, in the Sherfield Building, Imperial College, South Kensington. Refreshments will available on the landing outside the Theatre from 17:00. It is free to attend the AGM and Roger's talk.

As is traditional there will be a hot supper following the AGM, served in the Senior Common Room on Level 2 of the Sherfield Building. All details and supper ticket prices are included in a booking sheet packaged with this issue of Imperial Engineer. Please make sure you book your place at the AGM and supper by 19th May.

Revised CGCA Constitution, 2014

At the 2013 AGM a proposal to amend the City & Guilds College Association Constitution to reflect a move to Departmental Representatives was carried unanimously, and further the meeting gave the task of finalising the wording of the document into the care of the General Committee. That work started in the autumn of 2013. In addition to the Departmental Representatives the General Committee took the opportunity to update other parts of the Constitution to reflect current practice, for example that presidents now serve a two year term.

Another major area that has never been covered within our constitution is the Data Protection Act and a definition of what data we need to hold about members, what it is used for and who has access to it. A definition of those responsibilities was also added and at the General Committee meeting on 10th December the wording of the new constitution was reviewed and approved.

A new constitution document has now been prepared and will be presented for approval at the AGM on 4th June 2014. Copies of the document will be distributed electronically before that meeting.

CGCU creates its own High Society

One of the delights of occupying a position such as the CGCA Presidency is that it provides opportunities to be surprised. The evening of Tuesday 18th October of last year was one such occasion. Having pushed my way through the crowds in Leicester Square – assembled I was later informed because of the premiere of one of those films that people of my generation know nothing about – I was greeted at the entrance to the Cafe de Paris by an intimidating line of large 'security'. Noting my grey hairs and laboured gait they invited me to bypass the waiting queue so that I could join the guests at the CGCU Welcome Dinner for Freshers. What a surprise! Inside were males in dinner jackets and smart suits and females who looked as if they should have been at the adjacent film premiere – very different from the universal grunge favoured by today's students. For this

Chris Lumb – the OC Trust

was an event organised by CGCU especially to make newly-arrived Engineering students, many of whom were experiencing London for the first time, feel part of Imperial. And how well they succeeded. Just the right opening from the CGCU president Lejon, animated and convivial conversation at the dinner tables, an opportunity to hear briefly from OC Trust, the College and CGCA about the opportunities and delights that lay in store for them and professional-standard music from some of the students. With a

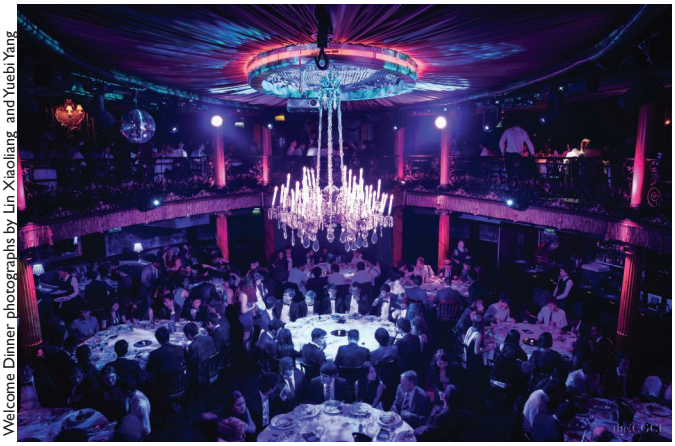
David Nethercot – CGCA

sellout attendance of over 250 and an obvious buzz of enjoyment, this was a wonderful evening. Of course, the three representatives from OC Trust, College and CGCA had the foresight to plead the need to travel home as the reason for leaving just as the floor was being cleared – presumably for the dancing and more boisterous aspects of the evening – so we will never know how the event concluded. But I

Jad Habib and Lejon Chua – CGCU

have no doubts that it continued to be highly successful, brought great credit to those who organised it and deserves to be a regular feature in the Imperial student calendar. Well done.

David Nethercot



Welcome Dinner photographs by Lin Xiaoliang and Yuebi Yang

RSMA Annual Dinner

This year the annual dinner was held at the Rembrandt Hotel in Knightsbridge. About 80 members, students and guests had an enjoyable evening. Geoff Parsons, past president of RSMU regaled us with tales of his time at college, as well as his career as a double Olympian high jumper.

Photographs: Sean Conner

Brian Wallace, Geoff Parsons, Mike Nott, John O'Reilly, John Horsburgh, Bill Hooley, (front) Arthur Smith, Pete Hoddinott

Past RSMA presidents Coen Louwarts (L) and Kurt Budge (R)

"Material Old Boys" Elly Jay and Simon Pike behind (R) and Douglas McIlwraith (on left with moustache), with geology undergraduates

Presidents John O'Reilly (RSMA) and Emily Pennington (RSMU)

Notice of the RSMA Annual General Meeting and Final Year BBQ.

Thursday, 26th June 2014

The Annual General Meeting of the Royal School of Mines Association will take place on Thursday, 26th June 2014, 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 2014 / 2015 academic year.

Following the AGM, at 19:00 our President, John O'Reilly will host a BBQ for alumni and the Final Year students of the RSM who will 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.

Peter Harding Memorial Medal

The recipient of the 2013 Peter Harding Memorial Medal was Harry Burgess, and was awarded for services to the RSMA in Toronto.

Harry read Mechanical Engineering in City & Guilds from 1963 to 1966, he then saw the light and took the conversion course to Mining Engineering at the RSM from 1966 to 1968. After 12 years in Africa, on the Zambian Copperbelt and South Africa, he migrated to Toronto in 1980. He soon thereafter started the "last Friday of the Month" RSM lunch which later changed to encompass all IC alumni and is now so famous that it embraces much of the Toronto mining community, but is still known by all as the RSM lunch, and 33 years on is still organised by Harry. It provides an excellent opportunity for mines persons visiting Toronto to catch up with alumni and industry peers and has proven an ideal forum for social and business interaction. He was at one time an Overseas Council Member for the old Institution of Mining & Metallurgy. Anyone from RSM visiting Toronto is always welcomed by Harry, and in his semi-retirement he is now able to participate for longer at the lunches!!

He could not attend the annual dinner in November to receive his award as he was preparing to head to sunnier climes in New Zealand to escape the Canadian winter, but sent a thank you note, accepting the honour, which was read at the dinner. Coincidentally the RSMA President spent Christmas and New Year with him in Wanaka, and presented him the medal before heading out to play golf in the New Zealand sunshine.

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Professor Alice Gast to become sixteenth head and first woman to lead Imperial

Professor Alice P. Gast will succeed Sir Keith O'Nions as President of Imperial from September 2014.

Professor Gast is currently President of Lehigh University and former Vice President for Research and Associate Provost at the Massachusetts Institute of Technology.

As President, Professor Gast will lead the College's strategy, including the development of its new 25 acre campus, Imperial West, and its links to government, industry, philanthropists and alumni. Her appointment concludes an international search for Imperial's new President and completes the appointments within a new leadership model announced by the Chairman of its Council, Baroness Manningham-Buller, in April 2012.

An internationally renowned scholar in the field of chemical engineering and a leader in higher education, Professor Gast has served as President of Lehigh University in Pennsylvania since 2006.

At Lehigh she has focused on the quality of undergraduate and postgraduate education and their integration with research. She has led a campus-wide strategic planning and implementation process, and launched major initiatives in sustainability, inquiry-based learning, neighbourhood revitalisation and campus master planning. Professor Gast has overseen a 47% increase in the size of Lehigh's campus estate, expanded the university's international presence, concluded its $500 million fundraising campaign, and helped to raise an additional $225 million during her tenure.

Before Lehigh University, Professor Gast was Vice President for Research and Associate Provost at the Massachusetts Institute of Technology and held the Robert T. Haslam chair in chemical engineering. She was previously at Stanford University from 1985 to 2001 as a professor of chemical engineering and as affiliated faculty at Stanford Synchrotron Radiation Laboratory. She has been a US Science Envoy to Central Asia and is currently a Board Director of the Chevron Corporation and Trustee of King Abdullah University of Science and Technology in Saudi Arabia.

Responding to her appointment Professor Gast said:

"I have always been excited by what goes on at Imperial, one of the world's greatest scientific universities. With its unique focus on science, engineering, medicine and business, and its integrated mission to teach, research and translate its work for the benefit of society, Imperial has a great leadership role in the world. I am therefore deeply honoured by this opportunity to serve as its President.

"I look forward to getting to know its whole community of staff, students, alumni, friends and supporters, and to helping Imperial to grow and to continue to push the boundaries of learning, discovery and innovation over the coming years.

"Sir Keith leaves a wonderful legacy and Imperial and the global science community are much stronger thanks to his leadership. Imperial's future looks very bright, and I am honoured by the invitation to help shape it."

Professor Gast, 55, was born in Texas and earned her bachelor's degree in Chemical Engineering from the University of Southern California (1980) where she was class valedictorian, before completing a master's degree (1981) and Ph.D. (1984) in Chemical Engineering from Princeton University.

Professor Gast is married to Bradley J. Askins, a computer consultant, and they have two children. As President of Imperial, Professor Gast will live on campus at the residence above 170 Queen's Gate, South Kensington, an historic building that is used by the College for a range of official ceremonial and meeting functions.

http://bit.ly/IE20President

Awards for process to turn waste into plastic

A cross-disciplinary team of Imperial students have been recognised for their project, which uses harmless engineered bacteria to turn landfill waste into a biodegradable plastic or bio-plastic. The team say the bio-plastic could be used in healthcare to make syringes and other disposable devices used in hospitals. They have also developed a method for breaking down the bio-plastic so that it can be easily disposed of when it is no longer needed.

The students won their awards at the International Genetically Engineered Machine (iGEM) competition, winning a gold medal for the project, coming first in the manufacturing section and third overall out of total of 200 teams worldwide.

The iGEM competition sees university teams experimenting in their labs over the summer, competing to develop microscopic devices that can be used to help the environment, advance health and medicine, improve IT and make food and energy production more sustainable. The teams make their devices from harmless bacteria and cells such as yeast, re-engineering their DNA to perform pre-determined functions.

Teams from universities all over the world descended earlier this month on the Massachusetts Institute of Technology in the USA, presenting their inventions at the annual iGEM competition. The projects were judged by a panel of leading scientists and engineers.

The Imperial team re-engineered the genetic code of harmless *E.coli* bacteria so that they can break down landfill waste and turn it into bio-plastic. Current methods for making bio-plastics rely on plants as the main ingredient, but this means valuable agricultural land has to be used to grow the plants. The team say their process could be scaled up to industrial levels and that using waste material instead of plants could free up agricultural land so that it can be used more productively for agriculture.

Imperial team member Jemma Pilcher said: "In the future, our system could provide a sustainable way to make an environmentally friendly alternative to petroleum-based plastics, which would reduce our dependency on oil. Additionally, this system would divert rubbish away from landfill sites and incinerators, which have very negative effects on the environment by releasing toxins, and instead use it as a resource."

"Technologies such as ours could one day be used to deal with the global challenge of how to dispose of ever increasing levels of waste," added team member Margarita Kopniczky. "Perhaps in the future we will have household appliances that contain engineered bacteria that turn domestic waste into new 3D printed bioplastic objects such as a plastic container to store the leftovers from a meal."

Since the competition began in 2003, Imperial has entered a team nearly every year in the iGEM competition. Each year, successive Imperial teams have reached the final six.

Professor Richard Kitney, Co-Director of the Centre for Synthetic Biology and Innovation at Imperial and team mentor, said: "Coming third overall in the world is a great achievement for our team and we would like to thank our colleagues for supporting the iGEM team and in particular the team's advisor Dr Richard Kelwick. One of the reasons why our teams do so well each year is that students take full ownership of their project, which is important for their development."

The team consists of Jemma Pilcher, 3rd year undergraduate in Biochemistry; Margarita Kopniczky, 3rd year Biology; Iain Bower 4th year Biology with Management; Wenqiang Chi, 4th year undergraduate in Biomedical engineering; James Strutt, MSc in Stem Cells; Matthew Chin MSc in Biomedical Engineering and Sisi Fan, MSc in Bioinformatics.

The students learn both scientifically and personally during the competition. This includes developing a research project from scratch and getting to experience the realities, rigour and challenges of carrying out laboratory research. They also learn to work as a team, communicating their ideas to external parties and presenting their work formally. This year the team presented their work to nearly one thousand colleagues.

Professor Paul Freemont, Centre Co-Director and team mentor, said: "Professor Kitney and I get enormous satisfaction in seeing a group of young colleagues develop their professional skills over the summer. It never ceases to amaze me how creative our teams can be in tackling major global problems and how extraordinarily determined they are in being successful. Already this project has received a lot of attention from the waste industry, which may lead to potential research collaborations in the future."

http://bit.ly/IE20IGEM

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

New catalytic converter could cut fuel consumption and car manufacturing costs

A new catalytic converter that could cut fuel consumption and manufacturing costs has been designed by an Imperial engineer. Tests suggest that the new design could reduce fuel consumption in a standard vehicle by up to three per cent. It could also deliver environmental benefits by reducing the amount of CO_2 that each vehicle emits.

Catalytic converters are expensive to manufacture because they use precious metals such as platinum to eliminate emissions. These metals currently account for up to 60 to 70 per cent of the cost of the component. The new design uses up to 80 per cent less rare metal, a development that could significantly reduce costs for vehicle manufacturers.

The prototype is also predicted to perform better than existing models because the rare metal degrades less over the lifetime of the component. Laboratory tests suggest that it deteriorates by only four per cent over a distance of 100,000 kilometres, compared to 35 per cent for a standard catalytic converter.

The prototype device was developed by Dr Benjamin Kingsbury, Professor Kang Li and Dr Zhentao Wu who are all from the Department of Chemical Engineering.

Dr Kingsbury says: "Catalytic converters are the most important component in a vehicle for controlling exhaust emissions. Yet their design has not changed since they were first developed in the 1940s. The prototype I have developed could make cars cheaper to run because they use less fuel. It could potentially help manufacturers to reduce their costs. Drivers could also be a major beneficiary of this device, which could save on fuel costs and ultimately lead to reduced CO_2 emissions."

A conventional catalytic converter is a ceramic block, which is honeycombed with microscopic channels that are coated in a rare metal such as platinum. Emissions travel from the engine to the exhaust system and through the channels, where the precious metal causes a chemical reaction to occur that eliminates the harmful pollutants.

The researchers have advanced an existing manufacturing process to improve the structure of the microscopic channels, increasing the surface area and enabling the rare metal in the device to be distributed more effectively so that less metal is used. The increased surface area also makes the catalytic converter's chemical reaction process more efficient.

The new design of the device increases fuel efficiency because it prevents 'back pressure', which is a build up of gases that can make the engine work harder, affecting its performance.

Dr Kingsbury has been awarded funding from the Royal Academy of Engineering to take his prototype to the marketplace. Dr Kingsbury and his partners worked with Imperial Innovations to establish an Imperial start-up company in December 2013 to market the prototype device. A key next step is to develop a production process for mass manufacturing.

http://bit.ly/IE20Cat

Data Sciences Institute opens

In the last two years the world has produced more data than in all of human history. Developing insights from better analysis of this information will enable us to improve our predictions of diseases in people, stimulate innovation, unleash waves of productivity and create new consumer services.

The Data Science Institute (DSI) at Imperial aims to capitalise on this data revolution, by underpinning multi-disciplinary collaborations between the College's academic experts and research partners in areas such as healthcare, financial services, climate science, and city infrastructure to create new solutions to complex problems. The DSI will also foster the next generation of data scientists and engineers by developing a range of postgraduate and executive courses.

Sir Keith O'Nions, President & Rector of Imperial College London, says: "Imperial is uniquely placed to play a leading role in data science. Our critical mass of scientific, medical, engineering and business expertise puts us in a strong position to harness the power of the data generated by our research. We are defined by multi-disciplinary collaboration and the large scale of our scientific and engineering collaborations at home and internationally. Industrial partnership is a key component of our work to apply the fruits of this research for the benefit of our society and economy. I would like to thank all the corporate partners who are helping to make our vision a reality."

The DSI is developing a range of industrial collaborations. For example, Imperial and Huawei signed an agreement last year to develop a data science lab to bring together researchers with cutting-edge facilities to build the next generation of big data applications. These partnerships build on the College's long-standing collaborations in data science with companies such as IBM and Thomson Reuters.

Professor David Gann,Vice President (Development and Innovation), says: "Data is the lifeblood of the twenty first century. Medical innovation, disease prevention, climate change research, the analysis of financial markets and consumer behaviour,and the development of cities capable of accommodating population growth, all require us to gain insights from large, complex data sets. Imperial's Data Science Institute will act as an international hub within Imperial West, the College's innovation and translation campus, providing an important location for researchers and industry to collaborate together in this field."

Professor Yike Guo, Director of the DSI at Imperial, said: "From the development of large data sensor networks to mitigate the effects of flooding in the UK, to using information collected from satellites to understand how changes in the Sun may affect our climate, there is already a wealth of research, which the Data Science Institute is seeking to harness.The Data Science Institute will extend our ability to address the frontiers of scientific research in the big data era. This launch is an invitation to industry and academia to let you know that the Data Science Institute is open for business.We are looking forward to working with all of you to put data at the core of research and innovation with the aim of building a healthy and sustainable modern world."

http://bit.ly/IE20DSI

Imperial engineer impresses politicians at House of Commons research showcase

Imperial researcher Dr Claire Donoghue was awarded a silver medal at the national SET for Britain competition held at Parliament this week.

The event, hosted annually by the House of Commons, aims to promote Britain's early-career researchers and give them the chance to discuss their work with Members of Parliament.

Over 200 researchers, including twelve from Imperial, exhibited their work at the competition, with prizes being awarded on the basis of outstanding research coupled with the ability to effectively communicate their work to those without a scientific background.

Exhibitors were shortlisted from hundreds of applicants, and were entered into five categories: Engineering; Biological and Biomedical Sciences; Chemistry; Physics; and Mathematics.

Dr Donoghue, a postdoctoral researcher in the Department of Bioengineering, was awarded the silver medal in the Engineering category for her work in designing software that can interpret MRI scans without human assistance and predict osteoarthritis - potentially allowing for earlier treatment of the disease.

Speaking of her success, Dr Claire Donoghue said: "I am thrilled to have been chosen to receive this award, particularly when the calibre of other entrants was so high, and I really enjoyed getting a chance to discuss my research with MPs. The event highlighted some of the exciting research taking place across UK universities and it was great to be a part of this"

Anthony Lim, a PhD student from the Department of Physics who also exhibited his work at the event, said: "Increasing and improving communication between scientists and MPs is really important, as often both sides lack an understanding of the work and pressures of the other. SET for Britain gave us an opportunity to bridge this gap."

Andrew Miller MP, Chairman of the Parliamentary and Scientific Committee, said: "This annual competition is an important date in the parliamentary calendar because it gives MPs an opportunity to speak to a wide range of the country's best young researchers. These early-career engineers, mathematicians and scientists are the architects of our future and SET for Britain is politicians' best opportunity to meet them and understand their work."

Other Imperial researchers presented work at SET for Britain from Chemistry, Materials, Electrical and Electronic Engineering, Civil and Environmental Engineering, Mathematics and Physics.

http://bit.ly/IE20SET

Bioengineering is here to stay

In this second article on Bioengineering at Imperial, Prof. Anthony Bull and Dr Jenna Stevens-Smith follow the last issue's description of the past fifty years of bioengineering with a look at the next fifty.

The last article described the history of the past fifty years of bioengineering, placing it into context, alongside the Imperial definition of the three pillars of bioengineering: biomedical engineering, biological engineering and biomimetics (biologically-inspired design). This article focuses on the next fifty years, highlighting a few key areas of development in bioengineering at Imperial.

The Department has five main research themes covering the breadth of the discipline and, as befits possibly the largest such department in the world, is able to go into depth in most of these. In addition to the research themes, the Department also leads on some major research centres that address current biomedical challenges. These centres work across engineering, medicine and the natural sciences and examples include the Centre for Neurotechnology, Medical Engineering Solutions in Osteoarthritis, and Synthetic Biology.

The most recent addition to this list is the Royal British Legion Centre for Blast Injury Studies at Imperial College London (CBIS), whose mission is to progress understanding of blast injury through research and education, in order to improve clinical treatment and rehabilitation and influence strategies such as equipment design. It is a unique centre in that the collaboration of engineers, biologists, physicists and medics is not only embedded in the civilian research world, but also serves as a research centre directly supported by the military. The clinical lead for the Centre is the Defence Professor of Trauma and Orthopaedics, Colonel Jon Clasper, and there is currently a handful of military medical officers conducting full-time research on the South Kensington Campus. Led by the Department of Bioengineering, CBIS looks at the effect of blast injury from cellular through to whole organ and limb level, with research looking at a range of systems including: musculoskeletal, lungs, head (traumatic brain injury), nerve, testes, and hearing (noise-induced hearing loss). Research in the Centre spans a broad remit from understanding the mechanism that causes muscle cells to turn into bone cells in a condition known as Heterotopic ossification (HO), which is the process by which bone tissue forms outside of the skeleton, to testing prescription boots and blast mats for their ability to mitigate the blast transferred to the soldier in an armoured vehicle. A recent development is the extension of the work into blast injury rehabilitation in collaboration with Headley Court, the Defence Medical Rehabilitation Unit.

The Centre's work is a very real application of bioengineering to a topical issue and has already had quantifiable societal impact through influencing standards for vehicle testing, surgical training and medical care. As such, this high profile work has attracted public interest from HRH Prince Harry, who officially opened the Centre's new laboratories on 17th October 2013, and Anna Soubry MP, Minister for Defence Personnel, Welfare and Veterans.

Imperial College, London

HRH Prince Harry opened the Centre

The Centre also works closely with charities such as Find a Better Way, founded by Sir Bobby Charlton (who also attended the official opening), which is a charity that helps civilian communities affected by the effect of landmines. This is a reminder that although there is an emphasis of CBIS on military blast, the research and subsequent findings are applicable to civilian scenarios such as impact injuries sustained through car accidents, plane crashes and other major trauma incidents including terrorist actions. The World Health Organisation state that 15,000-20,000 civilians are killed through landmine explosions each year and each month there are 1,000 explosions across the world.

Another expanding field of research in the Department is neurotechnology. The Department has strength in the diversity of its research in this area, from Dr Aldo Faisal's eye movement work, Professor Etienne Burdet's rehabilitative devices and Dr Simon Schultz' research on "reverse engineering" the information processing architecture of the brain to investigate the basic principles of information-processing in cortical circuits. There is set to be further development of this area of human-machine interfaces as our knowledge of the neuronal system develops alongside advances in technology. Some of the research into biomimetics falls under the neurotechnology banner, with Dr Holger Krapp researching the neuronal system of flies. Investment by the government and industry in the £10M Centre for Doctoral Training in Neurotechnology for Life and Health led by Dr Simon Schultz illustrates the recognition of the importance of this area to funders.

What is clear from all of these expanding areas is that bioengineering has arrived and is here to stay. It's recognised in four of the eight great technologies proposed by Rt Hon David Willetts MP in 2013, which include Big Data Revolution and Energy-Efficient Computing, Robotics and Autonomous Systems, Where Dry Meets Wet – Life Sciences, Genomics and Synthetic Biology and Regenerative Medicine. All areas which have seen further investment from the current Government.

But we don't have to hear from government to know that bioengineering is important. Changing demographics, lifestyle and medical care as well as opportunities in the life sciences mean that bioengineering is set to grow from strength to strength.

Prof Anthony Bull (Mech Eng 95) (left). After completing his sponsorship duties with Ford Motor Company, he returned to Imperial for a PhD in Biomechanics, and then after a series of postdoctoral positions, moved to the Centre for Biological and Medical Systems in 2000. This Centre became the Department of Bioengineering, and Anthony was appointed Head of Department in 2012.

Dr Jenna Stevens-Smith (right). After studying bioengineering at undergraduate and doctoral level, Jenna moved into a career in science communication. She founded Science Brainwaves in Sheffield while doing her PhD; then moved to London to run the public engagement, media and events for the Society of Biology. Jenna returned to her bioengineering roots in June 2013 when she joined the Department of Bioengineering as Outreach Manager.

The Deepwater Horizon Oil Spill

MSc student Leo Robertson won the RSMA Essay prize with this article about the causes of the environmental disaster that devastated the Gulf of Mexico in 2010.

U.S.Coast Guard photo, by Monica Leftwich

Fire boat response crews battle the blazing remnants of the off shore oil rig Deepwater Horizon April 21, 2010.

On the 30th of May, 6 days after the biggest oil spill in history, 11 lives ended, oil still flowed from the well causing unprecedented damage to beaches, sealife, wildlife, fishing communities, the lives of BP employees; then BP CEO Tony Hayward tells reporters 'I'd like my life back'.

In choosing a topic related to environmental issues, there's hardly one of recent times that has had more impact on the environment than the BP Oil disaster. Perhaps it would be more worthwhile trying to appreciate the subtleties of the everyday impact of modern life on the environment, rather than the few instances when something goes terribly wrong. However, back in 2010 when it happened I was a chemical engineering undergraduate, working as an intern for an Oil and Gas consultancy company. I heard environmental, chemical, civil and mechanical engineers talking about it every day, giving each other updates and opinions. It was an exciting place to be, I had a rare opportunity to gain a deep insight into what happened, ask questions, understand. And I did absolutely nothing to inform myself about the disaster. There's nothing wrong with me exactly, in fact I'm probably representative of a much larger populace, not only of engineers, who find it difficult to connect to environmental issues.

So, now to visit, and not revisit, the disaster, provide a brief overview of the technical problems involved, and consider what happens next.

The Macondo well, off the coast of the Gulf of Mexico, was being sealed off by cement to be temporarily abandoned before being used for production. The well was notoriously difficult, a "well from hell", with several unexpected problems during drilling. Deepwater drilling inherently presents more complications that drilling on land, since none of the mechanisms on the ocean floor can be accessed manually once installed due to the pressure and temperature conditions at that depth, 5000ft in the case of Deepwater Horizon. Also, at these depths, it is not possible to use a rig that is connected to the ocean floor: the Deepwater Horizon rig floated on the surface of the water, and thrusters were controlled via satellite to keep the rig positioned over the well, thus it is a more complex process than using a fixed rig.

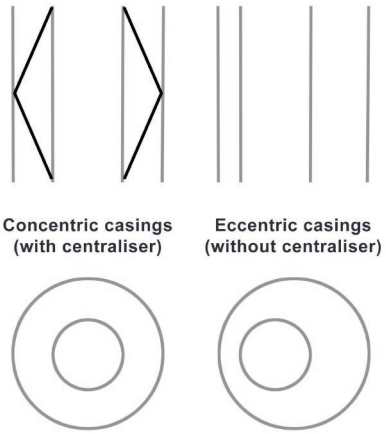
Once the well was set up, it was then plugged with cement, so that it could be left alone until the Deepwater Nautilus rig arrived to extract the oil and gas. In this operation, the cement has to flow down a pipe, or "casing", which is within another wider casing, and once the cement reaches the bottom of the centre casing it spreads out and occludes the lumen of not only the central casing but the wider casing as well. Both keeping the casing in the centre of the wider casing, and cement design, are two very important factors in ensuring a successful cement sealing.

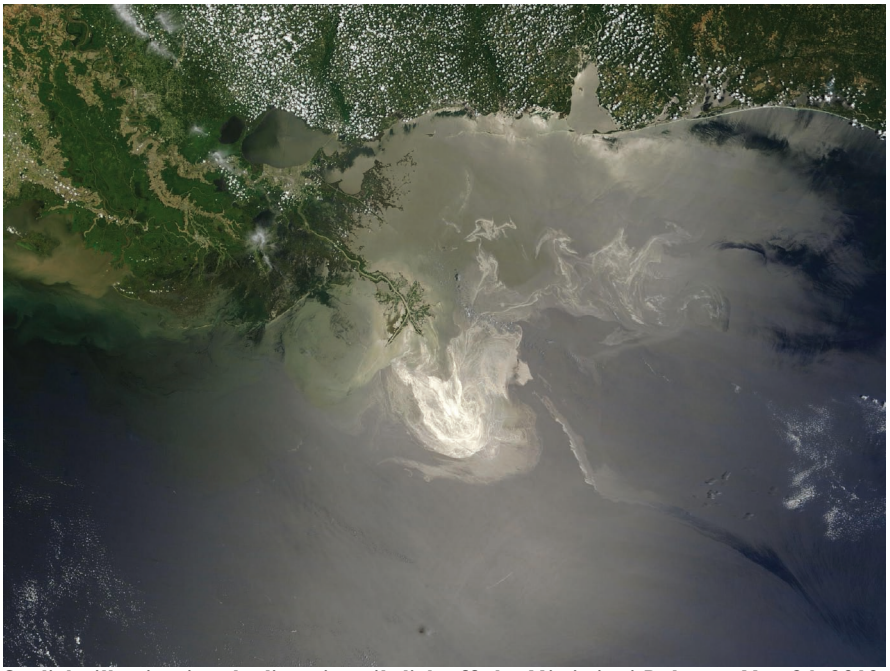
However:

1 Six centralisers, pieces of springy equipment that keep the casing central, were used, where twenty-one were recommended. Keeping the casing central is important so the cement can flow evenly around the pipe (as shown in the diagram below). It was planned to have fifteen extra flown in, but since they were of a different design, this was cancelled. It was thought that it would be better, as is standard industry practice, to do an unsatisfactory cementing job and subsequently correct it, rather than risk the complications caused by using differently designed centralisers.

2 It was decided to use a nitrified cement foam, produced by the company Halliburton. Pilot tests run by Halliburton showed that the cement did not retain the design composition. It did not remain homogeneous, and nitrogen was coming out of dispersion. This was not expressly communicated to BP.

After it was thought that the well was sealed with cement, to be turned into a production well later, it was given a positive and negative pressure test, which test the robustness of the cement seal under different pressure conditions. The negative pressure test involves a reduction of pressure in the well to test whether or not oil and gas enters, simulating the conditions during temporary abandonment of the well. If oil and gas entered, the pressure in the well would rise and would signify a leak, and indeed there was indication of a rising pressure in the well. Both how to perform this test and how to interpret its results are experience-based: there is no exact methodology. The reading of the test was thought to be a false positive created by the hydrostatic pressure of the column of fluid on a valve that was kept closed, known as the "bladder effect". Later analysis of the negative pressure test revealed that it had given indication of a lack of equipment integrity, and was wrongly interpreted.





Courtesy NASA/Earth Observatory

Sunlight illuminating the lingering oil slick off the Mississippi Delta on May 24, 2010, captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite.

A short time after the cementing job was completed, the well blew out, and oil and gas were forced up the riser (the pipe running from rig to seabed) and on board the rig. There was a huge explosion, and a fire , killing 11 of the crew. Oil started flowing continuously, uncontrollably from the well and into the Gulf of Mexico.

Particularly disturbing in this incident was the failure of the blowout preventer (BOP). The BOP is a very large piece of equipment that is designed to prevent oil from leaving the well in an uncontrolled manner, and it does this by sealing off the line using small rubber ring-type devices to close the pipe annulus, as well as rams that slam shut and close off the flow of material out of the pipe. There is also the blind shear ram (BSR), which cuts off the pipe completely using a high hydrostatic pressure, and allows the rig to separate off from the well and float away.

The BOP can be operated in one of three ways:

- Manually by pressing an emergency switch
- Using a "dead man switch", such that lack of activity will automatically activate the BOP
- Using an ROV vehicle, which can apply the hydrostatic pressure directly to the device to set off the BSR

Any one of these methods of activating the BOP could have prevented the disaster, and all three failed.

The rig eventually sank, the fire raged on and thousands of barrels were spilled into the ocean every day until the well was eventually closed off months later.

There were of course myriad attempts to cap the spill, including a "junk shot" in the BOP, where a highly viscous liquid along with "junk" such as pieces of string and golf balls were injected into the BOP to try and stem the flow, and the securing of a containment cap over the BOP to cap the spill. Both of these methods failed, too. It was the eventual construction of two relief wells that ended the flow, by diverting the oil to newly drilled wells where it could be safely capped.

The Deepwater Horizon disaster has been called a series of failures, be they mechanical, human or managerial, with the overarching driving factor of complacency. Jay Hakes of the National Oil Spill Commission stated that 'A lot of mistakes not only shouldn't have been made but [weren't] even consistent with normal industry practice'. During a speech given at the Cambridge Union Society on November 10th, 2010, Tony Hayward said of the likelihood of the Deepwater Horizon incident that 'all our corporate deliberations told us [that it] simply could not happen'. The BP technical report for the incident identified eight different safety mechanisms, from the cementing job through to the BOP, that were breached in order to create the resulting oil spill and fire. Indeed, in 2009 when Hurricane Ida hit the Gulf of Mexico, several oil rigs used the emergency disconnect, including the Transocean Marianas rig which was attached to the Macondo well, and yet there was no such disaster from any of these rigs since they "failed safe".

Can the need for deepwater drilling be ended? Yes: the USA can end the need for deepwater drilling in the Gulf of Mexico if one eighth of the population stops driving. However it might be better to ask if it really is desirable to end deepsea oil drilling: it is a feat of engineering, and the industry has learned a lot of lessons from the Macondo incident. If one eighth of the American population stops driving, it's not to say that the oil won't be needed in the future, it's a finite resource after all, and the extraction of it has potentially already peaked. Not to mention the fact that in almost all developed countries oil is behind the scenes of our everyday lives, giving us the lifestyles that we seem to have decided we are owed, even though only one hundred or so years ago the advantages of oil that we benefit from every day, were unheard-of and not taken for granted.

This leads on to the questions raised by this incident on a grander scale. What is it about these disasters that we can't connect with? Do we care? If we don't, why not? What can we do to help? If we can help, how can the horrific impact of such environmental disasters be transformed into a tangible human impact that the general public can tap into? Environmental issues, it turns out, are not only issues with the environment.

The truth is that deepsea drilling is here to stay. No work is without risk, and in all occupations it is our duty to minimise that risk. However, it is only with some degree of irony that it could be said that an incident such as the BP oil disaster will never happen again. This is why it is so important to take the time to learn from it.

I do hope that we're not done talking about the Deepwater Horizon disaster, because some of us, myself included, are a bit late to the discussion.

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Leo Robertson is a 25 year-old process engineer from Glasgow, Scotland, currently working for Statoil in Stavanger, Norway. Last year he attended Imperial College London, completing an MSc in Advanced Chemical Engineering with Process Systems.

This essay was the winning entry of the RSMA Trust Essay Competition, and Leo wrote it while performing research for his novel 'Findesferas', about an oil crisis in South America.

El Salvador Project 2013

CGCA's Old Centralians' Trust has for several years supported the El Salvador Project, which aims to help poor communities in El Salvador face natural disasters. Set up by the Civil Engineering Department in 2001, there have been Expeditions each year since. This article is based on the report from the 2013 Expedition team.

Project History

The El Salvador Project is a charitable volunteer project that provides simple and effective engineering solutions to poor communities in El Salvador who frequently face devastating earthquakes, volcanic eruptions and landslides. The project was first formed in 2001 within the Department of Civil and Environmental Engineering in response to two devastating earthquakes that killed over 1,000 people and destroyed over 150,000 homes. The first expedition took place in the summer of 2002 and since then has become an established annual undertaking in the student calendar.

Project Aims

The project this year has been redeveloped with a focus on three key areas: Engineering, Education and Evaluation. Our Engineering aim is to provide poverty-stricken communities in El Salvador with efficient and sustainable engineering solutions. Our Education aim involves working with the local communities during the project in order to facilitate the sharing of engineering knowledge and hands-on skills. This ensures that the development work can be maintained after the team's departure. Our Evaluation aim is to understand the effectiveness of our engineering solutions and to make continuous and ongoing improvements as necessary. Evaluation of previous projects is crucial for understanding how well our work has actually helped the beneficiaries.

Preparation for the annual expedition generally starts in autumn of each year with the team leader recruiting a new team of students for the project which takes place the following summer for approximately 6 weeks. Once a team has been formed, they work together to raise funds throughout the academic year through corporate sponsorship, grant applications and events. During this time, the team leader is also working closely with our partner organisations to develop a project for the summer expedition that is both beneficial and financially viable. Our partner organisations include the UK registered charity Engage for Development, the engineering consultancy Arup, an NGO in El Salvador called REDES, and Imperial College Union.

This year preparations for the project started a little later, in January 2013, and the expedition consisted of two stages. The first stage (lasting one week) was an evaluation of the project undertaken in 2011, which involved the retrofitting of seismically weak houses to improve their resistance to earthquakes. Once the team had carried out the evaluation and concluded that the retrofit is performing well, the team moved to a new community and retrofitted 9 houses in a village called San Jose Villanueva located approximately 22km south of the capital city San Salvador. This second stage lasted three weeks to give a total expedition length of four weeks.

Project Organisation

As a project run by students from Imperial, there is a society for the expedition which is registered under the student union. The committee members of the society do not necessarily go on expeditions themselves but liaise with companies to secure funding, recruit students for fundraising and interface with the union to gain approval for the project and to secure training and insurance for many aspects of the expedition. It is also through the union's support that the project is able to secure a large amount of funding from the university, both from funds allocated for student-led activities as well as the engineering departments themselves who have an interest in the development of their students outside of an academic environment.

Fundacion REDES are the local NGO that we work with in El Salvador. We have been working with REDES for the entire history of the project and have well-established people within the organisation whom we are confident to work with. Before the beginning of each year's project we contact REDES and establish a connection with the new project team. The transition phase is usually aided by one of the translators who worked on the project in the previous year, a student from Imperial whom REDES will have already met. We propose a project to REDES which we are aiming to complete the following year; this will usually have been semi-designed already, based on previously identified needs, in collaboration with Arup. We ask for REDES to suggest any refinements to our proposal, usually based on the specific needs of the beneficiaries whom we ask them to help us identify. During the team's time in the country, REDES is usually our main source of contacts for materials and labour resources, and it acts as our general guide for the duration of the project.

Engage for Development is a small charity group set up by Imperial alumni and past project members of the El Salvador Project. Their treasurer, Sebastian Kaminski, also works for Arup and provides the project with many of the designs which are implemented on the ground. The charity has a number of charitable student-led projects and acts as an advisory board, helping students gain confidence in running their own development initiatives. It serves as a function to the El Salvador Project by providing us with credible backing, which helps greatly with fundraising, especially through websites such as Virgin Money Giving. The advice it gives is also valuable for each year's project leader, who may not always be experienced in projects of this nature. Every year the project proposal is reviewed and approved by Engage before funding is allowed to go through their accounts.

Arup is a leading UK engineering consultancy with offices across the world. Their main work deals with structural design and they recruit many students from Imperial into their graduate positions each year. The designs which are implemented by the project teams are largely designed by Sebastian Kaminski and other practising structural engineers. Employees of Arup have designed many engineering solutions for the project, all of which have been implemented, including: sanitation facilities such as latrines; rainwater harvesting systems; retrofit designs for seismic resistance; and – a first for the 2012 project – eco-houses using locally-sourced materials in a design that it is hoped will be able to be implemented across the country in the future, on the basis of an encouraging evaluation report.

Project Fundraising

The team applied for various grants designed to aid charity work or student development. Imperial College has a number of grants and funding opportunities available, including the IC Trust, the Old Centralians' Trust of the City and Guilds College Association and departmental funding. The team were successful in securing funding from all of these sources.

The Retrofit Project

The retrofit project was first proposed for the 2011 project, following the evaluation of a house design implemented across many rural villages and communities in El Salvador. The accommodation, called *vara de castilla* houses, was originally designed by REDES.

The construction involves a thin steel frame, made from square hollow sections, with the walls built from horizontal bamboo rods which were then clad in mortar to finish. This design has been used by REDES over a long period of time, including some houses built during collaborating summer projects with Imperial.

Building vara de castilla houses (2011)

After a structural assessment by Arup, the houses were deemed to be weak, and fairly unsuited to an area of high seismic activity. Although El Salvador has not suffered any large earthquakes since 2002, the risk is high, and the original design could be unfit to sustain even low levels of seismic activity. A retrofit which could be implemented quickly and efficiently across multiple houses was essential to ensure the safety of the beneficiaries.

The Design

The retrofit was designed by Arup, and was specific to this particular type of structure. The houses were constructed in a very standard manner against the original design, so it was anticipated that implementing the retrofit across many houses at high speed would be plausible. The design aimed to brace all four walls of each room in the structure using large wooden beams, fixed to the wall horizontally at around a 2 metre height. The beams would be drilled and fixed to the walls internally using threaded bolts, which connected to metal plates on the external walls. The corners of the rooms would also be reinforced using small metal angles to ensure full effectiveness of the beams. The design would greatly improve lateral resistance in the event of an earthquake.

In addition to the retrofit plan, the addition of a metal angle in the porch would ensure a rigid connection improving on the weak spot-welds already in place and avoiding collapse in an earthquake. It was also important to ensure the walls of the houses stay as dry as possible, to prevent water leaching into the bamboo and causing rotting. The bottom 60cm of the walls, on the sides that were exposed to rain, would be painted with a water resistant paint, and cracks in-filled with a material called cement plastico. The houses would also be given roof extensions on exposed sides to reduce rain exposure.

The El Salvador Project 2011

In 2011 the project team travelled to the village of Costa Rica in El Salvador to implement the first batch of retrofits on the vara de castilla houses. During the six week expedition, the team completed 28 of the 30 houses in the community, with the remaining two being unoccupied due to extensive damage. The project was completed successfully, with a small leftover budget and within the forecast timescale. It was decided that, subject to evaluation of the design at a later date, the retrofit could then be used across the remainder of the vara de castilla houses in El Salvador.

The El Salvador Project 2013

The official project brief that was written by the project leaders and agreed with the supporting charity, Engage for Development can be seen in the sidebar (right).

The main purpose of the project was to evaluate the retrofit from the 2011 project in Costa Rica and, following any necessary modifications, to implement the same design in another village.

The community to receive aid from Imperial was identified by REDES, based on risk of seismic activity and willingness of the inhabitants. The identified community was around 45 minutes drive south of the capital San Salvador. Villanueva is a large town with around 20,000 inhabitants and a fairly developed centre. However the work to be conducted by the project team was to be on the houses in the rural outskirts called San Jose Villanueva. The El Salvador Project Team of 2008 had previously worked in the town, and had helped in the construction of the vara de castilla houses in accordance with REDES' design. These were the houses that the 2013 project team retrofitted.

Following the evaluation of the initial retrofit design in Costa Rica, it was decided that the design was fitting to its purpose, with little or no disturbance to the beneficiaries' daily lives. The village had experienced a minor earthquake since the retrofit in 2011 and analysis showed the structures had behaved as expected. Although the earthquake was not of a magnitude suitable to assess the structures further, it was deemed satisfactory for the same design to be utilised in San Jose Villanueva by the 2013 project.

Project Brief 2013

Background

Between 2002 and 2005 REDES and a partner NGO constructed 225 low cost vara de castilla houses for poor communities across El Salvador. They consisted of a lightly reinforced concrete slab, a sub-standard welded steel frame, cane, chicken mesh and cement mortar. After a structural assessment by Arup, the houses were considered unsafe in an earthquake or strong winds, and recommended to be retrofitted.

In 2011 the El Salvador Project successfully retrofitted approximately 28 houses in the high risk community of San Jose de Costa Rica. The retrofit consisted primarily of the installation of timber beams fixed with simple steel connections. In addition, the houses were given general maintenance, such as painting of the walls.

Project

A very useful project for the El Salvador Project in 2013 would be the evaluation of the 2011 project, followed by the retrofit of other vara de castilla houses in another community in El Salvador. Engage suggest the following:

- Visit the community of San Jose de Costa Rica to conduct a thorough evaluation of the project from both a technical and non-technical perspective.
- Learn from the results of the evaluation to adapt both the technical details and the method of implementation of the retrofit, as appropriate.
- Implement the retrofit fully in another high risk community within El Salvador.
- Conduct a training workshop in the community, explaining the importance of regular maintenance.
- Provide a maintenance manual for the community.

Prerequisites

For this project to take place, the following are prerequisites:

- REDES must accept and be happy fully with the proposal.
- A target community must be identified, and must be happy with the proposal.
- Engage for Development must be happy with the professionalism within the team from a project management perspective.
- Arup must be happy with the professionalism within the team from a site contractor perspective.
- The team must raise adequate funds by the end of June – approximately £1300-£1400/ person for general costs + material costs of £500 per house; so assuming 20 houses retrofitted = £27,000.

2013 – Costa Rica

The project began with an evaluation of the original retrofit expedition in 2011, in the village of Costa Rica. The team of 2011, which included Elizabeth Liu, one of the team leaders for the 2013 project, retrofitted 28 houses in this community with the same design. It was hoped that the retrofit was successful in its purpose, and also that it did not negatively impact the lives of the beneficiaries.

In addition to the original retrofit plan, the team of 2011 also rebuilt the walls of two houses in the community, which had suffered extensive damage due to landslides. Some of the houses were also fitted with roof extensions, small plastic corrugations which extended the roof edges by around half a metre, protecting the wall underneath from water. The team in 2011 did not have sufficient time to finish these, and had trained a group within the community to continue the work after their departure. Both walls and roof extensions were to be evaluated in addition to the retrofit, in the scheduled two days.

Photograph: 2011 project team

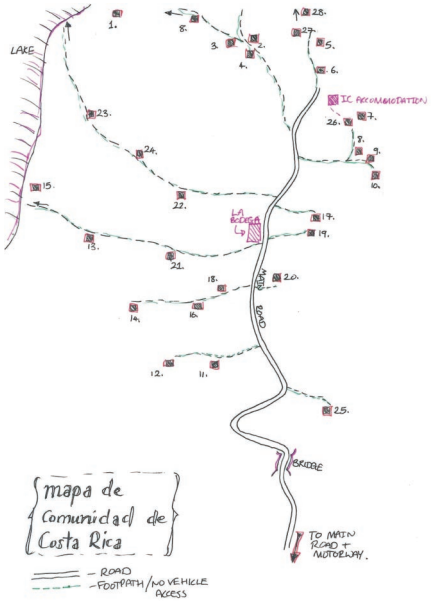
Wall destroyed by a landslide in Costa Rica

The team travelled to Costa Rica village on Monday 22nd July, with the aim of evaluating all 28 houses. Upon arrival, the afternoon was scheduled for a village meeting with the community, a chance for the team to familiarise themselves with the surroundings, meet the people they would be visiting and explain the purpose of the evaluation. It was also important to make sure that all members of the community were happy for us to inspect their houses and to answer questions as well as to make sure that we visited them at a convenient time. The evaluation strategy was extensively discussed with our supporting charity, Engage for Development, and it was decided to split it into two parts.

Part 1: Visual Inspection

A visual inspection of the house by the students, with the areas of particular interest agreed upon in advance. Most important were elements such as rusting and quality of fixings as well as signs of insects, damp and mould. Other factors that were to be noted besides the retrofit itself were the two walls that were rebuilt in 2011 due to damage caused by landslides, as well as the quality of the paint and roof extensions.

Each of the retrofitted houses was subject to a visual inspection by 2 to 3 members of the team, with a list of criteria to examine at each location. A tick sheet was used by the team members, each aspect being given a score out of 5, to provide a primary indication of the house condition, with extra comments encouraged where necessary.



Map of Costa Rica

All houses which had been retrofitted in 2011 were inspected. A rough map of their locations can be seen above.

Part 2: Beneficiary Interviews

A brief interview with the beneficiaries living in the retrofitted house. The questions targeted the work done by the students and how it had affected their everyday life. However it was also a point of interest to learn how the team interacted with the community two years ago – whether they enjoyed the experience, or felt like they had either learnt or contributed anything.

2013 – San Jose Villanueva

The Retrofit

Having carried out the evaluation in the village of Costa Rica, the team travelled to the village of San Jose Villanueva on 25th July. The overall conclusion of the evaluation was that the retrofit had been a success, and no major changes needed to be made to the design. One minor addition was included however, which was the painting of the ends of the wooden beams with preservative where they had been cut, in order to protect against termites.

Living Arrangements

In San Jose Villanueva the team had one main contact called Isaias, who is part of a community group in Villanueva and also has some involvement with REDES. It was through Isaias that the team rented a house to stay in for the three weeks spent in Villanueva. The house consisted of one large room where camp beds were set up, and another open plan kitchen area with a fridge and gas stove. Although the house had a plumbed toilet and shower, the water pipe supplying the house had a leak, therefore the team filled up a large tank periodically to avoid constantly flooding the street outside. The team also shared the house with one other tenant, a local shop worker called Jordie. The team cooked breakfast and dinner most days, and used a local comedor for lunch.

Beneficiaries

San Jose Villanueva has a total of 15 vara de castilla houses. Of these, 9 families agreed to the remedial works and had their house retrofitted. However, two of the houses were not the standard vara de castilla design and an alternative impromptu retrofit design had to be produced.

Operation

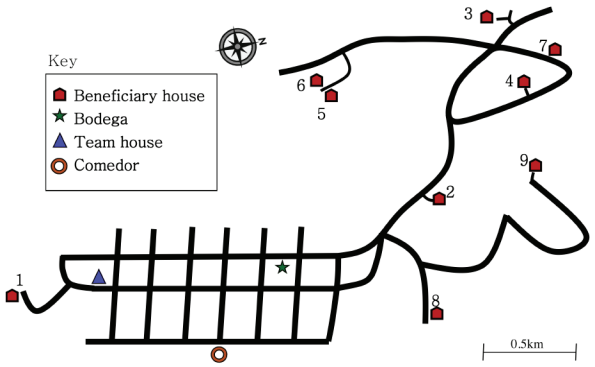
The team used a local bodega as a wood store and a place to hold meetings. The initial meeting with the community took place on Friday 26th July. At this meeting the whole team were able to meet the local villagers who lived in the vara de castilla homes, and explain to them the benefits of the retrofit. A schedule was then made for those who wanted the remedial works. The whole team worked on the first house together, led by Elizabeth Liu who had undertaken the retrofit before in 2011. Having completed this house together, the students split into two teams of five, and retrofitted two houses at a time simultaneously. Each team consisted of one team leader and one translator, as well as any members of the local community who wished to help. This was intended to provide knowledge transfer and to help facilitate the maintenance of the houses after the team had left. The teams were also mixed up at various points throughout the expedition to ensure that everybody got a chance to work with each other.

Variant House

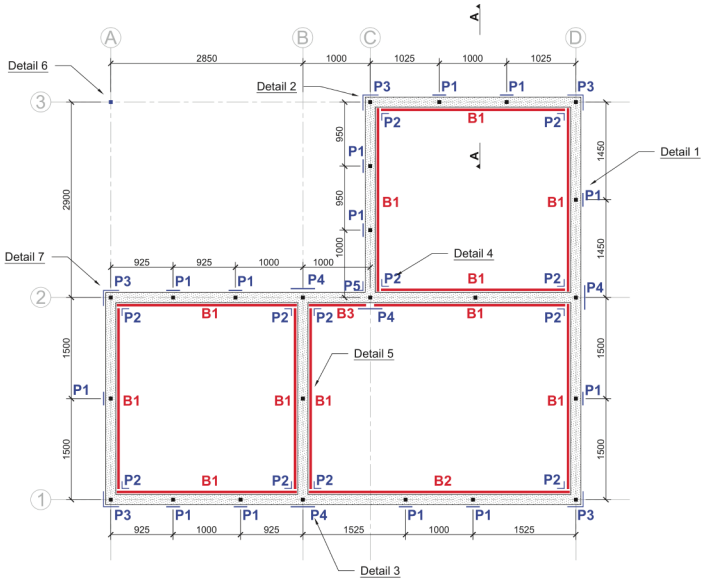
The unexpected variation of the vara de castilla house required an impromptu design. The house was rectangular in shape (as opposed to the standard L-shape), and did not have any porch attached to it. The new design required bespoke plates to be designed and ordered. These plates were attached to the rafters in two locations.

Photograph: 2011 project team

The 2011 project team with beneficiaries in Costa Rica

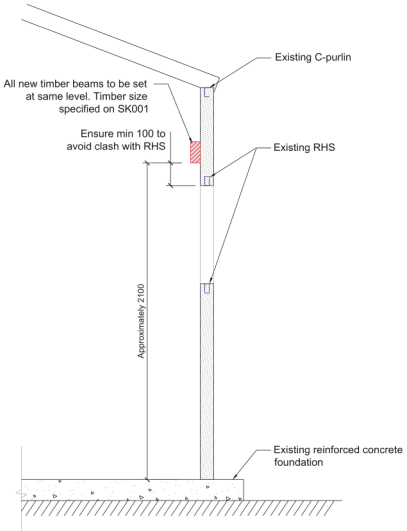


Map of San Jose Villanueva



Key

Existing wall. Typically 50-90mm thk
Existing steel columns. Typically 1"x1" or 2"x2" rectangular hollow sections
New timber beams
New steel angles and plates



Plan and section of the retrofit to the vara de castilla houses (Courtesy of Arup)

Photograph: gov.uk http://bit.ly/IE20ElSalvador

The 2013 project team with beneficiaries in San Jose Villanueva

The 2013 Expedition Team

Each year the team members are selected primarily from the Civil and Environmental Engineering department, as well as from other engineering departments in the university. Each member was requested to write a short application, describing themselves and the reason for their interest in the project. Every applicant was interviewed by the team leaders before the final team was selected. It was important for the members of the team to be able to work well with each other and easily adapt to different situations, with past experience and construction knowledge becoming a secondary factor.

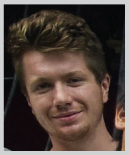
Robert Wright
Co-Leader
Ph.D. Student Second Year
Water Supply Systems Engineering

Elizabeth Liu
Co-Leader
Ph.D. Student First Year
Non-linear Structural Mechanics

Maria Sunyer Pinya
Spanish Translator
Ph.D. Student (visiting) second year
Flooding and Environmental Engineering

Carlos Poblacion
Spanish Translator
Undergraduate Second Year
Aeronautical Engineering

Bradley Pring
Health and Safety
Undergraduate Second Year
Civil and Environmental Engineering



Jack Wilkinson
Expedition Treasurer
Undergraduate First Year
Civil and Environmental Engineering

Orrin Lancaster
Expedition Treasurer
Undergraduate First Year
Civil and Environmental Engineering

Eric Leung
Undergraduate First Year
Civil and Environmental Engineering

Andy Xu
Undergraduate Second Year
Chemical Engineering

Sam Simanjuntak
Undergraduate Second Year
Civil and Environmental Engineering

Structural Monitoring in Tunnels

This is a story about an interdisciplinary project utilising a combination of engineering and geological skills

Introduction

It started with a chance meeting at Cambridge (a University located in the East of England) between Simon Maddison (Electrical Engineering 67-70, Computing 72-73) and Peter Wright (Civil Engineerng 71-74). Peter, associate director of tunnels at Halcrow (now CH2M), needed a system for monitoring tunnel distortion whilst remedial engineering works were taking place on the London Underground (LU). His company were contracted for the design work, for which Peter was responsible. Simon is COO with Senceive, which is a pioneer in the use of wireless technology for remote condition monitoring. Between the two of them they thought that there might well be an original way of using wireless sensors to solve the particular challenges of this project.

Background

In 2010 routine inspection of LU's Jubilee Line found water and sand running into previously dry sections of the tunnel. It turned out that this particular section of tunnel runs through an ancient sand channel, some 30m down and roughly underneath the line of the old Tyburn river, and similar in size to the Thames today. When built some 35 years ago, the ground had been dry, but now for some reason it was wet; apart from the water and sand running into the tunnel, the water was causing the base of the tunnel to rise, but the roof being constrained by the clays above was not. The tunnel was distorting and this was exacerbated by cavities developing between the tunnel lining and the surrounding geology. The net consequence was a compromise to the essential and tight clearance envelope needed around the trains and the real possibility of collapse in the future.

By 2012 it was clear that back grouting – filling the voids with fast setting cement - was going to be necessary in order to stabilise the tunnel, and a substantial £4m programme was commissioned. The overall system design involved mixing the grout on the surface, then pumping it down to the work area, using a system of fixed pipes and flexible couplings which could be configured as required on a shift by shift basis. These were routed down through service shafts and passages to the running tunnels, and then along the sides of the two tunnels to cover the area of the works. Oh, and yes, as this stuff sets quickly the pipes have to be flushed out with water at the end of shift. Additional pumps and tanks were situated in a small cross-passage between the two tunnels.

Problem & challenges

A very specific challenge in this project was that there would have to be little or no planned interruption to the running train schedules. All grouting works would have to be carried out in LU standard 'engineering hours' which are between 01.10 and 04:30 in the morning in this location. This in itself was a very ambitious goal, never done before on this scale whilst maintaining normal rail operations.

A crucial problem was how to monitor the tunnel whilst the works were taking place. The grouting could potentially result in changes in tunnel shape, indeed in places corrective movement was desirable. But the question was how to monitor the changes, in real time, whilst the grouting was in progress, and to ensure that the tunnel was subsequently stable.

Conventional means of monitoring would be impractical. A system of fixed wired sensors would take months to install, some 2000 sensor points at a prohibitive expense, and would involve a spaghetti of wiring that would potentially interfere with access to the grouting valves in the tunnel lining, quite apart from having to be installed right through the area from the start, rather than just at a particular area of shift work. Optical systems would not work as there would not be the required lines of sight with the grouting crew in situ, with all their equipment, access scaffolding and pipes, and the same applied to manual methods.

The Wireless Solution

The idea that Peter and Simon conceived was to use Senceive's battery-powered wireless tilt meters, positioned around the cast iron segments of the tunnel lining, to measure any rotational movement in each segment.

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Sensors in place, ready to grout

They thought that it should be possible to use this data to derive linear measurements of lining movement, and hence changes in the two key parameters: squat (i.e. tunnel height) and horizontal diameter. Following a number of white-boarding sessions with the project's tunnelling engineers, Simon dusted off his structures and mathematics to generate the necessary algorithms which provided a convincingly conclusive argument that this would work.

The sensor nodes are small battery-powered units, and with the use of wireless mesh networking protocols they provide a self-organising, robust and easy to deploy solution. The data hops from one node to its neighbours and finds its way back to a network gateway, in this case attached to a laptop for use in the tunnel. The big attraction of using wireless tilt meters were the absence of wires, the ability to provide measurements with all the crew and equipment in action, the speed with which they could be deployed, and the ability to move them as required to the locations of the particular shift's work.

Potentially this was a big risk for LU and the chief contractor, Costain Laing O'Rourke to use, but thanks to Peter's strong recommendation, and Senceive's confidence in its technology, they went ahead.

But there was still much work to do. The tilt sensors (MEMs accelerometers integrated into the wireless node) then used by Senceive were not sufficiently sensitive to meet the requirements of this application. In order to detect segment and lining movements of less than a millimetre, they were going to have to increase sensitivity by an order of magnitude. Moreover, Senceive's typical applications of remote condition monitoring for rail and civil assets normally required at most one reading per 20 minutes, and more typically per hour. This application would need readings to be reported ideally every minute. Design of the system was going to require two systems of 48 sensors each, for the two work teams; at the time this was a large network and reporting data many times faster than for previous installations.

Data would need to be presented in an accessible and friendly way for the monitoring engineers so that they could interact in real time with the lead grouting engineer - a lot of data from a large number of sensors. And finally there was the question of how to mount the sensors quickly and robustly to the tunnel lining so that the sensors could all be deployed by technical operatives in a matter of 10 minutes at the start of shift. Although the initial requirement was for the sensors to be used only during engineering hours, it was very quickly obvious that they should be left

using a novel Wireless System

from right across the discipline spectrum of the Faculty of Engineering, or in other words – Guilds and Mines.

in situ through normal running operations so that data could be collected post shift and demonstrate the stability (or otherwise) of the tunnel following grouting.

Fast development

Even ahead of the commercial commitment, four streams of development were started. A very high resolution accelerometer was identified after a painstaking search of the market, and the necessary design work started to produce the interface circuitry to integrate it within the wireless node, along with the parallel firmware coding to manage the sensor and extract the necessary data.

Senceive's existing Web Monitor interface was adapted and extended so that it would be able to present the data in a suitably accessible way with neat graphical displays and incorporate the necessary computations of the data to compute the composite tunnel distortion measures. It was also enabled to run on a laptop, rather than an internet accessible web server, that could be used in the tunnels. Further design allowed quick configuration of trigger levels on a ring by ring basis at the start of shift.

The wireless protocols were tuned and amended to allow the much higher data flows through the network, whilst avoiding the potential problems and challenges in a mesh network of data flooding. Some clever wireless design meant that data was updated at one minute intervals, with individual node reporting rates squeezed up to the best that could realistically be achieved at the time of once per 4 minutes. Another factor was the start-up time of the network. When being installed on a railway bridge for example, it doesn't matter if the network takes an hour to settle down, but in this situation it all had to work out of the box in a matter of minutes.

And then there were the fixings. Initial thoughts were of a form of mechanical clamp, but Peter believed that the use of modern high power magnets would be practical and simple, as well as quick to apply and remove. Initial experiments were conducted in a section of above-ground tunnel at the Acton depot. A spring balance was used to assess the shear force necessary to move the unit, and a simple design evolved that, with the aid of a small spirit level, could be deployed on any ring segment in a matter of seconds.

Modern magnets are strong. The components selected gave a maximum of some 48kgf direct pull on the fixing – not something you want to get your fingers trapped underneath - and as Peter discovered whilst doing some tests on his living room radiators, strong enough to take the paint off. Of course it was necessary to get the necessary acceptance from LU, and once

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Wireless sensor deployed on a ring next to a grouting valve

the design (now patented) was established, some dummy units were made up and positioned in a running tunnel for a couple of weeks, behind a mesh guard to ensure that nothing could fall on the track. They came through the test with flying colours and with no evidence of movement at all. What these trials did show however was the critical importance of removing loose material from the tunnel flange prior to fixing, to ensure an effective attachment – underground tunnels are dirty, with lots of iron oxide and brake dust to be brushed away!

From a standing start all this was completed in 3 months, to the point where the first batch of sensors was available for deployment in anger. Of course it did not stop there. Once this totally novel system went into use, unanticipated requirements came up – this is a very common experience with new

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Cross-passages are congested!

technology. Sometimes at the end of shift Simon would write up a task list, hand it over to the development team before heading off for sleep, and having the team work through the day on enhancements and upgrades in time for the following night's shift.

One requirement that came up very quickly was to have the system continue gathering data during operational train running hours. The problem was that there was nowhere safe to leave the monitoring laptop – high winds can occur in cross-passages as trains pass, and everything there needs to be secured, and it is certainly not permitted for personnel to be there. The nearest accessible location with power was up a 30m shaft, complete with steel mesh stairs and platforms, up to a further passage which linked to an electricity sub-station round the corner. To get the wireless signal back to this location, Senceive deployed a number of 'repeater' nodes – in effect nodes without a sensor. The data then piggy-backed to the new location of the gateway and laptop, to carry on collecting data, and was potentially accessible during the day. The first shift this was deployed, the repeaters were put in place in the last 10 minutes before hand-back, key locations being on the corners of the shaft and passages. It all demonstrated how flexible the system is.

Project Outcomes

In practice, it only took a couple of shifts to train up the operatives to place the nodes with confidence, using a wire brush and a small hand spirit level. Once in place, the first data comes back and the nodes can be 'baselined' to be ready for monitoring. Operatives were quickly aware of the sensors, the need to avoid accidentally moving them, and to notify the monitoring engineer if this did occur. When this did occasionally happen then it was straightforward to re-baseline the node, and carry on.

Prior to the start, trigger levels were set up on a ring by ring basis, depending on the history of the specific ring, and the degree of distortion it had already experienced. In some cases the trigger level was set as low as 2mm whereas for others it was as much as 20mm. Work was conducted on 10 ring 'packs', and four rings of nodes, 6 to each ring, was sufficient to monitor this. The monitoring engineer, and for many shifts Simon himself, was sitting on a rail crouched over the laptop watching the data intensely through the shift, conducting shouted interactions with the lead grouter as and when significant movements occurred.

Manual measurements at the end of shift prior to handback confirmed measurements from the wireless system, and were also cross-

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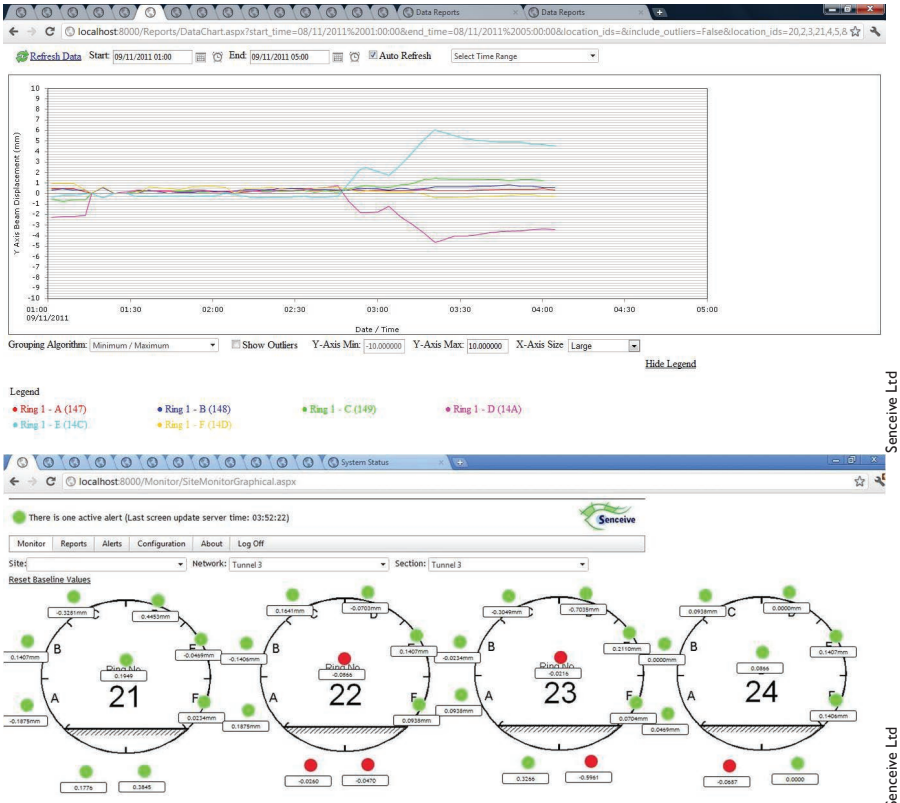
Monitoring engineer sits on a rail crouched over the laptop, intensely watching data



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Data from the sensors could be easily configured and monitored in real-time

correlated where permanent long term sensors were already installed, a significant vindication of Peter's recommendations at the start of project.

The grouting project took four months to complete, and the use of Senceive's wireless monitoring system saved an estimated £1 million pounds to the overall project cost. So enthused were all the parties, that the project was submitted for the prestigious International Tunnelling Awards, and won the Product Innovation Category in the Autumn of 2012.

For Senceive this has been just the start of its engagement in tunnel monitoring with wireless. Through 2013 systems have been installed in other LU tunnels, as well as a BT tunnel, to monitor the effects of tunnel boring, for London Power Tunnels, underneath a swathe of North London. Interestingly it was found that data collected from the second tilt axis of the sensor was able to accurately measure longitudinal tunnel settlement as well as rotational distortion from the primary tilt axis. Moreover it is now being deployed on a 3 year long project for tunnel lining replacement that LU is carrying out on other parts of the network. Another extremely ambitious project, a stretch of tunnel lining comprising concrete segments is being progressively replaced with steel segments, shift by shift in engineering hours, using two specially designed trains. Senceive's wireless tiltmeters are deployed ahead of the works, leapfrogging ring by ring, and further rings of sensors are deployed behind, some following the work as it progresses and some being left behind long term, to check on the tunnel stability post-works.

The system has been further developed to serve this project, enabling the data to be accessed not only from the nearest platform at any time, as was originally required, but also subsequent to the initial trials, by the engineers on the train but this time using a WiFi-connected portable device. Further installations are in place right now, for long term tunnel monitoring connected with a large scale demolition and replacement construction above four running LU tunnels.

A final thought

It is interesting to reflect on the interdisciplinary nature of this project and the exciting things that can happen when a diverse group of engineers come together to address a novel and demanding challenge. Simon reflects on his undergraduate degree, taken back in the 60's, and all that seemingly irrelevant stuff he studied in the first, then common, undergraduate engineering year – structures, mechanics, fluids, thermodynamics, engineering drawing etc. Not what he thought was relevant to a career in telecommunications and its convergence with computing! But an appreciation of all those disciplines has been invaluable throughout his career, providing the ability to think and communicate effectively in solving very diverse challenges and problems over the years – a great educational legacy from his time at Imperial.

Senceive Ltd

Wireless sensors in the thick of it

Tube Lines

Tube Lines

Tunnel lining replacement in action

Simon Maddison (Elec Eng 67-70, Comp. 72-3) has some 40 years of experience in managing the development and market introduction of leading edge technology products and systems, as well as building new companies from scratch. He is a Chartered Engineer, and a Fellow of both the Institution of Engineering and Technology and the British Computer Society. He is an enthusiastic alumnus, Student Opportunity Fund donor and recently served for three years as a Trustee for Imperial College Union.

Revolution in ocean science

We asked land sailing speed record-holder Richard Jenkins (Mech Eng 1997-2000) what he's been doing lately. His answer was quite surprising

In March 2009, I set a new land sailing speed record of 126 mph. It was a mission that I started in 1998, during the second year of my Mechanical Engineering degree at Imperial. I had thought it was going to be an easy challenge, but it took me 10 years to break the previous, American held record of 116 mph. It was all done on a tiny budget, while I continually tried to find funding. Every potential sponsor I tried to seduce would say: are there any commercial uses? Does the technology have any spinoffs? I would answer, 'Unfortunately, I don't think so, unless you like sitting in the desert for months waiting for wind!' I truly believed I was evolving a very specific but commercially useless technology, albeit great fun! But, 5 years later, I am now putting that learning to a much more valuable use.

After setting the land record, I soon realised that kids, a job and bills was not nearly as much fun as chasing records; so I started work on a project that I had been pondering in the back of my mind for a few years. The objective was the first unmanned boat to sail around the world. I have done a reasonable amount of offshore sailing and, truth be told, I don't really enjoy it. Leaving a port after a fun stay and arriving somewhere new is wonderful, but the monotonous wet bit in the middle, well, I'd be happy to hear the story in the pub of how miserable it was, rather than have first-hand experience. Even better, controlling a boat remotely, from the bar, seeing in real time just how rough it was out at sea appealed to my sense of humour!

The big challenge for unmanned vehicles is power consumption and reliability. It was immediately obvious to me that the self-feathering wing we evolved for the land yacht, with its small, low power trim tab control was perfectly suited to this application. Sure, a single element wing would not produce the high lift coefficients of an Americas Cup style multi-element wing, but this was not a race against anyone but oneself. Endurance was the key and the robust, single element carbon wing with non-corrosive bearings might just prove to be the perfect solution for longevity.

The boat platform had to be equally robust, providing a self-righting capability, low drag and resistance to entanglement from seaweed and ocean debris. I revisited a model boat concept that I was playing with when I was about 16. It was a hybrid between a multi-hull and a mono-hull, picking some of the best qualities of both concepts. Internal lead in a deep keel provided self-righting behaviour, small outriggers gave good righting moment while keeping the rig upright – essentially you get more thrust from the upright rig than the floats cause in drag. All the hulls can be wave-piercing and of minimum surface area and volume. In high winds, the leeward float just gets pushed under the water, to give a docile and gentle depowering.

There have been many autonomous boat projects attempted before, but they all seem to be the product of programmers, who think they have solved the sailing logic algorithms, so put a laptop inside a waterproof case and strap it to a conventional, normally soft-sailed boat. Needless to say, the unofficial record for autonomous sailboats stood at only around 100 miles before I started the project. My approach was going to be the opposite; start with the most robust and durable boat design that was possible to achieve, then put the most simple software on the boat. I felt reasonably confident about the boat design and hardware, but my Achilles heel was the software and electronics, of which I had only basic knowledge. Dylan Owens was a friend working nearby on a deep-sea sonar project and approached me when he heard I was working on an autonomous sailboat. He was planning a similar concept and had put a lot of thought into the electronics, but had not yet started on the boat platform. Dylan graduated from MIT, specialising in deep-sea robotics, with a lot of experience in sub-sea hardware and electronics. It seemed like a perfect opportunity, so we joined forces and set to work, self-funding what quickly became an expensive model boat! We called it Saildrone.

As the boat progressed and word got out to our friends and colleagues of what we were up to, there was a lot of interest. It was quickly pointed out to us that, if successful, this could do a lot more than set records and would be an extremely valuable tool for ocean science. Currently ocean science operations are carried out almost exclusively by large ships with very high operating costs, anywhere between $30,000 and $100,000 per day. There are lots of other methods of collecting data, like buoys, drifters & gliders, etc, but they often have limited deployment time and normally still require an expensive ship for deployment and recovery. If you could put the sensing hardware onto an unmanned sailboat, deploy it from a dock, send it to any point in the ocean and have it send back data by satellite, without the need for a ship, this would be a huge cost-saving. More crucially, as science budgets continue to get squeezed, it could also provide a way to collect many, many more samples than is currently achieved. As the world warms up, ocean acidification is drastically changing ecological systems, and could be one of the most pressing concerns for the planet. To begin to understand the causes and effects of ocean acidification, we need a LOT more measurements for scientists to grapple with. The only financially feasible solution to this is going to be many autonomous vehicles, sampling remotely.

Six months later we were lucky enough to get funding from the Marine Science Technology Foundation (MSTF) a non-profit organisation founded by Eric Schmidt, Google Chairman, dedicated to advancing technology in Ocean Research. Eric's belief in investing in technology to solve big problems, then using open source principles to share the collected data for the greater benefit of humanity, is revolutionary, especially in the ocean science

Saildrone LLC

Preparing for the trip to Hawaii in July 2013


Saildrone LLC

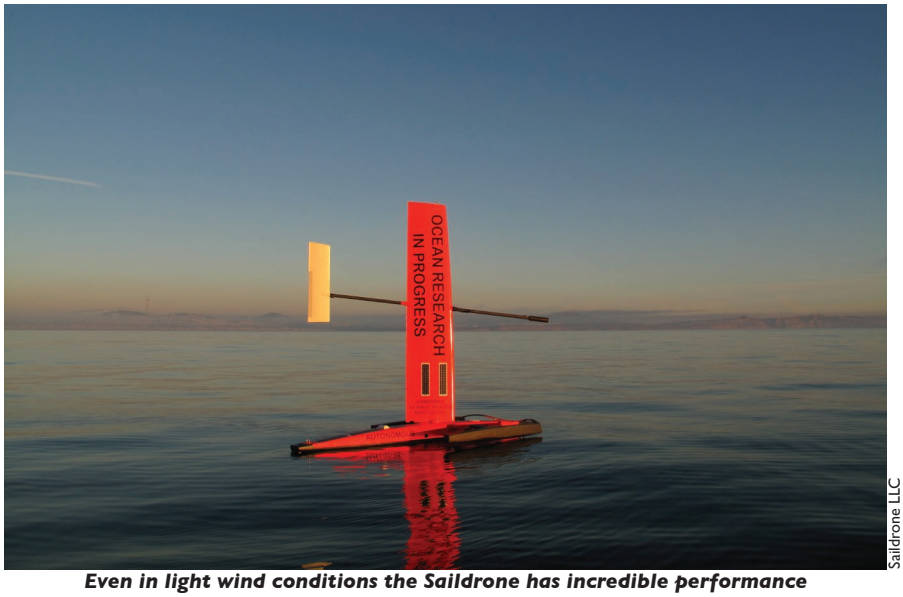
world. His thinking could not have come at a better time, as governments and institutions struggle to maintain their ageing fleets of ships and instrumentation. MSTF support enabled us to accelerate our development from a low-budget side-project, to a dedicated project with 4 full-time employees.

Less than a year after I had teamed up with Dylan, we launched Saildrone 1 (SD1) and began testing. It was immediately obvious that this was an extremely seaworthy configuration. I would love to claim credit for the sea-handling qualities, but they were almost all pleasant surprises. The oversized keel provides significant roll damping, so the boat is not tossed around by the waves, moving more like a 100 foot yacht rather than the small light 20 footer that it is. With a very light wing and low centre of gravity, pitch forces are small, enabling it to get though some very nasty seas, without moving the wing around very much. This is crucial as it keeps the flow attached on the wing airfoil, providing constant power as a result. Due to small reserve buoyancy, waves simply wash over and past the boat, rather than jerking it around as it would if it had high sides. Light wind conditions were initially my biggest concern, but we were again pleasantly surprised, with incredible light wind performance, moving Saildrone along at almost the wind speed in only 1 or 2 knots of wind. With almost no air drag, a slippery thin shape and no crew banging around on deck shaking the wind out of the rig, it simply glides along, not stressed about the slow progress that normally drives sailors insane!

We slowly increased the levels of autonomy from a simple RC yacht into a fully autonomous vessel, able to get to any point in the ocean, or follow a rhumb line within a few meters without any human intervention, regardless of wind or tide. Monitoring and control is done via our own iPhone app; telemetry and commands sent via iridium giving global coverage and only about 8 seconds delay from pressing send on the iPhone to the boat acting on the command.

Power for the onboard electronics is provided by solar panels on deck. Power consumption is one of our most significant breakthroughs, with the computer and actuator system drawing only 3 Watts with full duty cycle. This enables the boat to operate indefinitely (from a power perspective), even at extreme latitudes where light is short. Everything on the boat, down to the actuators and circuit boards is completely customised, and housed in mil-spec submarine-grade housings, all rated to depth. There is a 100kg payload bay for scientific instrumentation, with power and a serial data connection supplied from the main electronics housing. With high precision inertial measurement units and a computer running at 20Hz, control authority was one of my biggest surprises. Put simply, a computer is infinitely better at sailing the boat than a human. The 'brain' assesses every input then makes fresh decisions on tactics and boat control 20 times per second, 24 hours a day. No fatigued decision-making and no mistakes, just logical, repeatable control.

Collision avoidance was on our radar from day one. As soon as you mention unmanned or autonomous boats you get the normal retort of legal jargon and are told why 'it is not possible'; but like it or not, autonomous vessels on land, sea and air are here to stay, so we decided to tackle it head on and evolve a solution. I am not going to address legal minutiae here, but instead propose the logical, robust and safe system that we have developed. As well as the normal navigation lights, we have 2 systems for collision avoidance. Automatic Identification System (AIS) and an 'Active Echo' radar antenna. The boat can receive and transmit an AIS signal and will autonomously avoid any AIS target it encounters. The active



Saildrone LLC

Even in light wind conditions the Saildrone has incredible performance

echo system listens for radar sweeps and upon hearing a signal, transmits back the same frequency at high power, appearing as a very large target on a ship's radar. Using Iridium Satellite communications, the Saildrone reports what AIS or radar targets it encounters to mission control, who can give it additional instructions or actions if required. Finally we have a high power strobe on top of the mast, with variable flash settings. All the systems, AIS, radar and lights can be turned on or off remotely and we can run in silent listening mode if so required. As a very last resort, the bow of the boat is soft foam & rubber, which crushes on impact, so it is virtually impossible to pierce even the weakest of materials. Currently all inshore missions, where we might encounter non AIS-reporting targets, are escorted. We believe that the Saildrone, sailing at 3-5 knots with these measures, poses infinitely less threat to shipping than the average single-handed sailor often travelling at significantly higher speeds in much heavier, less forgiving boats. We are currently working with the US Coast Guard, who have been very supportive, to test these safety features and explore the legal classification aspects.

Our workshop is in Alameda, on the east side of San Francisco Bay, which provides the ideal testing ground for the Saildrone. Very strong tides and the entire range of wind strengths enabled us to put the boats through the toughest tests before they were allowed out unaccompanied. In May 2013, we achieved the first unmanned and autonomous rounding of the Farallon islands (30 miles offshore from San Francisco), departing and returning to Alameda, covering 103 miles in 50 Hours. In early July we sent SD1 to Hawaii, to try and set the first trans-ocean record for a drone. It covered 700 miles in the first 5 days, in 20-28 knots of wind the peak speed it reported back was 10.2 knots! About half way across, 1000 miles out, we detected a small error in one of the encoder values. Most likely salt water penetration to the encoder or wiring, but it meant the wing power control was compromised, so we turned the Saildrone around and headed for home. 27 days after departing San Francisco, we recovered it at Santa Cruz harbour, just south of San Francisco. SD1 had covered 2100 miles on the journey and returned in control, in perfect mechanical shape. The problem turned out to be a bit of corrosion inside one of the electrical connectors, which was an easy fix.

During that first pacific mission, I flew down to LA for a National Oceanic and Atmospheric Administration (NOAA) science conference. During the flight I was monitoring the Saildrone's progress on my iPhone via onboard WiFi. Our app gives us a plethora of routing information, both measured and forecast, and as the wind was shifting, I sent it a new command to transition to apparent wind-following mode as opposed to the route it was currently on. As the airhostess filled my wine glass, I noted the 12ft seastate and the 26 knots of wind that the drone was experiencing and smiled. If, only a few years ago, someone had told me I would be flying at 30,000 ft controlling a sailboat 1000 miles away in real time, I would not have believed it. More surprising to me was that monitoring and controlling the boat via the very intuitive app was not only fascinating, it was strangely addictive, leading to compulsive checking, almost 24/7. Seeing the data pour in, then making an alteration and watching the speed change in real time was compelling. You are your own navigator and captain, with an ever-alert and never-yielding crew.


Saildrone LLC

SD1 undergoing testing in San Francisco Bay

One month later, on the 1st October 2013, we once again released Saildrone from San Francisco, to attempt the crossing to Hawaii. 34 days later, the 'Honey Badger', as it was now affectionately known, sailed into Kaneohe Harbour in Hawaii, completing the first ever ocean crossing by an unmanned sailboat and setting a new world record by a considerable margin. It had demonstrated speed, precision and durability far in excess of any other autonomous ocean platform, but more importantly, it had silenced the critics, who had denied it was possible. The response from the ocean science community was overwhelming, with almost every major research institution enquiring about the payload possibilities of the Saildrone platform.

At the time of writing, 4 months after the successful Pacific voyage, we are forging ahead with a rapid expansion and have some fascinating science missions in the pipeline. We have taken on a few more staff; a full-time programmer and another electrical engineer, with our objective for this next phase being to prove the scientific value of the platform. To achieve this, we have teamed up with some brilliant scientists and are building a small fleet of Saildrones to be outfitted with precision instruments. These drones will be deployed on some cutting-edge science missions over the next 12 months in locations from the Gulf of Mexico to the Equatorial Pacific and northern Alaska.

Needless to say, we are very excited about what the future holds for Saildrone. We have multiple patents filed and believe our capability exceeds that of any of the competing technologies. Not only could Saildrone revolutionise ocean science, but there are many other roles, in sampling, policing and protection for industries such as fisheries, oil and gas, and border protection, to name just a few. I have also not forgotten the seed that started the project, that of the first unmanned circumnavigation, and we may well be sending a boat, or two, off from San Francisco with that exact goal in mind soon. Watch this space.

Richard Jenkins currently holds the world speed record for wind powered vehicles at 126.2 mph. He grew up spending most of his time on the water either fishing off Western Australia, his family home, or sailing in southern England where he went to School. At 14 years old Richard started designing boats and built a number of radical prototypes. At 17 he sailed across the Atlantic, then continued to do yacht deliveries around the UK and Mediterranean to help cover college fees. He read Mechanical Engineering at Imperial, where he set out to break the outright landsailing speed record of 116 mph. It took 10 years & 5 different vehicle evolutions to finally succeed. Richard then moved to San Francisco and, amongst other projects, founded Saildrone LLC, with the aim of using his wing and sailboat knowledge to produce an unmanned, autonomous vehicle to reduce the cost of ocean science measurements.

Who's doing what and where

DIARY

Saturday May 10
Imperial College / Chapter
Imperial Festival – Annual Alumni Reunion
South Kensington campus

Saturday May 17
CGCA London Walk
10:30 Walk around the Livery Companies, rounded off with a pint. All welcome. Please contact Alice Spain for further details alice.spain@hotmail.co.uk

Wednesday June 4
CGCA
AGM & President's Evening
Venue: AGM Pippard Lecture Theatre, Level 5 Sherfield Bld, 17:30
Supper – Senior Common Room approx 19:00
South Kensington campus
(Booking form on the back of address carrier)

Thursday 26 June 2014
RSMA
AGM / Final Year BBQ
Venue: 58 Prince's Gate, South Kensington,
AGM 18:30, BBQ 19:00
(Booking form on the back of address carrier)

Friday 12 September 2014
Faculty of Engineering
Teaching Awards Ceremony
Venue & Time: tbc

Friday 28 November 2014
RSMA
130th Annual Dinner
Venue: The Rembrandt Hotel, 11 Thurloe Place, Knightsbridge, London SW7 2RS, 19:00 for 20:00

Saturday 29 November 2014
CGCA
2014 Decade Reunion Luncheon
Venue: Polish Club Ognisko, 55 Exhibition Road, 12:30 for 13:00
(Booking form inserted)

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

Report from West Coast USA by John Gardiner (Civil Eng 66-70)

I should be packing our house contents for an imminent move, so it's an ideal time to drop you a line.... So we ARE moving house - all of 300 yards, and our alpaca farm is staying put. Christi and I led a group including schoolchildren to design and construct a bioswale from a large but lifeless ditch 320ft (100m) long outside our local elementary school. We just completed putting 250 native plants in - now for the irrigation!

I'm finding new interests as a city councillor, including finding land etc etc for a much-needed Little League Baseball field, near our future Skateboard/BMX park, and leading an initiative to expand our Warming Shelter (for the hungry and homeless – 2 meals a day for 25 souls or more, and overnight accommodation in the Immanuel United Methodist Church when the temperature drops below 40F - about 5C. The immediate need is for mobile showers and laundry (and more volunteers) and longer-term we need transition housing (no work without an address!) and permanent homes for these folks. It's the biggest social challenge I've faced – and that's saying something!

We're both singing in our Spring concert shortly – I'm singing a couple of verses of All Through the Night, in Welsh, solo – and we're enjoying the incredible musical talent – quality and diversity – of this area, along with every form of Art you can imagine! We're well known for dancing – and lots more follow us on the floor! Our rich social life, with an amazing number of friends whom we see every week (many every day at the PO or library or shops, or just passing in the street) is complemented by life with our alpaca herd – some of the finest in the country, with now 5 streams of products, including delicious alpaca meat!

I continue with river restoration – currently modifying two large box culverts under roads in northern California that are fish barriers, and have just attended the biggest RR conference in the USA, in the awe-inspiring Columbia Gorge – it was good to be back there after a break of 8 years! Met many old friends, including Prof Colin Thorne of Nottingham Univ, who is thoroughly entrenched in the Pacific North-west, I'm delighted to say! We're also meeting new emigrants from the UK and those who've been over here awhile and have found this secret hiding place in Oregon, with its extraordinary geology, 50M years without glaciation and 280 endemic floral taxa – see http://worldwildlife.org/ecoregions/na0516.

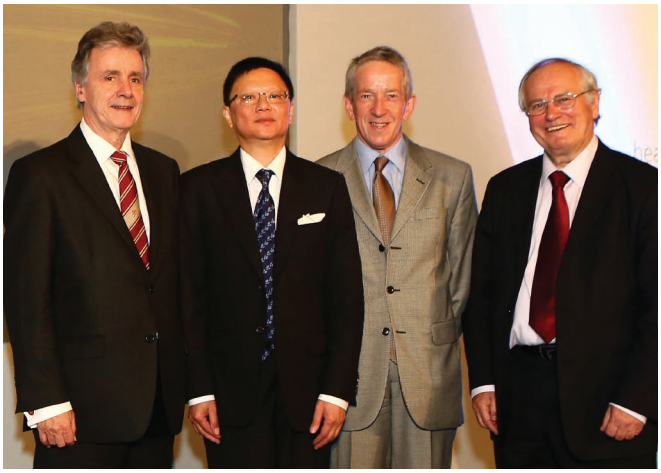
So put us on your itinerary, OCs all – you may need your phone GPS units; hint – not all work here! As the old adage might have put it – East, West, West's Best! Seriously, you'll never forget (or regret) a trip down Highway 101 to see the spectacular coastlines of Oregon and California! we're a hop, skip and a jump inland, near the California border - a place called Cave Junction (near the famous Oregon Caves) that retains more than a whiff of the Wild West.....!

Please give my love to IC and ol' London town – my birthplace and favourite city!

Cheers! John

Dr John L. Gardiner MBE PE

Dr Robin Sham (Civil Eng 85) receives ICE Gold Medal



Dr Robin Sham has received the Gold Medal from the Institution of Civil Engineers (ICE). The medal is ICE's premier award for civil engineering excellence for an individual whose sustained contribution to civil engineering over many years is of significant magnitude and stature. In the nearly 200-year history of the ICE, only 20 gold medals have been presented.

"This momentous event signifies a milestone in my career, but not the finale, because there is really so much more to learn and to contribute," said Robin. "Three decades on and across several continents, new challenges still provoke in me boundless inspiration and enjoyment. I certainly recommend a career in civil engineering to aspiring young engineers."

The medal was presented by Professor Barry Clarke, ICE president at the ICE Awards ceremony in october (above left). Robin was also delighted to be reunited with Professors Nethercot, Burland and Lloyd Smith (above).

WE WANT YOUR NEWS

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

44th Triode meeting 3rd January 2014

Decade Reunion

Eleven Triodes attended the City & Guilds Decade Reunion on 30th November 2013 (see opposite), including Tony & Deborah Godber and Paul Cheung! (We accounted for about a third of the attendees!) After a meal, drinks and speeches at the Polish Club (opposite Mech Eng), Peter Cheung kindly gave us an excellent tour of Elec Eng where we saw some very impressive demonstrations including the fully automated beer bottle orchestra, 3D printing and some worried students who wondered what their Head of Department was doing there on a Saturday afternoon!

44th Reunion

Eleven Triodes appeared at the George, braving storms and gales, and after a few pints we moved on to have dinner at the Thai Square. As tradition dictates we stopped at the Triode Loo to convince some poor passer-by to photograph us (see above)! Of those that came:

Peter Cheung remains head of EEE at Imperial. He's now been there for 5 years and will continue until at least 2015. His offer of "free lunch" for any Triode visiting Imperial will definitely be extended to at least 2015! As is his offer of the use of the labs (and a few spare students?).

Peter Wright is now permanently on holiday as he has been retired from BT for a year now. He is working with the Scouts as he is currently District Secretary and also Webmaster for his local group (and for the Triodes by the way). He and Peter Marlow have now completed their sporadic walk of the Pennine Way and he plans to write the book (or read one!).

Phil Harris had a mini reunion of former ITV colleagues in Yorkshire on the top of Emley Moor tower this year, he said it was a bit windy. They finished with a special dinner at the National Media Museum in Bradford, a great meal accompanied by friends and technology from those pioneering days. This year he's suggesting that he might retire – we'll see!

John Harding has been working as a consultant with CACI this year. He's been working at some of the bigger mobile operators in the UK, advising on OSS deployment. His wife Anne has finally retired from helping people with their money problems and is now a lady of leisure (creating money problems for John?).

Dave Mansfield is still spending much of his time in retirement looking after his 94 year old father who has severe dementia but they now have a carer visiting every day. He has helped his elder son with the purchase of their first property (in the London area) which he is now spending most weekends renovating to save his son more expense.

Hari Singh looked really well and when we commented on this he said it was down to golf, he is now playing of a handicap of 9! He still spends a few months every year in Goa, India, but when not playing golf he has serious granddad duties to attend to.

Rut Patel is currently working for the NHS as a Project Manager. However, things may change in the near future - watch this space. In the past year he has been busy as his daughter got married and his daughter-in-law gave birth to boy all within a month. The baby, who was 2 weeks old at the time, even attended his auntie's wedding.

Richard Lewis has decided to retire from teaching, it just doesn't seem to be worthwhile, perhaps because of his age he mused. But what next? He is still pondering.

Peter Marlow is still running his own business (Softcopy Limited) and is mainly occupied managing IT projects for Government. His daughter is running in the London marathon, so he'll be there on the Sunday to cheer her on and of course Hugh. He said he was pleased to complete the Pennine Way this year with Pete Wright (see above).

Sid Seth is still working on his new innovations. The identification of assets business has taken some shape and he is now developing higher definition tagging equipment (maybe you should have a chat with Peter Cheung?). He also has two other projects running but they are of course secret!

Martyn Hart. I left Gartner, the US research company, in June 2013 and now work for my own company (Extend) mainly in the public sector. I've also stepped down as Chairman of the UK's National Outsourcing Association after 20 odd years - to devote more time to family stuff!

Those that couldn't make it and we've heard from:

George Gabrielczyk says he has been busy retiring since his 35th birthday and never more intensely than from the moment when, for his 60th (2 years ago), he bought 1000 acres at Jelenino. At the time, George said to himself "enough was enough" and he planned to relax and watch as things grew, nurtured by the sun, fanned by the wind, watered by the gentle rain etc etc. He has to face invasions of beavers (he has 50 acres of beavers so if anyone is interested in having a few, just come and collect), and chastise land-hungry neighbours who have invaded his territory.

However he still hasn't given up his corporate responsibilities on the board of two public companies and buying businesses in China (deal signed in Shanghai end of December), Poland, France and Germany.

He and his now 1,000 deer wished us all a Merry Christmas and a Prosperous New Year!

Steve Glenn unfortunately couldn't join us because of the weather. However, he told me that he is still slaving away and is thinking about retirement maybe in three years or so. He has, of course, other duties the main one being a granddad! (Seems to be a repeating theme!)

Hugh Culverhouse is now working on a part-time basis, but on Sunday 14th April he runs in the London Marathon! At the Munich Marathon in October 2013 he managed to improve his personal best (from Prague 2012) by nearly 2 minutes to 3:21:48 (which was good enough for 19th place out of 167 in the German Champs for his age group M60). He pushed back some training barriers this year with London 2014 in mind and his body is telling him that it's near the limit. He says there will be no more marathons after London, but we'll see.

Tony Godber's travel budget (and leave budget) unfortunately didn't run to a third trip to the UK within a few months. But perhaps once he retires he can make it one January.

Some of you will already have got an update in person when Tony was over in November for the Decade Reunion, but he says there has been no major change since last year, other than the children seem to be gradually moving out of the family home. So the large house they had to build to accommodate them all as teenagers will have lots of space to spare. Ideal for anyone interested in a holiday in Western Australia!

On the work front, he's still working for Rio Tinto, continuing to expand their rail network to move lots of iron ore destined for China (and elsewhere). Retirement is starting to feature in the plans, but probably not for 2-3 years.

Alice Spain took early retirement in 2011 and has been enjoying the new freedom. However, she wanted something to get her teeth into. Over the past couple of years she's turned her hand to some technical writing and teaching, not to mention travelling to far-flung places. But at last she's found a worthwhile project – a derelict property needing restoration. It's in Norfolk so she'll be moving there in the next couple of months. There's no heating and the roof leaks so it'll be hard work for a while. The garden's a bit of a wilderness too. But Alice is sure it will be worthwhile in the end…

Nick Hiscock sent me a note to say he had "Man Flu" so he could not make it this year. But he says his wife Sue is still practising as a vet so he spends his "retired hours" collecting, repairing, advising on and re-selling British and Austrian Cavalry Weapons (he was a weapons engineer in the RN for 27 years) and also searching out arms for the folks (including a daughter who demonstrates mounted skill-at-arms at the UK Battle Proms each Summer). As he has sold weapon spares to a bloke in Australia he now also counts himself as an International Arms Dealer! However, he assures us that he is otherwise sane and enjoying his retirement.

Tim Dye did come to the Decade Reunion and I understand he's also on granddad duties but fills in his time with many more activities, especially pottering about in Norfolk – sounds idyllic! Maybe he should speak with Alice?

Those that couldn't make it and we haven't heard from (can anyone help?): Ian Heap, Geoff Banks, Pat Mason, Graham Castellano, Martin Clemow.

The next two Reunions

The next Triode reunion (it will be our 45th as we had two meetings in year one, two in 2003, and two in 2013!) will be on Friday 2nd January 2015 at The George, Fleet Street, from 7 pm-ish.

As a note for your diaries the following year (2016), because the first Friday is a bank holiday, it will be on the next Friday - 8th January 2016 (Triode rule 2B).

Martyn Hart
Arch Triode

RSM Mining, year of '61

The Mining students, year of '61, last graced the steps of the Royal School of Mines in August 2011 (see a photo in IE issue 15 p23) when we commemorated the 50th anniversary of our going up to Mines in 1961. Ten older and wiser ex-students, with spouses, attended that get-together. Now, another three years has passed and we meet again to celebrate the 50th anniversary of our graduation in 1964. This time, we are meeting up in Bath from the 17th – 20th June. Brian Calver has arranged a full programme of city tours, visits to the theatre, trips on the river and even a game of golf for the enthusiastic. And to close the proceedings, a reunion dinner on Thursday 19th June

Anyone who is not aware of this reunion, (we like to think we've spoken to everyone), should contact Julian Bennett on:

julian.bennett@btinternet.com

CGCA Annual Decade Reunion Lunch 2013

The traditional CGCA 'Decade Reunion' took place at the newly refurbished Polish Club ("Ognisko"), opposite the college main entrance, with a very respectable turn-out of 48 alumni, students and guests. Of particular note was the group of 12 alumni who graduated in 1973, including eight members of the self-styled '73s 'triodes' from Electrical Engineering. Time was available for meeting old friends – and indeed meeting new ones – over an introductory drink, before taking seats at table.

President David Nethercot welcomed everyone on behalf of CGCA and explained that the retiring London Walks organiser, John Backhurst, and guide Malcolm Dick, who was also standing down, together with their wives, had been invited to share in the reunion as a 'thank-you' for their efforts over a number of years. In future the walks will be organised by Alice Spain, who was also present to take up the mantle (Alice's first walk will be announced during late Spring).

Once the meal had begun, David Law (organiser) invited volunteers from each decade to take the floor between courses in order to reminisce on their time at Guilds.

Tony Stock (Chem Eng 61-63)

Chris Lumb

recalled the King Kong Show, the building of Southside Halls (since knocked down and rebuilt); The Collcutt Tower being saved for the nation by John Betjeman (and wondering how it still stands as it had been previously buttressed by the Imperial Institute Building itself) and hops (or dances to the youngsters) held regularly in the Union building. The '63-ers were part of a lucky generation; there were no fees, and there were grants & awards into the bargain. (Tony is one of the '63s Chemical Engineers who have founded a Chem Eng Scholarship offering £12.5K for 4 years, as mentioned in IE issue 19).

As the sole representative of the '93-ers, Mufeed Saleh (Civil Eng 93),

Chris Lumb

who had managed to fit in a visit to the UK from his base in Abu Dhabi, recalled how coursework tended to get postponed with inevitable time conflicts with exam revision. Mufeed is grateful for the reputation of a top degree from Imperial and its recognised reputation around the world.

Martyn Hart (Elec Eng 70-73)

Chris Lumb

recalled the 1970s as the time of GB's entry into the EEC, the US Watergate scandal, and the appearance of the Austin Allegro, whilst noting that literally on the day Richard Nixon claimed on TV: "I am not a crook", Monica Lewinski was born! There were memories too of "Mrs Thatcher – Milk Snatcher!"; power cuts, the 3 day week and revising by candle light, yet they all passed their finals! Martyn had a lovely story about the overwhelming resourcefulness of Guildsmen when put up against some London Business School students.

Speaking for the 1950's, John Stoton (Mech Eng 50-53) commented

Chris Lumb

that in those days, there was a much better view of Guilds from Exhibition Road. John remembered going for a management interview with what was a computer manufacturer right at the start of that industry. He also compared the capabilities of the current pocket calculator run off 2 AA batteries to that of the devices then, which required up to 100kW or more. John had strong memories of Morphy Day and at the same time noted that 1950 was the first year that Imperial took students straight from school rather than solely ex-service men playing 'academic catch-up' after the war. Perhaps this made some of the pranks more 'junior', as he remembered seeing footsteps up a wall! John contemplated that if Queen Victoria hadn't imported a German husband, there would have been no Great Exhibition, and thus no great financial surplus with which to purchase the 80 acres on which Imperial was subsequently located, and hence there would have been no Imperial.

The final speaker was CGCU's current President, Lejon Chua, who talked about the current edition of Spanner, reviewed the Union's roles, including social and welfare, and recorded the appreciation of the CGCU Executive for the strong support received from alumni through CGCA. Lejon then led the assembled company in a Boomalaka (after being reminded that in years past, the President held up the Spanner above his head for the duration). The Spanner and Bolt Bearers, Alexander Johnson and Annabel Felton, were also present, and Boanerges had been brought along by driver and co-driver Mateusz Gocek and Ben Wainwright. Bo had been parked in Princes Gardens at the rear of the club, after a certain amount of negotiation with Security, and several members were able to renew their acquaintance with Bo after the meal.

David Law

Chem Eng Group 57–60 Annual gathering at IC

Attendees, from the left, were Don Latimer, Paul Gallagher, Tony Davis, Malcolm Cross, Barry Daniels, Jim Friend, and Eric Schmidt.

Our group met for the annual new year gathering in the Beit Quadrangle cafe/bar on 18 February last, over lunch. Turnout was lower than has been in the past – but I guess we are all getting somewhat older!! The barman was helpful (as usual) in taking photos - and the best is included herewith.

Interest was expressed in a possible group outing in the summer with partners. Weald and Downland open air museum being a possibility.

Tony Davis

Letter from John Moore (Mech Eng 62-65)

Dear Chris:

Thank you for your letter of 18th December with its Christmas greetings. I was delighted to receive the print of the architect's drawing of the original City & Guilds Building by Alfred Waterhouse. As you said, that building was being demolished during your time at South Kensington (1958-61), while I sensed its end briefly during my entrance examination in 1961-62 and benefitted from the new building from 1962 to 1965.

In the bottom right hand corner of the print is Waterhouse's signature. With my magnifying glass I tried to make out the date – I think it is 1881. Is that correct, and when was the building completed?

Of course the print brought back many happy memories of my time in Kensington. I have taken the liberty of adding some images to the print in the attached jpg file, retaining the coats of arms and the main entrance as I seem to recall that on my first visit.

It was exciting to travel the 200 miles by train from Birkenhead Woodside or Rock Ferry to Chester, Wrexham, Shrewsbury, Wolverhampton, Birmingham and London Paddington. Chester was key; the train pulled in, changed engines and pulled out backwards for the rest of the journey to London; so I would face backwards to Chester since I wanted to face forwards in a good seat for most of the way!

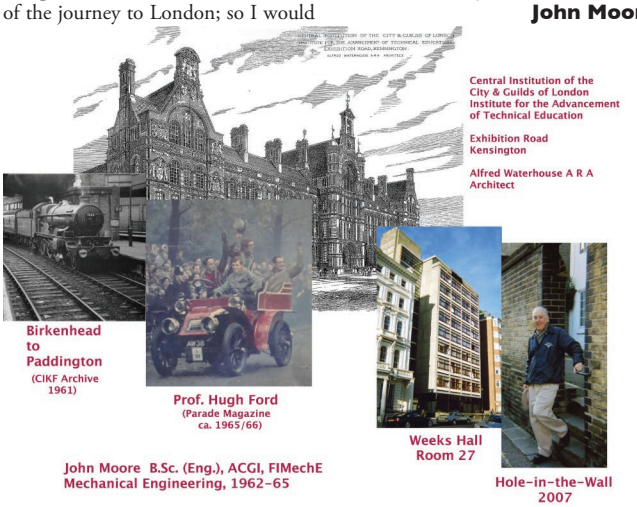
Boanerges and Spanner are hallowed images for Guildsmen. So it was a great surprise one Sunday in 1965-66 in Cambridge, Massachusetts, to see Bo' with Professor Hugh Ford on the cover of Parade Magazine in the newspaper showing the start of their London to Brighton run!

I was most fortunate to live in Princes Gardens, Room 27 in Weeks Hall, adjacent to the residential areas of South Kensington and Knightsbridge. It was just a short walk through the Mews and the Hole-in-the-Wall to Brompton Road and Harrods, which was always well worth a visit. Hyde Park and Kensington Gardens were just a block away, and our housekeeper, Mrs. Turner's boxer dog, Max, loved to go on walks! Watching the high flying kites at the Round Pond was fun on a Sunday afternoon.

With all best wishes for the continued success of Imperial Engineer, and continued recognition of the contributions and significance of City and Guilds in the 21st century with prosperity for its teaching, training, engineering and research.

Yours sincerely,

John Moore



Imperial spinout lands Silicon Valley investor

In the Autumn 2012 issue of IE we featured BBOXX, a spinout company from the e.quinox charity at Imperial that provides battery charging stations powered by renewable energy to communities not connected to a grid supply in developing countries. In the last issue we reported that they were named Best Enterprise in the UK in the Lloyds TSB 2013 Enterprise Awards. Since then the company has received a US$1.5million investment from Vinod Khosla, one of the founders of Sun Microsystems who now runs a billion dollar venture capital business based in Silicon Valley. BBOXX also received a further US$400,000 from the British venture capital fund Synergy Growth.

http://bit.ly/IE20BBOXX

Engineers in fashion

Roma Agrawal (Civil Eng 05), author of the Engineering Brand article about diversity in engineering in IE issue 19, has been chosen as part of a select group of inspirational British women from a range of fields and backgrounds to feature in the new Marks & Spencers Leading Ladies campaign. "I am delighted to be representing engineers," she told us. "I was thrilled to participate as this is a unique opportunity to engage with a wider audience and break down stereotypes surrounding women in science and engineering. We are real people, and can be fashionable and feminine whilst professional and technical."

You can find out more about the campaign, including an interview with Roma, at

http://bit.ly/IE20Roma

Google lures spider into their web

A small London-based company, spider.io, founded by Computing alumni from Imperial, has been acquired by Google to help fight online advertising fraud. Of the seven employees, the first three are Imperial alumni: CEO and Founder Dr Douglas de Jager (Computing 04-05, 05-09), Chief Scientist Dr Simon Overell (Computing 01-05, 05-09) and Chief Architect Dr Ashley Brown (Computing 01-05, 05-09). Ashley Brown was CGCA liaison officer on the CGCU Committee and Lord Mayor's Show coordinator; in 2009-10 he was ICU President.

"Advertising helps fund the digital world we love today," says Neal Mohan, Google's vice-president for display advertising. "But this vibrant ecosystem only flourishes if marketers can buy media online with the confidence that their ads are reaching real people, that results they see are based on actual interest. To grow the pie for everyone, we need to take head-on the issue of online fraud."

Over the last three years, spider.io has been building a reputation for its world-class ad fraud fighting operation, exposing some high profile scams in the past year – including fraudsters who hack into personal computers to create botnets that impersonate web user to generate fake advertising views. In February, Google announced that they had acquired the company with the intention of using their fraud fighting expertise and including their fraud detection technology in Google's video and display ad products.

http://bit.ly/IE20spider

Racing engineers reunion

A group of over 70 alumni, students and staff met to network, celebrate their achievements and catch up on the latest news from today's student engineers.

Since 2000, Imperial has formed interdisciplinary teams of undergraduate students who design, make, test and race racing cars and bikes. Since 2011 the focus has been on low and zero emission vehicles under the Imperial Racing Green (IRG) banner. These teams have won a number of races and accolades, most recently claiming first place in the Class 2 Design category at Formula Student, the flagship international race series organised by the Institute of Mechanical Engineers.

The reunion brought racing teams past and present together for the first time. Among guests were alumni working at Mercedes, Rolls Royce and Jaguar.

The group caught up on the latest news on current students' projects; the battery electric vehicle being built by Imperial Racing Green called EV2, and the all-electric superbike being created by the IC+ team.

Students delivered technical presentations about their work, speaking about the electronic systems they are developing to control the cars, their methods to thermally manage the batteries to improve performance, and their improvements to the aerodynamics of the cars. Updates from the pit garage included the news that the EV2, which the team hope to enter into the 2014 Formula Student race, reached an important milestone last week with its first successful test on a dynamometer, a "rolling road" for testing a car's performance.

Students past and present swapped experiences from their time on the team. One alumna, Alice Rowlands (Mech Eng 06-11), recounted how she threw a pair of old boots into a washing machine, strapped a battery pack on top, switched the machine onto the fast cycle and then watched closely as everything shuddered about violently.

This was not a new and unconventional method to wash dirty boots, says Alice. In fact, it is one of her fondest memories of her time working with the IRG team in 2010. Alice and her team-mates were testing the battery.

"We wanted to test how vibrations from the vehicle affected the performance of the battery," said Alice. "So we turned an old washing machine into a makeshift test rig in the workshop. The experiment worked perfectly and we even put a picture of the 'rig' in our project report!"

"Working on an IRG car and doing all those fun experiments was a good way to demonstrate to employers my interest in motorsport and the automotive industry in general," said Alice. "I think the technical understanding I gained was particularly important in terms of my understanding of how hybrid and conventional vehicles work," Alice added.

Alice now works for McLaren and specialises in modelling and analysing powertrains – the components that generate power in a car. She also develops computer models that enable engineers to analyse in more detail how the race cars perform on the track. In addition, she works on a simulator to understand how the car and driver interact to produce the best possible lap times during a race.

http://bit.ly/IE20Racing

A CAF Volunteer until he retired

DEREK (DARBY) A ALLEN (Mech Eng 42-45)

Born on October 1, 1925, in Gravesend, Kent, Derek died peacefully at home on June 26, 2013, aged 87.

After an education at Cranleigh, he obtained a BSc(Eng) and ACGI, from Imperial, becoming a Chartered Mechanical Engineer, CEng, MIMechE. For two years 'Darby', a naval nickname by which he preferred to be called, was a Sub Lieutenant RN and served in the Glory and the Belfast. Later he was President of TS Lion (a Sea Cadet training ship). He joined Bestobell in 1947, finishing as Managing Director in 1974. From 1975 to 1983 he worked for Delta.

Darby ended his career doing charity work behind the Iron Curtain and was a CAF Volunteer until he retired. He enjoyed writing books on various subjects and drawing.

Darby's first marriage, to Joan Felton, was dissolved. His second was to Susan Lavender, who died 33 years later, and his third to Penelope Trevorrow, who survives him, together with two children from his first marriage and a step-daughter from his second. He was a wonderful husband to Penelope for 17 years and a caring father, and grandfather to 8.

Penelope Allen

Award-winning academic

LAWRENCE J AUSTIN (Chem Eng 58-61)

Starting as an undergraduate at Imperial in 1958, Lawrence was awarded the David Spurr Memorial Medal (for Chemical Engineering student of greatest merit) in 1960. In the same year he was elected to Links Club.

In 1961, Lawrence graduated in Chemical Engineering with 1st class honours (the only first class awarded by the university of London that year!). In the same year, he was awarded: the Hinchley Medal, by the Institute of Chemical Engineers, as 'the student of greatest merit at the final examinations in Chemical Engineering'; the Royal Society of Arts Medal, which is given to 'the outstanding college final year student – in addition to high academic standard, such qualities as character and powers of leadership are taken into account'; the William Peck Prize, which is presented to a 'student in the Department of Chemical Engineering and Chemical Technology for proficiency in the final examinations in Chemical Engineering and in the design project'; and was elected president of City and Guilds Student Union.

In 1961 and 1962 , he was awarded the Salteres Industrial Research Scholarship.

In 1963, he became an assistant lecturer in the Chemical Engineering Department and was awarded his PhD in 1966. Awarded the Armstrong Medal and Prize, in 1966, for an outstanding piece of research, he was appointed lecturer in Chemical Engineering Department, in 1967. From 1966-1969, he was appointed examiner to Council of Engineering Institutions.

In 1969, Lawrence left the academic world for a long and distinguished career both in the UK and abroad with Shell International Petroleum Company, from where he retired early on medical grounds in 1995.

He was always incredibly proud of his association with Imperial College.

Innovative and distinguished engineer

JOHN ROLAND CROOKALL (Mech Eng 61-62)

Professor John Roland Crookall was an innovative and distinguished manufacturing engineer and university leader.

John was born in 1935, the only son of Dr Robert and Gladys Crookall. He was evacuated from London during the flying bomb period in WW2, to live with relatives in Barrow-in-Furness, where he went to school. On returning to London, he attended Dorking County Grammar School.

A five year apprenticeship at de Havilland Engine Co Ltd followed, and John later joined the staff as a performance and design engineer on aero-engines. He became a visiting lecturer at Willesden College of Technology, took a postgraduate DIC at Imperial and then went on to take a PhD at the University of Nottingham. Moving back to Imperial College, he became lecturer and course manager of the MSc course in Production Technology.

After nine years, he was made Professor of Manufacturing Systems at Cranfield University, later becoming head of the Department for Design of Machine Systems. Shortly after, he merged his department with the School of Production Studies to form and head the College of Manufacturing, the only such organisation in the country. In 1982, he obtained major funding from IGM UK to found and chair a new Computer Integrated Manufacturing Institute at Cranfield, a company Limited by Guarantee, which received the meritorious commendation of the DTI 1986, and the LEAD award of the US Society of Manufacturing Engineers in 1991.

He developed Masters courses and programmes for industry, always encouraging his students to develop their talents, and showing personal interest in their progress.

He was a founding member of the Oxford University Press Series on Advanced Manufacturing. He was a Fellow of the Royal Academy of Engineering and on four committees devoted to scholarships for Industrial Secondment, Travel, Professional Development, and a Trustee of the Panasonic Trust. He participated in the Academy's study on "Productivity in UK Manufacturing Industry".

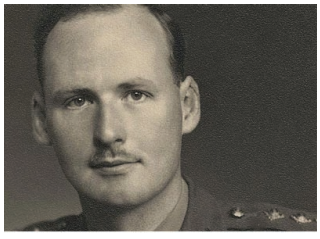
John retired from Cranfield in 1990 and became a consultant in intellectual property, patents and copyright, and an international speaker on global manufacturing. He served on many committees, including the UK Government's Cabinet Office Advisory Committee on Science and Technology, (ACOST) writing a report on "Advanced Manufacturing Technology" for the Parliamentary and Scientific Committee 1985-91 and the British Library Advisory Committee.

John died in November, 2013.

More complete versions of obituaries marked with an asterisk * can be found on our website http://bit.ly/ImperialENGINEER

Army officer who won an MC and advanced standards at British Rail

TRAVERS COSGROVE (Civil Eng 38-40 Hon Sec C&G Athletics Club 39-40)



John Travers Cosgrove, who has died aged 93, was awarded an MC in 1945; he subsequently worked for LNER and British Rail and was responsible for the design and introduction of innovative equipment and safety measures.

John was born on October 9, 1920, in British Columbia, and educated at Marlborough before going up to Imperial to read Civil Engineering. He gained a Blue for cross-country running.

He joined the Corps of Royal Engineers, and was posted to 244 Field Company Royal Engineers (FCRE), landing in Normandy shortly after D-Day.

On March 4 1945, Cosgrove was a sapper officer, taking part in an advance on Wesel. Reaching Issum, where an attempt to lay a bridge had failed and a large armoured force was held up, he came under heavy artillery fire. When the RE officer who had been trying to lay the bridge was injured and evacuated, Cosgrove took over, directing the operations of armoured bulldozers for three hours under intensified mortar and shell fire until a Scissors bridge was successfully launched. The citation for his award of an Immediate MC stated that his initiative, courage and resource had played a vital part in the continued advance, and that he had "added to an already brilliant record of service yet another outstanding example of personal bravery".

Demobilised in 1946, he worked first for the London & North Eastern Railway, then for British Railways Scottish Region and, later, the Western Region. In 1950, Travers Cosgrove married Elizabeth (Betty) Davidson.

From 1962 to 1976, he was the Materials Handling Officer on the British Railways Board, introducing a number of innovations which became familiar sights, e.g. the luggage trolleys at main-line stations and the multi-functional cages for the parcel service, which he researched and designed.

He worked on the development of fork-lift trucks and sorting conveyors and he identified safe distances from platform edges for passengers, initially for the Advanced Passenger Train but subsequently used on all platforms and indicated by a yellow line.

In retirement, he recruited sapper veterans to attend annual reunions. He also used his expertise to help restore and reopen the Keith & Dufftown Railway, Morayshire, and to assist people with disabilities to live full lives.

Travers Cosgrove, died December 27, 2013. He is survived by Betty and their daughters. *

The last gentleman in the business

ALEXANDER LAMB CULLEN OBE FRS (Elec Eng 38-40)

It is with sadness that we announce the death on December 27, 2013, of Alex (Alexander Lamb) Cullen.

Professor Cullen combined the sharpest of scientific minds with a gentle personality and a great sense of humour. He was born in London in 1920, and was educated at Lincoln School and Imperial College, studying Electrical Engineering at the City & Guilds College between 1938 and 1940. During WW2 he worked on early radar at the Royal Aircraft Establishment, Farnborough. In 1946 he took up a lectureship at UCL, where he worked with Harold Barlow in microwave research. In 1955 he was appointed to the Chair of Electrical Engineering at the University of Sheffield, and he was awarded an OBE in 1960. In 1967, Cullen returned to UCL, succeeding Barlow as Pender Professor and Head of Department.

When, in 1977, Professor Cullen was elected Fellow of the Royal Society, the citation read:

'Distinguished for his work in microwaves. He has shown remarkable creative ability and a novelty of approach to the problems he has tackled, culminating in new knowledge of surface-waves, new microwave measurement techniques, new principles for active antenna arrays, new microwave applications of electromagnetic beam waves and of waveguide techniques.

'He has an international reputation as one who stands in the forefront of microwave engineering, and his contributions, particularly to ultra high frequency power measurements and open resonators, are acknowledged as an outstanding achievement.'

Professor Cullen was awarded the Royal Medal in 1984, 'in recognition of his many distinguished contributions to microwave engineering, both theoretical and experimental, and in particular for research on microwave antennae'. In the same year, he received the Faraday Medal of the Institution of Electrical Engineers (IEE, now IET).

Alex married Margaret in 1940, and they had a long and happy marriage, with three children: Michael, Isobel and David.

Alex was an accomplished jazz musician, playing drums and clarinet, arranging and composing. In his Lincoln School days he had played music with fellow pupil, and later broadcaster, Steve Race. The pair kept in close touch throughout their lives.

In January 1986, Cullen was a signatory of a letter to The Times, calling on Prime Minister Margaret Thatcher to 'Save British Science'. This led to the foundation of the Save British Science pressure group (now the Campaign for Science and Engineering, CaSE), which has built up an enviable reputation with politicians and the media in representing the concerns of scientists and engineers.

Cullen was also a published writer, of 'Modern Radio Science', in 1988 and a biography of Harold Barlow, in 1990.

When Eric Ash, who succeeded Cullen as Pender Chair in 1980, later left UCL to become Rector of Imperial College, he remarked that Alex was 'the last gentleman in the business'. There is no-one who would disagree with that. *

Engineer and inventor

DAVID MARTIN LEAKEY (Elec Eng 50-53, 55-58)

Born on July 23, 1932, Dr David Leakey died, aged 81, on September 26, 2013.

Leakey was educated at Imperial College and worked in the telecommunications industry, rising to hold several directorships and become a member of the Royal Academy of Engineering in 1979. He was a Freeman of the City of London and a Liveryman in the Worshipful Company of Engineers, and the co-inventor of 9 patents. Leakey became a visiting professor at the University of Bristol in 1985 and was awarded an Honorary DEng from the university in 1995. He retired, as Group Technical Advisor at British Telecom, in 1992, but continued to work in the telecommunications sector.

From 2001 to 2007, David served as a trustee of the IEE Benevolent Fund (now IET Connect) charity.

Engineer and Physicist

RONALD A LAWES FREng (Elec Eng 58-61, Physics 73-76)

Ron Lawes was born on September 26, 1938.

He studied Electrical Engineering at Imperial, and combined an active scientific research career with management responsibilities in large-scale government and industry-funded nanotechnology research projects. He had particular interests in nanolithography processes (X-ray LIGA, electron beam lithography, laser micromachining) and technology transfer from academia to industry. He researched the cost and manufacturing tolerances associated with microsystems.

He was a director of a small industrial microsytems start-up company - MiniFAB (Aust) Pty - based in Australia, and SSTRIC Ltd, a spin-out company from Edinburgh University.

Professor Lawes was Director of Engineering at the Rutherford Appleton Laboratory and the Founding Director of the Central Microstructure Facility (CMF) until he retired in September 2003. He subsequently continued his scientific career as a Visiting Professor both at Imperial and at Birmingham University.

Chris Lumb

Ron Lawes at Decade Reunion, 29Nov'11

Ron was a Chartered Engineer, a Chartered Physicist and a Fellow of the Royal Academy of Engineering (FREng).

Ron died on November 3, 2013, aged 75. *

43 years dedicated to public service... and golf

KEITH WILLIAM LEWIS AO CB (Civil Eng 55)

Keith Lewis' remarkable vision, immense capacity for hard work, attention to detail and commitment to public service, over 43 years, left indelible marks on the organisations with which he was associated.

Keith was born in Adelaide, on November 10, 1927 and grew up during the Great Depression and Second World War. He attended Adelaide Boys High School, joined SA Water as a junior draftsman aged 16 and studied civil engineering at Adelaide University.

In 1953, Keith was awarded the prestigious Rockefeller Foundation Travelling Fellowship to study public health engineering at Imperial. It was here, living at the Victoria League, that he met his wife of 55 years, Alison Fleming of Bulawayo, Zimbabwe.

Returning to Australia, Keith resumed his meteoric rise at SA Water, eventually becoming, at 46, the youngest Director and Engineer-in-Chief for the Department in its history.

Key career accomplishments include the controversial introduction of fluoridation of Adelaide's water, the consolidation of the state water legislation into a single SA Water Resources Act, and the introduction of the Metropolitan Water Filtration and River Murray Salinity Control Programs. However, his management skills and vision were most clearly demonstrated as he conducted a massive modernisation of the Department.

He held another 14 senior part-time positions for both the South Australian and Federal governments, including: a secondment to create the Department of Environment and Planning; sitting on the South Australian Commission for the River Murray; and chairing many high level committees in the water and energy sectors.

Keith was made a Companion of the Most Honourable Order of the Bath in 1981 and an Officer of the Order of Australia in 1994. He was also elected an honorary member of the Institution of Engineers of Australia, became a Fellow of the Australian Academy of Technological Sciences and Engineering in 1982, was inducted into the South Australian Engineering Hall of Fame and served as President of the Unley Lions Club.

An accomplished golfer, Keith won full-colours for Imperial and, for his many contributions, as a Member, Captain and eventually President of the Kooyonga Golf Club, he was made only their 8th Life Member.

Keith died peacefully at his home, on November 15, 2013. He is survived by his wife Alison, daughters, grandchildren and a close extended family. *

Long-serving MEP

JAMES MOORHOUSE (Aero Eng 45-46)

Cecil James Olaf Moorhouse was born on January 1, 1924. After St Paul's School he went to King's College and Imperial College, reading Engineering and Advanced Aeronautics.

He joined de Havilland as a designer in 1946, moving to BOAC after two years as a project engineer, then joining Shell in 1953, becoming its environmental conservation advisor in 1968. From 1973 he was RTZ's group environmental affairs adviser, becoming a consultant after his election as an MEP, in 1978.

As a long-serving Conservative MEP, he became a spokesman for the Conservative group on subjects from external trade to human rights, but made his mark mainly in the fields of transport and relations with Japan.

He urged Japan to open up its internal market by reforming its distribution system; in 1997 he complained that the odds were still stacked against exporting to Japan, with its distribution system still closed and its markets heavily regulated.

Though firmly on the left of his party, Moorhouse was not an instinctive rebel but, after the conclusion of the Maastricht Treaty, the party's original MEPs came under increasing Eurosceptic attack for having "gone native". Moorhouse regarded William Hague's refusal to contemplate membership of the single currency as the final straw and, in 1998, he defected to the Liberal Democrats

James married twice, first in 1958, to Elizabeth Huxtable. They had a son and daughter; the marriage was dissolved in 1995. In 1997, he married Catherine Peterson.

James died on January 6, 2014, aged 90. *

Natural curiosity and delight in ideas

DAVID J SPENCER (Chem Eng 55-58)

David J Spencer died on 21 September 2013. He is survived by Monica, whom he married in 1966, and 3 daughters, a son and 7 grandchildren.

After graduating in 1958, David joined the Atomic Energy Research Establishment. After a couple of years he moved to British Titan Products Co. Ltd, now Huntsman Pigments, where he spent the rest of his working life. At first he worked at their Grimsby Plant. In 1962 he moved to the Group Process Engineering Department on Teesside and became involved in the development of the manufacture of titanium dioxide pigments via the oxidation of the titanium tetrachloride.

In 1971 he was a member of the commissioning team of the first commercial-scale plant, and was later appointed site Technical Manager. From 1981, until his retirement in 1990, he was Group Process Engineering Manager. He was appointed a Fellow of the Institution of Chemical Engineers during this time.

In retirement he continued his interests in music, playing bridge and reading extensively. He became an excellent cook and developed a love of gardening and, more especially, visiting gardens.

He had a natural curiosity, a deep appreciation for that which was beautiful and a real delight in ideas. He was a quiet family man who applied his personal and technical skills with great effect as a team leader and player.

A Guildsman, through and through

ROBBY (EATON HOLROYD) ROBINSON (Mech Eng 35-38)

Robby Robinson was many things: an engineer who worked on the first jet engine with Frank Whittle; President of CGCA (90-91); a member of Links, who attended the annual dinners well into his nineties; a first class rifle shot in his youth and, later, a fervent golfer; a businessman who won the Queen's Award for export three times; a man who charmed women; a noted wit who wrote his own funeral oration and provided the pew cushions in the church to ensure that everyone was sitting comfortably to hear it. Robby had a great sense of fun and was always optimistic, but he was also a serious engineer and businessman.

Eaton Holroyd Robinson was born on 29 November, 1915, in Glasgow. Despite his names being long-established family names, Robby showed early individuality by deciding that 'Robby' or 'Robin' was more suitable. Educated at Merchant Taylors' School, Robby excelled in rifle shooting and rugby, while mathematics and sciences were his best subjects.

At 17, he went up to Kings College, London to read Chemical Engineering and claims he failed his first year because he fell madly in love. Kings' loss became the Guild's gain. Moving to Imperial, he studied Mechanical Engineering. He was captain of London University Rifle Club and, aged 22, was chosen to shoot for Scotland, at Bisley. He got the top score.

He qualified as a pilot but, when WW2 broke out, found that, as a post-graduate trainee at Rolls Royce Aero Engines, his engineering expertise in the manufacture of aero engines was seen as more important for the war effort.

In 1940 he was transferred to a secret project in Rugby, which turned out to be the development of the first jet engine, designed by Sir Frank Whittle, producing the first jet engine ever, in 1941.

His war time experience was a disappointment: being unable to take up his Fleet Air Arm commission; working long hours; having little social life; working on a top secret project he couldn't talk about that, in the end, did not contribute to the war effort (Whittle's jet engine was not adopted by the RAF until the end).

After the war Robby joined the Aviation Department of Shell and was posted to India and Pakistan for three years. Turning down the offer of another posting in Pakistan, he left the company and joined management consultants, Urwick Orr. During the next six years, he re-organised twelve organisations including a food warehouse, the government of Zambia and bra-makers Berlei.

He married Shirley Reilly in 1956 and they had a family: two girls and a boy. He returned to industry, becoming MD of Leslie Hartridge, a small engineering firm making testing equipment for diesel pumps and injectors.

Hartridge had only 75 employees, very old machine tools, was generally rundown and had no export market. Robby's knowledge and experience enabled the company to expand, selling products overseas. He set up and became President of its US subsidiary and was President of the Garage Equipment Association. He was also on the council of the Motor Manufacturers and Traders. Hartridge won the Queen's Award for Exports three times, and later the Queen's Award for Technology. Robby retired in 1980 and began advising other businesses on exports.

Life changed in 1984 when Shirley was found to have cancer. She died the following year.

In 1987 Robby married June Micklem, MBE. They went on honeymoon to South Africa. Every year thereafter he returned to Cape Town, often meeting up with other Guildsmen.

Robby took up golf and joined Stowe, finding new friends, keeping fit. He also joined Stowe Church, with its exceptional speakers and friendly congregation. He became a committee member of the Friends of Buckingham University, playing bridge there regularly.

Robby was involved with the Old Centralians. He took over as publisher of the Central Magazine in 1984, for a year, but was still in charge in 1990 when he became President. During his presidency he initiated an appeal which resulted in the offering of Accommodation Bursaries to provide funds to selected students, to allow them to afford accommodation closer to the college.

Now known as 'Student Activity Awards', these awards are still available and, over the past 20 years a total of around 300 have been made, with an aggregate value of around £200,000.

June died in 2012. After a period of mourning, Robby determined to celebrate his 98th birthday by booking a local hostelry for lunch, inviting friends and family. Although Robby died on November 19, the booking was maintained for his wake.

Robby said he owed his longevity to June's care and their partnership, his devoted family, and to his many friends. He wrote, "But I must also thank the Lord and my parents, for giving me a very low blood pressure and a low pulse rate - and prunes for breakfast!"

He ended, "Thank you and farewell dear friends until we meet again, and we will meet again." *

Roderick Rhys Jones (Civil Eng 61-64)

Setting industrial standards

DAVID WHARTON RUSSELL PRICE (Chem Eng 48-51)

David Price was born in Portsmouth, on April 18, 1924.

Aged 15, David had been sent to France to perfect his French; returning alone in late August '39, overnight in unlit trains full of French serviceman, was a memorable experience.

At 18, he had a 'Reserved Occupation' in Woolwich, making bearings for tank wheels, and serving in the Home Guard. But, having lost two cousins serving in Fighter Command, he felt he had to join up. He joined the Duke of Wellington's Regiment, and became 'DWR Price, DWR'.

He was posted to Egypt where his unit was responsible for installing telephones in the RAF HQ. Here he met Margaret who was a WAAF Officer. They married on June 25, 1948.

On leaving the army, David read chemical engineering at Imperial.

His first job was with Albright and Wilson in the Midlands. He then moved to work in Glamorgan, for Midland Silicones. Joining Dupont in 1957, he was sent to Michigan for a year to train in the designing and running of a chemical plant. He did both of these things, with the new plant producing neoprene just outside Londonderry, where he moved in 1958 and where Jonathan was born in 1961.

David remained with Dupont, moving to its Head Office in 1964, and becoming involved with marketing, specialising in rubber hoses used in the automotive industry; Margaret would often join him on annual conferences near Geneva, Dupont Europe's HQ. This work led on to his chairing committees concerning rubber and, later, plastics for the BSI and ISO – for whom he travelled widely for conferences.

Having taken early retirement, he was consultant to Stirling Lloyd, a firm providing damp-proof membrane for bridges, both in the UK and US. (He had previously been involved with the Thames barrier.)

In 2000, David and Margaret moved to Wells and found a house on the stream fed by the Bishop's Palace Moat; it was here at home that David died in July 2012, aged 88.

Inspired three generations of students

JOHN LESLIE STOLLERY, CBE FREng (Aero Eng 48-51, 51-52)

John Stollery, who died on June 28, 2013, aged 83, was a distinguished engineer. He contributed to the understanding of high-speed flight and inspired three generations of students to follow careers in aerospace.

John attended East Barnet Grammar School, before studying study aeronautical engineering at Imperial, achieving a BSc and an MSc. He joined the aerodynamics department at the De Havilland aircraft company in 1952.

In the late 1950s, as flight speeds increased, new problems required engineering solutions. Experimentation was the only reliable tool and new facilities were needed. John was a pioneer of the "gun tunnel", building a machine that could deliver a speed of 3km/sec for about 10 milliseconds. His team made important contributions to the understanding of high Mach number flows and provided practical design information for missiles and aircraft intended for flight at more than five times the speed of sound.

In 1956 he married Jane Reynolds and returned to Imperial as lecturer in aerodynamics. An outstanding academic with a gift for experimentation, he also worked with Donald Campbell's team on the Bluebird projects.

Promoted to reader in aerodynamics in 1962, he was awarded a DSc for his collective research in 1972, then moved to the College of Aeronautics, Cranfield University, as professor of aerodynamics, in 1973. He became head of the college in 1976 and was later also dean of the faculty of engineering and pro-vice-chancellor.

He was chairman of the defence technology board at the MoD, and of the aviation committee at the DTI, and a member of the airworthiness requirements board at the CAA.

He was also president of the Royal Aeronautical Society in 1987, an honorary fellow of the Royal Aeronautical Society and a fellow of the Royal Academy of Engineering. In 1994, he was made a CBE for services to the aerospace profession. He retired from Cranfield in 1995, but continued working with students.

Jane died in 2009. John is survived by their four sons. *

Secret of centenarian's longevity: "Not dying!"

GEORGE ELLIOTT WILD (Civil Eng 31-34)

George was born near Chesterfield on December 12, 1913. After Hulme Grammar School, he read Civil Engineering and Surveying at Imperial and, on leaving, immediately joined John Mowlem, for whom he worked for the rest of his life, as a civil engineer, rising to become a board director.

In WW2, he joined the OTC and then the TA and was posted to Corsham as an Artillery staff officer. He married Nancy Tilley and the couple had two daughters, Elizabeth and Mary.

After the war, George worked at Shellhaven and on various tunnelling projects. In 1956 Mowlem sent him to Persia. He thoroughly enjoyed his projects abroad, visiting many countries, usually in the tendering team. In 1958, he was in charge of the building of Immingham Dry Docks.

George was in charge of Mowlem East Africa in Kenya, until Independence. He returned to Head Office to become a full board director in charge of tendering and finance.

Fishing was a passion that he held and practised all his life, he and Nancy sharing the hobby with equal enthusiasm. In 1966, they bought a retirement cottage, conveniently near good trout rivers. Nancy died in 2002.

George believed in 'moderation in everything' and had an excellent sense of humour. When he was asked to what he attributed his longevity, he immediately retorted, "Not dying."

He was enormously well-read and delighted in well-honed verse. He liked words to be used with engineering precision. He was very much loved by his four granddaughters, 10 great grandchildren and 1 great-great grandchild.

George died on January 22, 2014, aged 100.

George celebrating his 100th birthday with members of his family including daughters Mary (right) and Elizabeth (left).

From Ningpo to Toronto

YUAN LU LI (Elec Eng 55-58)

Dr Yuan-Lu Li was born in Ningpo, China and had his early education in Singapore.

He studied at Imperial and, in 1958, obtained a First Class degree in Electrical Engineering. In 1964, he received a PhD from the University of Birmingham, on a Commonwealth Scholarship.

After his return to Malaysia, he was appointed Chair of Electrical Engineering, University of Malaya, in 1969.

Emigrating to Canada, Dr Li spent 17 years with Bell-Northern Research Ltd. and was a co-inventor of 5 patents.

Returning to Singapore, he became the Head of the Maths and Science Centre at Ngee Ann Polytechnic from 1987 to 1997, during which time he also served on the Council of the Institute of Engineers Singapore and as Chairman of a subcommittee of the ASEAN Committee of Science and Technology.

Dr Li passed away in Toronto, Canada on August 7, 2013 at the age of 82. He leaves behind a wife, three children, and five grandchildren. *

NOTICES IN BRIEF

PETER HENRY CALDER OBE FREng

Dr Peter Henry, Formerly Concorde Project Director, died peacefully on August 31, 2013, aged 87 years. Dearly loved husband of Mary Rose.

JOHN RYDING (Elec Eng 57-60)

John, a loving husband, father and grandfather, died peacefully on August 29, 2013 after a long illness. He had spent much of his working life at the University of Manchester Institute of Science and Technology, thoroughly enjoying the environment and student company.

MAURICE DAVIDOV (Mech Eng 54-58)

Born on September 19, 1936, Maurice Davidov died on September 23 , 2013, aged 77 years.

Maurice and his wife, Barbara celebrating their golden wedding anniversary in 2011.


THE ROYAL BRITISH
LEGION