



# Imperial ENGINEER

**THE YUKON SUN**  
**VIRTUAL REALITY**  
**TRAVELS IN RUSSIA**  
**CIVSOC IN ROMANIA**  
**VOLCANOES & STORMS**  
**LURE OF CONSULTANCY**  
**NUCLEAR DECOMMISSIONING**

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

ISSUE 24 *SPRING 2016*

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**Cover: Photograph of a beautiful rotating jet of viscoelastic liquid water resembling a spinning dancer – demonstrating the effect of adding a tiny amount of polymer to water. An example of fluid dynamics research at Imperial, this photograph won first prize in the Weir and Wonderful category of this year's Engineering and Physical Sciences Research Council national science photography competition. (See p6)**

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## Imperial ENGINEER

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Short URLs at the end of items indicate more details online. All the links in this issue can also be found in our bit.ly links at: [bit.ly/IElinks](http://bit.ly/IElinks)

STORY IDEAS FOR THE NEXT ISSUE BY AUGUST 15 2016

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Welcome to the Spring 2016 Issue of Imperial ENGINEER! The past two years since I was preparing at this time in 2014 to take over from David Nethercot have flown by, and now we are preparing for, amongst many other matters, this year's AGM in June and my successor to take over. And I want to start this report by highlighting my successor's award of a DBE in the New Year Honours List to become Dame Judith Hackitt. I am sure all members offer their congratulations as I and my fellow Committee Members were pleased to do earlier in the year.

You could do so in person by coming to our AGM at 17.30 on Wednesday 8th June. As you may recall from last Autumn's IE, we have been undertaking a strategic review and seeking input to that review from members via a survey to give us your views on CGCA and the CGCA you would like for the future, for which we so far have a 12% response from those invited. And the link to the AGM? The results of the review are to be presented by Dame Judith when she takes over from me as CGCA President at the AGM.

CGCA is the members' Association, not just mine or Judith's, and we hope that, if you can, you will come to hear the outcomes, and want to get involved in delivering them. See <http://www.cgca.org.uk/eventssubsite/president.html> for the details and book to come along not only to the event but also the supper afterwards. Alternatively, for those receiving a paper copy of this Imperial ENGINEER, please do not throw away the wrapping - the booking form is inside it as well as the magazine.

The AGM and President's evening is just one of our regular activities. November saw an excellent Decade Reunion Lunch and December saw my wife and business partner, and fellow alumna and member of CGCA, Jean Venables deliver the Christmas Seminar talk on nuclear decommissioning - see the article on page 18 reporting the essence of her talk and some recent developments in the subject.

Jean's contribution to our programme is an example of the wealth of expertise and experience within CGCA's members. I think we should make more of those experiences for the benefit of other members and current students. We would be pleased to have offers of talks and articles from many members exploring their role in the increasingly wide spectrum of engineering and related activities.

The most recent major event in our calendar was our Annual Dinner, held in the Fishmongers' Hall on February 26th. I was delighted to welcome Professor David Balmforth as our Principal Guest, especially as he is a Visiting Professor in the Department of Civil and Environmental Engineering at Imperial as well as immediate Past President of the Institution of Civil Engineers. And it was also excellent to continue our strong and developing relationship with Imperial's leadership by hearing from Sarah Porter Waterbury, the College's first Vice President for Advancement, in her reply to my toast to the guests. More details of the event are on page 4.

Two final matters to report - and, I hope, to prompt you into action. First, we continue to develop our relations with the Departmental Societies, seeking to use members' expertise and experiences to assist current students in a range of ways. If you feel you could help develop these activities in your current or past department, do please get in touch with our Secretary, Nigel Cresswell ([nigel.cresswell@hotmail.co.uk](mailto:nigel.cresswell@hotmail.co.uk)), and Events Coordinator, Charles Parry (Charles.Parry81@alumni.imperial.ac.uk), in the first instance. Secondly, you will see on pages 5 and 23 details of this year's Imperial Festival and Alumni Weekend on 7th & 8th May. If you wish to make contact with us - or even better help with our participation in the event - please get in touch with Nigel and Charles on that topic too.

It has been - and will continue until June - to have been an honour to be CGCA President for the last two years, and I look forward to supporting Judith in her presidency rolling out a new strategy for the Association.



**Roger Venables**

## PRESIDENTS REPORT



**John O'Reilly**

I prematurely said last year that I was penning my last piece for the Imperial ENGINEER but this is my last effort before I hand the presidential baton to Tim Cotton at the AGM in June. It has truly been a privilege to have served the RSMA in this capacity and to be once again closely involved with the Institution where I endured so many happy times a half-century ago. At times it has been frustrating but nevertheless rewarding and I believe we have a sound basis for a positive future both in our relationship with the College but more importantly in embracing the students of today to encourage them to become part of the future of the RSMA.

The 131st Annual Dinner, held in November, again at the Rembrandt Hotel, was a tremendous evening with 125 attendees, in a beautifully appointed room. Once again, a pleasing aspect was the number of students attending generously sponsored by alumni. Our excellent guest speaker was alumnus Paul Atherley, Managing Director of Berkeley Energia, who are developing the world class Salamanca uranium project in Spain. That camaraderie between alumni and students was again in evidence and those with stamina subsequently boosted the profits of the union bar into the early hours. This year's dinner will again be held at the Rembrandt which has proved a convenient venue for both travellers and students. At the dinner, the Peter Harding Memorial Medal was awarded to Teresa Sergot for her unstinting efforts on behalf of the RSMA over many years. A standing ovation from all attendees was testimony to the respect and affection that she has earned. Over the last three years I have much appreciated Teresa's wise counsel and witnessed the efforts she puts in on behalf of both Associations, and sincerely thank her for her contributions. A new annual award, presented for the first time, was the Professor Rees Rawlings Award which recognises significant contributions to the life of the College community by younger alumni (aged under 40 years). The initial recipient was John Sykes, now based in Perth (Australia), a former President of RSMU and still actively involved with the RSM. The prize is a working replica miner's lamp, suitably engraved, and the Association sincerely thanks Rees for generously sponsoring this award.

The annual sporting events against Camborne only went ahead after last minute changes of venues due to the terrible flooding in Cornwall. The changes obviously suited Camborne and the Bottle was lost 5-14, our first loss since 2010, with further losses in soccer, women's hockey and squash. One bright feature was the retention of the Sharpley Cup with a 3-3 draw in the men's hockey, and tennis also won their match.

The data sharing agreement with the College is in the final throes of completion prior to being signed by both parties. This will result in the Association having better access to members for mailings, fund raising etc.

The Association will shortly be making a renewed appeal for funding, to both alumni and industry. Donations are essential if we are to fulfil our ambitions of being able to financially support individual students when in severe genuine need, and to also support events like the 'Camborne weekend', grants for college-approved expeditions, society events, freshers' week etc. We are extremely grateful to those alumni who have contributed to date and your generosity is much appreciated.

The website is currently being overhauled - unfortunately due to pressures of work this had only been sporadically updated, but is a prime focus for the committee. The RSM now has over 2000 alumni on LinkedIn and retains a strong presence on Facebook.

A couple of dates for the diary. The Association AGM will be held on Thursday 23rd June, at 58 Princes Gate at 18.30. This will be followed by the final year Bar-B-Q, at the same venue, which is always generously supported by members. As many members as possible are encouraged to attend. The Imperial College Alumni Weekend will be held on the 7th and 8th May and the RSMA will again host a stand at the event. This is a great opportunity to see what is happening in today's Imperial College.

In conclusion, a huge thank you to the committee for their sterling work and support over the last three years.



# CGCA annual dinner at Fishmonger's Hall

Ever since the OC's dinner in 1988, which was the last time the Association was at Fishmongers', I have always said, to anyone who might be interested, or would listen, that Fishmongers' is my favourite Livery Hall. Having been to Apothecaries', in June 2015, there was stiff competition, but learning that the Association's dinner was to be at Fishmongers' I leapt (like a salmon?) at the chance to go to this wonderful hall. Not only is it directly on the mighty Thames (and so gives one enviable views that can be enjoyed from the deep and very comfortable window seats),



**Clare Lupton and guest enjoying the Thames view from one of the window seats**

it also boasts candelabra with real candles in (the quality of the 60 lux per candelabra has to be seen to be believed), and it has carpets woven to mirror the moulding on the ceilings. The quality of the company was matched by the history of the surroundings. Google the Fishmongers' Hall to learn of the unique architectural style following the fire in the Second World War that saw renovation completed in 1954 – and yet this livery company is one of the 12 great livery companies and one of the oldest with more than 700 years of history. I remembered seeing Narwhal tusks when I visited previously – and unsurprisingly they are still there. If you ever get the chance to go to this Hall, take it.



There is the dagger that killed Wat Tyler – it was William Walworth the Lord Mayor of London that wielded it in 1381 – it is a dagger that means business – and is on view at the Hall, rather sobering on such an evening. Surrounded by many Guildsmen and women, the glittering Hall glittered with conversation amongst the gathered alumni. Spanner, Bolt and Bo made their presence felt, and kept the Links alive – several Links bow ties were on show, and the Boomalaka rang out once the President remembered to introduce it. Professor Roger Venables and his wife, Jean, were the most generous of hosts, welcoming all to this wonderful evening at one of the 16 Livery companies that founded the



**CGCA President Roger Venables greeting Dame Judith Hackitt, the next President of CGCA**



**Roger Venables greeting Chris Lumb, who, among other things, has the unenviable job of collating obituaries for IE**

City and Guilds of London Institute for the Advancement of Technical Education, in 1876.

I was reminded that my namesake, Robert Lupton, was a Master of the Watermen & Lightermen in 2003 – which I count as a great honour. [http://www.parishregister.com/watermen\\_and\\_lightermen.html#masters](http://www.parishregister.com/watermen_and_lightermen.html#masters) gives you lots of information of this ancient body of men, who still race every year for the Doggett's Coat & Badge Race.

The C&G Students were represented well in the evening and although I didn't manage to speak to any of them, I think they all had a good time, and I hope they will be back, lifting Spanner and Bolt aloft.

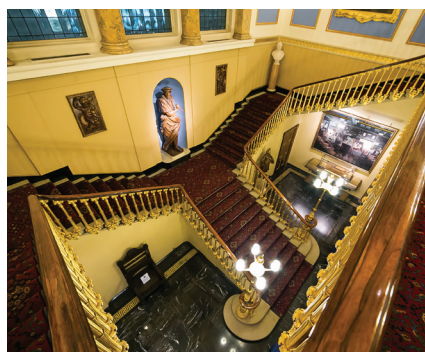
We were treated to an excellent discourse from the guest speaker, Professor David Balmforth, BSc PhD CEng FICE FCIWE. David is



Executive Technical Director at international consultants MWH and is the Immediate Past President of the Institution of Civil Engineers (ICE). His work involves urban flood control, managing pollution and adapting to climate change in the waste water sector. He is currently working on major projects across the south of England and is an advisor to the Singapore Government. David worked on the UK Government's Foresight Project, the Pitt Review Advisory Panel and the UK Government's Strategy Group on Engineering, Infrastructure and Climate Change Adaptation. He has close links with the academic world, and Imperial in particular, as a Visiting Professor in the College's Department of Civil and Environmental Engineering. He spoke with wit, noting that an early boss of his ensured that original thinking and initiative were well and truly squashed, by announcing to the only young men in his department who had sufficient gumption to take original action (one David Balmforth) that the only person who was to



**Roger Venables greeting David Nethercot, the previous President of CGCA**



Photographs by Ziyuan Mao



## CGCA AGM and President's Evening, 2016



**Roger Venables greeting Teresa Sergot**

have good ideas in his department was to be The Boss. Thankfully David paid sufficient attention to the merits of this approach to both escape its clutches and not put it into practice elsewhere.

The food and wine were, as ever, by themselves reason enough to be at the evening. Delicious whether you were omnivore or vegetarian, tee-total or willing to enjoy the delectable vintages of both wine and port that were uncovered from the cellars. Really, if you weren't there, you missed a treat.

The company, the surroundings and the victuals – all were splendid. Make sure you go next year & enjoy what very few people can have access to, make the most of your heritage & bring your guests. Colleagues, husbands, wives and children should all come and enjoy what your Association gives you access to, don't miss out if you can help it.

**Clare Lupton**  
(Mech Eng, 1985-88)



**Prof. David Balmforth gave an excellent speech**

The CGCA Annual General Meeting and President's Evening will take place on Wednesday, 8th June, starting at 17:30 in the Read Theatre, Level 5, The Sherfield Building, Imperial College, South Kensington. Refreshments will be available on the Level 5 landing from 17:00.

The AGM will include a review of the year by our President, Roger Venables, the handover of the Presidency for the next two years to Dame Judith Hackitt, presentation of the accounts for 2015 and the election of Committee Members and Officers.

The AGM will conclude around 18:00 and will be followed by

a presentation by Judith of the Association's Future Direction and Strategy.

Attendance at the AGM and Strategy presentation is free and your Committee encourage you to make every effort to attend this important meeting.

Following the presentation, you may optionally attend the President's Evening Supper, to be held this year in the Queen's Tower Rooms, Level 1 of the Sherfield Building. This should commence at around 19:00 and will include drinks on arrival, a hot buffet supper with wine or soft drinks and coffee or tea afterwards. Those coming to the supper must

book in advance and ticket price is £32 per head.

Guests of members are very welcome at the AGM and supper.

A flyer for the AGM / President's Evening is included in the packaging for those who receive a paper copy of Imperial ENGINEER and you can use the booking form on that flyer to indicate your attendance at the AGM and book tickets for the supper. Alternatively please see the 'Events' section of the CGCA website where you can download the booking form.

<http://www.cgca.org.uk>

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# DEVELOPMENTS AROUND THE ENGINEERING FACULTY

## New Year Honours

Several Imperial staff, alumni and friends have been awarded with New Year's Honours.

**Judith Hackitt** (Chem Eng 1975) was awarded a DBE for services to engineering and health and safety. Dame Judith is Chair of the UK Health and Safety Executive (HSE), current Vice-President of CGCA and will be taking over as President of CGCA at the AGM in June.



**Dame Judith Hackitt**

Alumnus **Michael Uren** (Mech Eng, 1943) received a knighthood for his services to philanthropy. Among Sir Michael's philanthropic investments is a £40 million gift to found the Michael Uren Biomedical Engineering Research Hub at Imperial's White City Campus.

Professor **Maggie Dallman**, Associate Provost (Academic Partnerships), was awarded an OBE for services to bioscience.

**David Miles**, Professor of Financial Economics at Imperial College Business School, received a CBE for services to monetary policy. Between 2009 and 2015, Professor Miles served on the Bank of England's Monetary Policy Committee.

**Clive Hargeaves** (Civ Eng, 1988), Technical Services and Facilities Manager in the Department of Civil and Environmental Engineering, was honoured with a British Empire Medal. Clive has supported the Department for 35 years as it rose to become one of the world's top-ranked centres in its field.

In addition to the honours announcements, the Queen has admitted three new members to the

Order of Merit. The award, which is limited to 24 living recipients, is granted to those who have rendered exceptionally meritorious services towards the advancement of the arts, learning, literature and science.

The new members include Professor **The Lord Darzi**, Director of the Institute of Global Health Innovation at Imperial, for his contributions to medicine. Lord Darzi joins his colleague Sir Magdi Yacoub, Professor of Cardiothoracic Surgery, who joined the Order in 2014.

Sir **James Dyson**, who opened the Dyson School of Design Engineering at Imperial last year, was admitted to the Order of Merit for his work in industrial design.

Professor Dame **Ann Dowling**, President of the Royal Academy of Engineering who delivered Imperial's Athena Lecture in 2015 and received an honorary doctorate from the College in 2013, also joined the Order.

Several other Imperial alumni were also recognised in the New Year's Honours list. Among them were four recipients of the OBE: **Ian Pigott** (Wye College, 1992) for services to agricultural and countryside education; **Josephine Farrar** (MBA, 2000) for services to local government; **Stephen Smye** (MSc Physics, 1980) for services to healthcare research; and **John Edmunds** (PhD Biology, 1993) for services to infectious disease control, particularly the Ebola crisis response in West Africa. **Michael Jacobs** (PhD, Surgery, Anaesthetics & Intensive Care, 1998) received a Knighthood for services to the prevention and treatment of infectious diseases.

Two other alumni received British Empire Medals: **Rudolf Oppenheimer** (Elec Eng, 1953) for services to Holocaust education and awareness, and **Robin Woodd** (Civ Eng, 1969) for services to the community in Hemel Hempstead, particularly through the Samaritans and St Mary's Church. **Paul Cosford** (Medicine, 1987) received a CB for services to public health.

## Chemical engineers from Imperial win photo prize

An image of water rotating in what appears to be slow motion is one of the winning entries in a major science photography competition.

Professor Omar Matar, from Imperial's Department of Chemical Engineering, and his team took the image as part of their research into liquid jets. The Imperial entry is one of five to take top place this year in the National Science Photography competition, which was organised by the Engineering and Physical Sciences Research Council.

Liquid jets are common in a range of industrial equipment and even daily life, from crop irrigation systems, to aerosols, and engine fuel injection systems for cars and trucks. Researchers around the world are investigating these liquid jets to understand their dynamics, so that improvements can be made to maximise their performance.

The liquid jet in the image appears to have viscous globular tendrils, which spin in a downward trajectory, in a similar fashion to the fluid-like movements of a contemporary dancer. This effect was created by adding a tiny amount of harmless polymer into the liquid. Adding the polymer gives the liquid jet more elastic-like properties and the team were exploring them in more detail when they took the winning photo.

Normally, a liquid jet breaks apart due to a combination of different forces including gravity and the liquid's surface tension. The team says the polymer they added acts like microscopic springs, which keep intact the distortions caused by the jet. This effect, together with centrifugal forces, makes the liquid exhibit a complex, curved shape, while the surface tension creates vertical ripples.

Professor Matar said: "The EPSRC competition gives us engineers a chance to reveal to the world some of the truly beautiful sights we see every day as part of our research. I am really pleased that our work was recognised by this competition. Liquid jets are the silent heroes of many processes, so it is great to see this process stepping out into the



Matar Fluids Group (led by Professor Omar Matar)

metaphorical limelight and getting its due credit. I am also sharing this award with many members of my research group, so congratulations to my team for making this acknowledgement possible."

The research was also carried out by Dr Zhizhao Che, a postdoctoral research fellow from the Matar Fluids Group, and Fen Shi Wong and Panuvit Bunrittaphol, who are both undergraduates in the Department of Chemical Engineering at Imperial. The research was funded by the EPSRC Multi-scale Examination of MultiPHase physics in flowS project.

Teams from the Universities of Aberystwyth, Edinburgh, Oxford and Cambridge were also prize winners in the EPSRC competition.

**Colin Smith**

## Imperial – the UK's most international university

A new ranking by Times Higher Education (THE) has found that Imperial is the UK's most international university.

The study, which also placed Imperial as the 10th most international university in the world, considered each institution's proportion of international staff, students and research papers

published with at least one co-author from another country.

London is also the world's most international city for higher education, with 15 universities in the top 200, putting it ahead of the whole of the United States, Canada and France.

Professor Alice Gast, President of Imperial College London, said:

"Imperial's international outlook is fundamental to its excellence. No university can achieve world-class status without a global community of staff, students and collaborators. Innovation often emerges from the creative synergies that occur when people from different cultures, disciplines and sectors come together."

In 2015, both Times Higher Education and QS ranked Imperial as the world's 8th best university. That year, Reuters also found Imperial to be Europe's most innovative university.

The full THE international ranking can be viewed at:

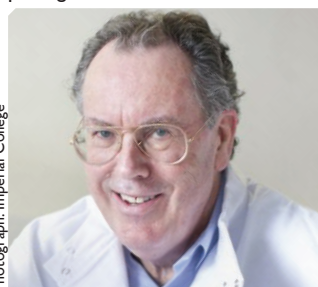
**bit.ly/IE24-International**



# DEVELOPMENTS AROUND THE ENGINEERING FACULTY

## Recognition for Imperial Bioengineering pioneers

Two of the pioneering professors responsible for Imperial's Bioengineering Department have recently been recognised by prestigious institutions.



Photograph: Imperial College

**Professor Richard Kitney**, founding head of the Department, has been made a Fellow of The Royal Society of Edinburgh (RSE). He is one of 56 'distinguished individuals' elected to become Fellows of the RSE this year. New Fellows come from sectors that range from the arts, business, science and technology, and academia, and their varied expertise is expected to support the advancement of learning and useful knowledge in Scottish public life. Professor Kitney will officially receive his honour at a ceremony on 16 May in Edinburgh.

Professor Kitney said: "Medical information systems and synthetic biology are both relatively new fields. It has been gratifying to be around to mould their development. It is always humbling when you are recognised for the work that you do. However, science and engineering is a collaborative life-long process and this honour also recognises the efforts of my peers, colleagues and students that I've had the pleasure of working with over the years."

Professor Kitney currently co-leads the Centre for Synthetic Biology and Innovation at Imperial. Synthetic biology research involves re-engineering harmless host cells, such as bacteria, so that they can perform new tasks. Professor Kitney and his colleagues have, amongst other things, been developing the processes and systems to commercialise this science on an industrial scale.

In 2008 and 2009, Professor Kitney chaired the Royal Academy of Engineering's inquiry into synthetic biology, which laid the foundations in the UK for this field of science.

Most recently, Professor Kitney sat on a ministerial leadership council that has helped to steer the redevelopment of a UK roadmap for synthetic biology. The aim of this is to accelerate commercial opportunities for businesses in the UK. He is also a member of Synbicate, which is an innovation and

knowledge centre that is dedicated to promoting the adoption and use of synthetic biology by industry.



Photograph: Imperial College

Meanwhile, the current head of the Department **Professor Anthony Bull**, will be inducted into the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows in April 2016. He was elected for outstanding contributions to the 'basic mechanics of joints and tissues, and the study of military blast injuries'.

Professor Bull's research focuses on understanding the basic mechanics of joints and developing new technologies to diagnose and treat injuries and diseases. His work has been applied in a range of areas such as developing better sports therapies for UK rowers and cricketers; understanding the effects of blast injuries to mitigate their effects on military personnel; and improving our understanding about how age-related diseases, such as osteoarthritis, affect the mechanics of the body.

Professor Bull is the Director of the Royal British Legion Centre for Blast Injury Studies at Imperial. This is the first collaboration of its kind in the UK, where civilian engineers and scientists work alongside military doctors, supported by charitable funding, to reduce the effects of roadside bombs and Improvised Explosive Devices (IEDs).

Professor Bull also leads the Musculoskeletal Medical Engineering Centre and Sports Innovation Challenge. These activities put Imperial at the forefront of translational musculoskeletal and rehabilitation research in the UK.

Professor Bull said: "I am delighted to accept this honour which is recognition of the excellent work carried out by my many colleagues and students."

Professor Bull will be one of 160 new Fellows to be inducted into the College of Fellows Class of 2016 at a formal induction ceremony during AIMBE's 25th Annual Meeting at the National Academy of Sciences Great Hall in Washington, DC on April 4, 2016.

**Colin Smith**

## Imperial engineer recognised by American Academy

An Imperial researcher who helped to stabilise the Leaning Tower of Pisa has been elected to the US National Academy of Engineering.

Emeritus Professor John Burland, from Imperial's Department of Civil and Environmental Engineering, has been elected as a Foreign Member. Election to the Academy is among the highest professional distinctions accorded to an engineer. Professor Burland was only one of 22 Foreign Members and the only UK engineer to be elected this year.

Professor Burland said: "I only just heard about the news so I am still recovering my composure. At present I feel stunned, surprised and elated! I know that extremely high standards are demanded of individuals for Foreign Membership of the Academy, so this recognition means a great deal to me. Imperial must take the credit for this honour and it is yet another indicator of what a fabulous place this is. I plan to celebrate with the department and I'll also have a family celebration as well, but I know they will make sure that I don't get too big-headed."

Professor Burland's research focuses on engineering challenges related to the interaction between

the ground and structures made of masonry. He is responsible for the design of many large engineering projects such as the underground car park at the Palace of Westminster and the foundations of the Queen Elizabeth II Conference Centre.

Professor Burland was also a member of the Italian Prime Minister's Commission for stabilising the Leaning Tower of Pisa from 1990 to 2002. In addition, he was a member of the international board of consultants that advised on the stabilisation of the Metropolitan Cathedral of Mexico City from 1992 to 1998.

Professor Burland was also London Underground's expert witness for the Parliamentary Select Committees on the Jubilee Line Extension and has advised on many geotechnical aspects of that project, including ensuring the stability of the Big Ben Clock Tower.

Professor Burland will attend a ceremony in Washington on 9 October 2016, where he will be formally inducted as a Foreign Member of the US National Academy of Engineering.

**Colin Smith**

## New £24m 'Internet of Things' research hub

A new collaboration should ensure that the UK remains a global leader in the 'Internet of Things'.

The 'Internet of Things' (IoT) describes a world where the physical objects around us – everything from heart pacemakers to fridges – are connected via digital networks. The PETRAS IoT Hub will explore the technical, ethical and social issues associated with these networks. It aims to make the UK the world's best place to develop and deploy new internet technologies.

Imperial College London is part of the new consortium of nine universities, which has received £9.8 million support from the Engineering and Physical Sciences Research Council (EPSRC), as part of a UK Government investment in IoT research.

An additional £9.7 million comes from partners including businesses, NGOs, and public bodies. With just over £4 million of additional support from the participating institutions, the total investment in the PETRAS IoT Hub comes to £24 million over 3 years.

Imperial will be the technical lead on two out of five themes – 'Safety and Security' and 'Harnessing Economic Value'.

'Safety and Security' lead and

Deputy Director of the Hub, Dr Emil Lupu, from the Department of Computing, said: "We aim to create a new generation of systems for applications in health and wellbeing, transport, household technologies, and infrastructure and utilities, which fulfill our need for safety, security, and privacy. The burgeoning Internet of Things must be able to face unexpected circumstances, be robust to cyber-attacks, and be able to adapt to face new threats as they emerge."

'Harnessing Economic Value' lead, Professor Michael Huth, also from the Department of Computing, said: "The broad array of objects that are becoming networked – gas meters, lights in our homes, heart pacemakers, insulin pumps for diabetics, water distribution systems, cars, and more – opens up the possibility of creating innovative ecosystems in which these technologies will have social and economic benefit."

The possibilities are pretty much endless and may include new social platforms or economic mechanisms. But these novel systems should be unobtrusive and easy to live with, and we must be able to trust them."

**Nancy W. Mendoza**

# Operational Independence

## and the Lure of Consultancy

Dr E.Andrew Wyatt (EE 1971-74, 74-77) looks back on the experience of leaving salaried employment to set up as a self-employed consultant, offering advice for those who are thinking of doing the same.

Many engineers at some time or other in their career consider the possibility of going self-employed and setting up as a consultant. Most decide to stay put, reckoning that the big company benefits they enjoy are worth the many frustrations they endure. Some however take the plunge...

First, some history. Bright eyed and bushy tailed, I left Imperial in 1977 with a PhD in heavy electrical engineering under my belt and a conviction that the world of manufacturing industry was for me. At the time, ICI was one of the UK's foremost industrial companies and it was there that I underwent my graduate apprenticeship. Little did I know when I joined that the company was in its death throes, plagued by high energy prices, underinvestment and ineffective management. Used to a blistering work rate at Imperial it was disappointing to experience the plodding pace that was a characteristic of my workplace. Eventually, in 1981, I took voluntary redundancy and left for the UK Atomic Energy Authority where I worked on the design of the Trident Submarine Shore Test Facility at Dounreay. It was there that I realised that long term large scale projects didn't suit me – my talents were in short term high stress projects where the results, if not exactly instant, came through rapidly. Consequently, in 1984, I joined a building services consultancy practice as an Associate Partner, leaving when it hit financial trouble to form my own firm, in 1986.

Setting up a consultancy from scratch requires a number of essentials – the four 'Cs' of courage, cash, co-workers and clients. Right from the start, I was determined to be part of a small team that could offer a wide range of skills. My colleagues in the venture included a mechanical/public health engineer, Ian Foden, who was also a capable salesman, and a mechanical engineer, Paul Walker, who specialised in computers and associated applications. As for me, I provided expertise not only in the electrical discipline but also in finance, human resources, and safety systems engineering. Looking back on events now, I am convinced that it was the amalgam of three ambitious individuals with non-overlapping skills that led to the success of the venture.

Strapped for cash and realising that the most important priority was to obtain clients, Paul and I set Ian up in an office whilst we took on (rather miserable but well paid) short term agency contracts to provide the necessary working capital. As the first clients came along, first Paul and then myself left contract

work and joined the business full time.

I cannot emphasise enough the importance of obtaining one or two clients of substance as early as possible. We were very fortunate to forge relationships with Drake & Scull and Yorkon to whom we showed total commitment and were rewarded with a series of commissions over many years.

Once established and with a strong client list, the next step was to build a dedicated team of technical staff who shared our ethos and commitment. Surprisingly perhaps, we had mixed results with staff recruited direct from university and as an alternative started taking on intelligent, enthusiastic and sociable young people who for a variety of reasons had ended up achieving poor academic results. These individuals we sent off on day release courses, first at HNC level and then as undergraduates. It is hard to think of one who today is not a chartered engineer working at the highest levels of the profession. I might add that during the 1990s we invited final year students at Imperial to apply to join us for graduate training and received not a single enquiry – a reflection perhaps of the commonly held, but erroneous, view among undergraduates that the construction industry is mundane, intellectually undemanding and incapable of providing attractive career paths for the very best engineers. Indeed it often forgotten that construction contributes approximately £10bn to the UK economy and employs over two million people.

A significant change to the business occurred as a result of the 1992 Further & Higher Education Act which stripped colleges of further education from local authority control. Since the sector had for many years suffered from chronic underinvestment and

many colleges were barely viable due to their dilapidated estate, central government was persuaded to finance an extensive programme of refurbishment. Much of the work required was of an electrical and mechanical nature (hence our interest), but structural repair, asbestos removal, re-cladding and re-roofing were also required. Ultimately, this led to our employment of a chartered architect and the provision of quantity surveying services to the sector.

Finally, in 2007, I left the practice, in part because over-familiarity with the work was stifling my enthusiasm and in part because I wanted to develop new skills elsewhere (predominantly in Italy – but that's another story!). Mercifully, the partnership agreement we founders had signed in 1986 provided an equitable basis on which my departure could be planned, and negotiations came to a conclusion without rancour. I might add that it is a source of pleasure that to this day the business continues to operate successfully and shows every sign of outliving its founding partners.

Looking back at my time at Imperial, I realise not only the value of my technical education but also the value of the associated studies courses I took at the time, particularly those delivered by Prof Sinclair Goodlad in the fields of English language and communication. The key to business success is not just technical competence and an ability to innovate; equally important is the skill to present complicated ideas in simple terms both orally and in writing. Were there subjects which could have been offered that would have enhanced my career further or more rapidly? Well, an introduction to contract and employment law would have been very valuable as would an understanding



**New Management & Industrial Innovation Centre for Knowsley Community College, Merseyside – designed by EDP and opened by Tony Blair in June 2007**

Photograph: Felton Construction Ltd



of the psychology of negotiation. As one who was offered the opportunity to take part in the Erasmus programme a few years ago I would heartily recommend potential students to consider MEng programmes that include a year spent abroad learning a foreign language and experiencing an unfamiliar culture.



In creating and maintaining a successful engineering consultancy practice I have learned a number of lessons which I would pass on to colleagues today thinking of leaving salaried employment and going it alone:

1. Be careful to adopt a name for the firm that reflects what you do and the aspirations you have – we chose Engineering Design Partnership as it reflected our desire to create a multi-disciplinary, cooperative enterprise devoid of the egotism of its founders!
2. Examine carefully, critically and with expert help the structure of the business you wish to create. Is it to be a partnership or limited company, and how is the equity to be shared?
3. Decide at the outset how the business is to be valued (eg is goodwill to be included?) so that when a founder eventually leaves, dispute can be avoided and he/she can be paid off promptly without causing a cash squeeze.
4. Surround yourself with positive people who have complementary skills and who compete with industry rivals not with each other.
5. Forge long term mutually beneficial and trusting relationships with a small number of clients who are prepared to help you through troughs in the economic cycle.
6. Constantly be on the lookout for new business areas allied to your core activity that might lead to risk reduction through diversification as well as additional profit.
7. Invest in people – taking individuals who have the right mental attitude and training them to take on ever greater responsibilities.
8. Control debtors and conserve cash.
9. Make succession plans and train senior staff sufficiently to ensure a painless transition.

## BBOXX secures innovative funding

We have previously featured BBOXX, a company founded by three Imperial Electrical Engineering graduates in 2010 to provide off-grid energy solutions across the developing world.

BBOXX recently announced a major \$15m fundraising round which will accelerate the company's vision of improving access to energy for more households in Africa and the developing world, including a novel approach of securitising the rooftop solar systems. BBOXX, founded by Christopher Baker-Brian, Laurent Van Houcke and Mansoor Hamayun whilst they were graduating from Imperial, was spun out of the Imperial student charity e.quinox, which received funding from the CGCA's OC Trust in 2009 to carry out electrification projects in rural Rwanda. BBOXX has continued to have a close connection with Imperial since 2010; eight Imperial students have carried out internships as part of their Imperial degree and the company employs 12 Imperial graduates in East Africa and the UK, mainly in engineering and operations roles.

This latest round of funding means that BBOXX will have secured a total of \$9.8m in equity investment and \$5.3m in debt funding in 2015, including a scalable working capital facility. This has been contributed to by existing investors DOEN Foundation, Bamboo Finance, Ceniath, Khosla Impact Fund and Synergy Energy, as well as new backers ENGIE Rassembleurs d'Energies and MacKinnon, Bennett & Co.

As part of the investment, BBOXX has secured a landmark \$500,000 (51m KES) securitisation deal with Oikocredit, a Dutch social investor and worldwide cooperative providing loans and equity to enterprises within low income countries. This is the industry's first ever deal – called Distributed Energy Asset Receivables (DEARs) – that uses securitisation as a means of financing solar home systems in Africa. The securitisation will allow BBOXX to realise income from its payment plan sales model up to three years earlier, and with the additional investment allows the company to produce more solar home systems and therefore bring power to more households living without grid electricity.

Mansoor Hamayun, CEO of BBOXX,

said: "BBOXX started out with a vision to bring affordable, low carbon energy to the developing world, using a data-driven business model. 2015 has seen us take great strides in making that vision a reality, and this latest round of funding, in particular the groundbreaking securitisation deal with Oikocredit, means that we can now rapidly scale-up our business model and roll-out BBOXX across our key regions in Rwanda and Kenya. 2016 will be an incredibly exciting year for BBOXX – watch this space!"

David ten Kroode, Renewable Energy Manager at Oikocredit, said: "We are proud to be part of this innovative way of financing. By demonstrating how securitisation can be used to finance home solar systems, we pave the way for other lenders to scale up the much needed investments in this early stage growth sector. This deal also supports our mission of improving the lives of low income people by giving them access to clean energy."

BBOXX aims to access local capital markets with rated notes later in 2016, extending its securitisation facility. Launching a rated, local currency note program will allow BBOXX to attract institutional investors in Kenya both as private placement opportunities and also listing the notes on the Kenyan exchange. The company has already sold over 55,000 solar kits and impacted 275,000 lives across 35 countries, by providing more secure energy supplies which don't require an electrical grid infrastructure. The kits have replaced the use of kerosene, candles and batteries, reducing both costs and carbon emissions. The majority of customers pay for the equipment via a three year hire purchase agreement, paid monthly via a mobile payment scheme. BBOXX employs 160 people, with the majority based across its core regions of Kenya and Rwanda, helping to sell, install and maintain the systems.

The International Energy Agency estimates that there are 1.2 billion people on the planet without access to energy. Off-grid power systems are an efficient way of electrifying rural areas of Africa and Asia, rather than laying expensive transmission lines to extend national grids. Rooftop solar panels can power a few lightbulbs and small appliances such as a television, fan and mobile phone charger, bringing electricity to many households for the first time.





# North to the Yukon Sun and Dredge No.4

Retired in Vancouver, our Canadian correspondent Nigel Fitzpatrick (Metallurgy 1962-65, 65-68) says that his memories of metals are usually suppressed but surfaced when he and Joan visited the Yukon. They went in August, advised and encouraged by friends attuned to Parks Canada's steps to restore Dawson City and conserve gold mining icon 'Dredge No. 4' nearby.

With a tenth the population and almost four times the area of Iceland, the Yukon Territory is landlocked along its western border. Miners swarmed there from California when nuggets, grains and dust of placer (alluvial) gold were found near the confluence of the Klondike and Yukon rivers in August 1896. Landing in the area of Skagway, Alaska, they climbed mountain passes to the Yukon. Cold, tired and grumpy, they were safely disarmed by a small force of North West Mounted Police before floating downriver to work mostly on others' claims. Dawson City was founded, and its population rose to 30,000 before the September 1898 discovery on the less well governed beach at Nome, Alaska, drew the swarm away. Newer, less labour-intensive, mining methods also displaced people. Today, Dawson's population of 1,319 (2011 census) to 2,000 (2015 city guide) swells in the summer as hotels, motels, campgrounds and RV parks draw in customers to enjoy the long days. The iconic 'city' brilliantly preserves its Victorian colour and permafrost-tilted wooden buildings.



With flights even coming directly from Germany to Whitehorse, accommodation for a last minute trip was scarce. The lucky result was two stays in Whitehorse sandwiching a weekend in even sunnier Dawson City.

We reached Whitehorse August 5th on an Air Canada Embraer 190 and stayed in a downtown hotel. Next morning it was a short walk to the 'White Pass and Yukon' office to begin a bus and train day trip to Skagway. From the bus we saw sand dunes in the compact Carcross Desert and were reminded that the mountain rain shadow gives Whitehorse the lowest precipitation of any Canadian capital city. A narrow gauge railway runs over White Pass and it took us down to Skagway whence thousands rush today by cruise ship. We went down in cloud on the train but a bus returned us to Whitehorse under blue skies through



dramatic scenery.

On August 7th, we took Air North's afternoon flight. Their Hawker Siddeley 748s are renowned for short take off and landings and are perfect for Dawson City's gravel runway. We enjoyed a choice of hot sandwiches and arrived with still six hours before sunset.

Dawson City though is 15 km from its airport. We had not thought to pre-arrange pick up but were saved from a long delay by a kind couple who were on their way to pick up their boat in Dawson. They were collecting it to take it out to a placer mining operation near where *Call of the Wild* author Jack London had lived. We learned about the sustainability of modern Yukon placer mining (see overleaf). Dropped next to a permafrost-tilted heritage building, we were much relieved when our rescuers pointed to the newly built bed and breakfast we had booked!

Next morning, 2°C was scheduled to reach 25°C and we 'layered'. Our interest in placer gold mining sharpened by the chance meeting with miners, we phoned the tour company that Parks Canada has adopted to look after what had been the largest floating mining machine in North America. 'Dredge No.4', a bucketline sluice dredge, has been restored close to where it last operated along Bonanza Creek a tributary of the Klondike River. We were driven out to the site by the guides and we had a very worthwhile morning and extra history lesson there and back.

Most gold produced today in the Yukon comes from areas that were not glaciated and where placer mining dominates over hard rock mining. During the ice ages, precipitation was slight enough that, though Dawson area was and is endowed with permafrost, it was glacier free. Dawson is still the physical centre

of placer mining in the Yukon.

Early miners melted the permafrost down to the bedrock with fires, then sluiced the earth, soil or gravel obtained with water. With jets of water replacing the fires, and steam engines and then electric motors replacing manual labour, mining evolved to dredges of the generation we saw. Though economical, the steps on board these gravel-grabbing machines missed gold, a third some say. Old areas are being worked again with more sophisticated equipment. New areas are still being discovered.

Back in Dawson before noon, we browsed the well-stocked farmers' market and found that the long day enables the growth of some spectacular vegetables. Then we watched the start and much of the annual Outhouse Race. Seven teams of four runners ran the streets, each with a fifth team member seated in an 'outhouse' on wheels. A women's team of can-can dancers normally take first place but this time an all male Parks Canada team won.



We offloaded some 'layers', applied sunscreen and walked the length of Dawson twice before dinner. We secured tickets for a unique fishing boat trip on the morrow, before visiting homes that celebrate poet Robert Service and authors, Jack London and Pierre Berton. We found shade at the former just as



an excellent reading began. The 'Jack London' cabin is twinned with one in the US, and part of both came from the site where the miners we had met were active – so we felt connected!

In the cool of our second morning we hiked to Crocus Bluff which overlooks the confluence of the clear Klondike and silt-laden Yukon. The Han First Nation people (Tr'ondëk Hwëch'in) sadly relocated from the triangle between the rivers to Moosehide after the sudden arrival of the 30,000 hopeful gold-seekers.



**Crocus Bluff view of clear Klondike joining silty Yukon**

After lunch in Dawson we were picked up by a Han guide in his fishing boat. We went down the Yukon River past Moosehide to see his salmon catching "fish wheel", a fishing camp and a magnificent home he moved from Dawson.



**Han fish wheel based on a Chinese design**

We also saw the remains of Fort Reliance, a trading post abandoned in 1876 when gold was found and fur trading with the Han was eclipsed. After dinner, we enjoyed the splendid panoramic view from Midnight Dome on a shuttle bus tour.



Our last day in Dawson was dampened only slightly by a shower as we still had the Museum (a small gold ingot was cast before our eyes) and the paddle steamer S.S Keno to shelter in.

A pre-booked shuttle bus took us from our B&B to the airport. A full Hawker lifted from the gravel runway and we were back in Whitehorse. Next day we were picked up by a car dealer who was renting us a Subaru Forester. We drove first to the Yukon Transportation Museum where amongst trains, sleds, trucks and cars, hangs a reconstructed *Queen of the Yukon*, a Ryan M-2, a plane type modified by



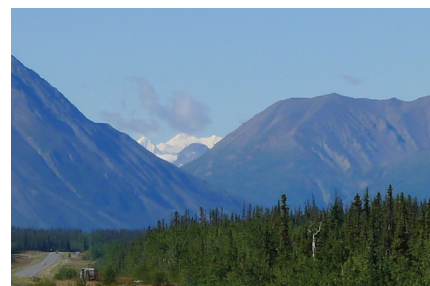
**Queen of the Yukon, sister plane to Lindbergh's Spirit of St. Louis**

Charles Lindbergh as the Ryan NYP, called *Spirit of St Louis* in which he flew solo across the Atlantic.

Then on to the splendid Beringia Interpretive Centre close by. Bones found in the permafrost by miners show that when Siberia was linked to the Yukon, humans and giant mammals roamed in along a glacier free corridor while camels roamed out.



Another day we drove to and hiked in the Wild Animal Reserve on the Takhini Hot Springs Road before enjoying the heat in the spring-fed pool nearby. Next day we much



**Distant Mount Kennedy and Hubbard from the highway to Kluane Park**



enjoyed the empty road and sunny drive to Haines Junction and views of Kluane Park. We took our lunch to Kathleen Lake and hiked a little.

On August 14th, after seeing the huge S.S. *Klondike* (filmed for Street View by Google just before), we returned the Forester. The dealer delivered us to the airport in good time to get back to Vancouver.

Today, placer gold mining operations in the Yukon continue even with costs that include restoring topsoil. The tourist industry is growing enormously.

Tourism, industry and indigenous people are all challenged north of Whitehorse by the increasing rarity of planes certified for gravel runways. The majority of Greenland's airfields have paved runways. Canada and Greenland-governing Denmark have similar GDP's. Will Canada follow Denmark's example with paved runways? Studies are underway at least.

The Yukon is a great place to visit, especially from Vancouver. You don't have to stake a claim, but if you are over eighteen there is that possibility still! For background, the Yukon government's guideline on how to do so is an excellent read: [bit.ly/IE24-YukonStake](http://bit.ly/IE24-YukonStake)



**King's Throne from Kathleen Lake**





**Dredge No. 4**

Dredges were brought into the Yukon not long after gold was discovered in large quantities in the Klondike, the first dredge being built in the autumn 1899.

One of the two dozen dredges that worked this area, Dredge No. 4 rests on Claim No. 17 Below Discovery on Bonanza Creek and near the spot where it ceased operations in 1960. The largest wooden hull, bucket-line dredge in North America, it was designed by the Marion Steam Shovel Company.

It was built in 1912 for the Canadian Klondike Mining Company on Claim 112 Below Discovery on Bonanza Creek. It commenced operations in May of 1913, and dug its way upstream in the Klondike Valley into what was known as the 'Boyle Concession', sinking there in 1924. In 1927, it was refloated and continued to operate from the Klondike Valley to Hunker Creek. The ground at the mouth of Hunker Creek was so rich that the dredge produced as much as 800 ounces of gold in a single day on Claim 67 Below. It operated until 1940. The

dredge was rebuilt on Bonanza Creek by the Yukon Consolidated Gold Corporation and from 1941 to 1959 worked the Bonanza Creek valley.

Dredge No. 4 is 2/3 the size of a football pitch and 8 storeys high. It has a displacement weight of over 3,000 tons, with a 0.45 cubic metre bucket capacity. The dredge could dig 17 metres below water level using hydraulic monitors and washing the gravel banks down.

The dredge was electrically powered from the Company's hydro plant on the Klondike River about 48 kilometres away, requiring 920 continuous horsepower during the digging operation. Extra horsepower was needed occasionally for such things as hoisting the 'spud' (pivot) and the gangplank.

The dredge moved along on a pond of its own making, digging gold bearing gravel in front, recovering the gold through the revolving screen washing plant, then depositing the gravel out of the stacker at the rear. A dredge pond could be 90 metres by as much as 150 metres wide, depending on the width of the valley in which

the dredge was working. The operating season was on average about 200 days, starting in late April or early May and operating 24 hours a day until late November.

The dredges were a very efficient means of mining for gold. The very fine flour gold however was very hard to save, as were nuggets too large to go through the 2 centimetre holes in the revolving screen, or those caught in the nugget catcher. These went up the stacker and out to the tailing piles.

During the summers of 1991 and 92 the dredge was excavated, refloated and relocated to its current position on higher ground to protect it from seasonal flooding. Over the last two years, Parks Canada has made a significant investment in the restoration and stabilization of the Dredge. This significant historic resource and local tourism attraction is at the mid-point of a multi-year restoration project.

[bit.ly/IE24-Dredge4](http://bit.ly/IE24-Dredge4)

Nigel and Joan were rescued from Dawson City airport by Tammy and Hayden Cowan whose placer mining operation, HC Mining Ltd., has been operating on Moosehorn Creek, a tributary of Henderson Creek, in the Dawson mining district since 2004.

HC Mining were awarded an Honourable Mention in the 2008 Leckie Awards for Outstanding Placer Mining Reclamation Practices. They were commended for their efforts in accelerating the re-establishment of their property for use by wildlife and the public. The commendation notes that the restoration measures used by HC Mining go beyond best practices in mining reclamation. The very steep overburden piles, which blocked passage across the valley, have been reduced to gentle slopes. The creek has been armoured along its length and a settling pond is in place for catchment of any sediment while slopes stabilize. Top soil

has been spread to enable entrapment of water and airborne seed, which will encourage rapid re-vegetation.



**HC Mining owner Hayden Cowan (left) receiving his 2008 Leckie Award**

The award is presented annually at the Yukon Geoscience Forum for excellence in environmental stewardship, outstanding social responsibility, and leadership and innovation in overall process.

[bit.ly/IE24-Leckie](http://bit.ly/IE24-Leckie)



**A view upstream of H.C. Mining's operation on Henderson Creek in 2014**



# Virtual Reality: Without the Hype

A lot has been written about Virtual Reality (VR) over the last year or so, and much of it has been so full of hype that it is hard to work out what is really going on, how important it is right now to businesses, and how important it will be in the years to come. David Burden (EE 1979-82), managing director of Daden Limited in Birmingham, produced a very helpful white paper to give organisations a better idea of what VR can, and can't, do for them now and for the rest of 2016, and some idea of what might be achievable over the next few years. This article is based on David's white paper.

## What is Virtual Reality?

Let's start with the basics. VR involves users putting on a 'head mounted display' (HMD). Inside the display are usually two screens, so each eye gets a slightly different view of the image they are looking at – resulting in a 3D stereoscopic effect. As they move their head the head-tracking in the display adjusts the viewpoint accordingly. There will then usually be controls to move around the scene, and to interact with it. All this can give the user a real sense of 'being there', and a world so real that people literally try to reach out to touch it. The key point is that most users put on a VR headset and just go "WOW!" But what happens after the wow – or is the wow all you need?

## Smartphone vs Integrated Headsets



**Google Cardboard**

Two broad approaches to HMDs are emerging. The **Smartphone** approach, e.g. Google Cardboard (£10-£20) but also Samsung Gear VR (£90), is to use a smartphone as the display, processor and movement detector. You slip an ordinary phone into a holder (which often just has a set of lenses and nothing else), and voilà you have a VR headset. The Google Cardboard is made out of cardboard (except the lenses), and so may not last long in normal use. There are plastic versions though, while the Samsung Gear VR is an altogether more solid device.



**Samsung Gear**

The **Integrated** approach, e.g. Oculus Rift (£529), HTC Vive (£745), Sony Morpheus (£360?) is to create a headset with all the displays and functionality built into it,



**Oculus Rift**

but using an ordinary computer or games console to generate the graphics. In both cases audio can be added to enhance the sense of immersion.

There are pros and cons with each, but the key point is that right now (early 2016) the only ones you can go onto Amazon or into the High Street and buy easily (and cheaply) are Google Cardboard or Samsung Gear.

An important point to remember is that what you experience in terms of content in both approaches can be identical. Each approach, and each headset, may have its strengths and even unique features, but in general they are just different ways of accessing a VR experience.

## Photospheres, 3D Video and 3D Models

The second absolutely essential distinction to make is between the different types of experience you can have in VR. They fall broadly into two camps:

- those sourced from 2D content, and
- those sourced from 3D content.

A LOT of the current VR hype is actually around 2D content – typically a 2D image (still or video) stretched into a bubble with the viewer in the centre. In VR the 3D effect of such a photosphere can be very effective, and in many examples you can move between photospheres by clicking on hotspots – just like the 'virtual tours' on web sites over a decade ago. However you can only see what has been captured in the image, and interactivity is often very limited. By contrast VR experiences derived from true 3D models can allow you to go anywhere and interact with anything. Which approach is best for your purpose depends very much on what you are trying to achieve, and the size of your budget.

2D photospheres result in much smaller download sizes (depending on the resolution of course) and can be developed very quickly at low cost but don't provide much interactivity or user agency, and are best used for simple applications such as showing sights or the interiors of buildings. 3D models, on the other hand, are time-consuming and expensive to develop and result in huge files that can take a long time to download, but provide users with freedom to explore and interact and are much



**HTC Vive**

better for training, data visualisation, exteriors of buildings, and multi-user environments.

Note that there is some possibility to combine techniques, for instance by creating a 3D model and then generating photospheres of that model. This can be useful to show future buildings in hi-rez but with a small download size.

## Single or Multi-User

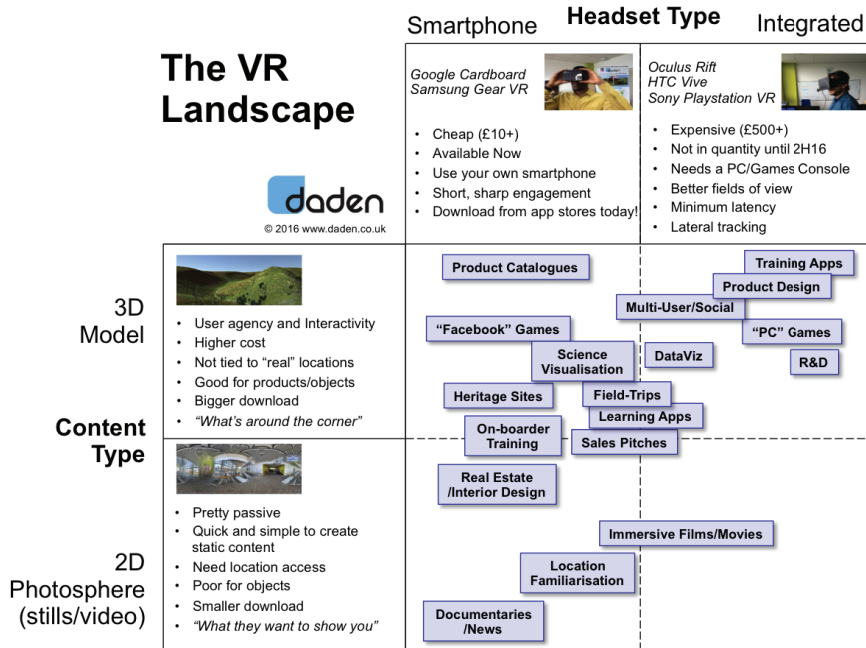
Most VR experiences are single user – there's just you inside the world. However a lot of people, ourselves included, are excited by the idea of multi-user VR apps – so called social VR. Here each user is represented as an avatar – just as in a multi-user game or virtual world, and can see and communicate with other users. This enables the experience to be not just immersive but collaborative and social too. As well as bespoke multi-user systems (which is what many of our projects are) there are a number of social VR systems under development from various developers.

## The Bad Stuff

Unfortunately it's not all plain sailing with VR, and there are a number of challenges which we just don't find with 2D screen-based applications (even when being used to view a 3D world). Some of the most important, and which any project needs to consider, are:

- **Latency** – Latency is the delay between you doing something in the physical world (e.g. pressing a button, or moving your head), and the image on the screen changing in response. If the latency is high (> 20ms) then not only do you lose some immersion but you can also start to feel nauseous – the motion sickness that many people get from using VR. How much the latency and nausea affects people varies from person to person, and also depends on the application design, but it's a good reason to keep VR experiences short if working with the public. Note that, for some users, the effect is more acute when they leave VR and return to the physical world – in the same way that a seafarer can take their time to find their land-legs. Whilst there appear to be big differences in latency between smartphone and integrated headsets, there is a danger of

## The VR Landscape



getting very audiophile about all this – so try it and see if you are happy with it, and use that as a guide.

- Safety – When you are wearing a VR headset you can't see the outside world – so if you are standing, there is a real danger of tripping over or bumping into cables, furniture and other people. So either make sure you have a clear space, and/or someone 'spotting' for the person wearing the headset – or sit them down. There is a big debate about 'standing' vs 'sitting' use of VR, and how that then affects perceptions of movement in VR. Interestingly the HTC Vive headset has a forward facing camera which 'bleeds' the physical world into your VR view if you get close to a wall or other obstruction.
- Text – We are so used to reading text on a PC screen that it comes as a surprise to find that reading text in VR can be really hard. It can be difficult to position yourself to read text on an in-world piece of paper or PC screen, and having it go 'full-screen' but then move as you look around is also disconcerting. This can make things challenging when it comes to creating training and learning materials in VR, so you are best focussed on learning by doing (or hearing), than learning by reading.

### Can You Use VR Now?

VR is most certainly something that you can make use of now. But you do need to know what you want to achieve, what the best way of achieving it is, and what budget and timescale you have available.

Quite honestly, until probably 3Q16, possibly well into 2017, a smartphone approach is almost the only way forward. Devices such as Oculus Rift DK2 are in very short supply, and even the consumer version will also be hard to come by once it launches in March (new orders won't be delivered until July). Set that against your smartphone and £10 on Amazon for a Cardboard and it's not a hard decision to reach – but see later for why you might consider the Integrated approach.

### What Can I Do with Google Cardboard?

Google Cardboard (and any of its clones) is ideally suited to very quick VR experiences – probably 2 minutes at most. Although you can get straps it works best when you just lift it to your eyes and look. The only control is a single button, so interaction can be limited, but it's more than enough to get someone into a VR environment, look around, go "Wow", explore a bit, learn something and come out. Anything more than that and you start to need a head-strap, probably a separate controller, and you need to make sure you're in a safe environment (and preferably sitting down). The sidebar to the right identifies some suitable applications for a smartphone approach.

### If I Insist on Oculus Rift?

If you really love the tech and must have something that uses an integrated headset such as the Oculus Rift, then there are three prime use cases that work:

- Something that you can use internally, or at a trade show / customer experience point, with your own (small) supply of headsets (maybe only 1) – giving them a slightly longer and fuller experience than they'd get from a Google Cardboard, maybe up to 10–20 minutes.
- As part of a research project where quantity is less likely to be an issue. Either an academic or in-house / commercial project, focussed either on psychological effects or product / service development or just increasing organisational awareness of VR.
- Something that appeals to early adopters and influencers who will already be buying their own headsets, helping to show that your company / organisation is embracing new technology, but not really as an immediate sales or lead generator.

Otherwise we'd recommend waiting until later in 2016 to see what the availability, uptake and cost of integrated headsets is like.

### The VR Options Landscape

The diagram above summarises the two key decisions in any VR project just now –

## VR Opportunities with a Smartphone approach

### Real Estate & Heritage Internals

Photosphere: Good fit, very quick, as long as you have access to the location.

3D Model: Quite expensive in time and money, and large download. Can reduce download by making photosphere from model.

### Real Estate & Heritage Externals

Photosphere: Not quite so good, as people like to look 'around' and 'over' a building. Could do so with drone/3D video but significant increase in cost.

3D Model: Better fit, particularly if architect's 3D models available.

### Product catalogues/Object viewers

Photosphere: Poor fit, as photospheres typically look outwards.

3D Model: Good fit, as user can look all around an object, and interact with it.

### Virtual Field Trips

Photosphere: OK, but user limited to places from which the photos were taken.

3D Model: Good fit, as user can walk (or fly) anywhere within the area.

### Knowledge Education

Photosphere: Poor, as hard to put in text, animations or interactivity.

3D Model: Better, but still problems with text, so use graphic animations and audio for explanations.

### Skills Training

Photosphere: Poor again.

3D Model: Good fit, as focus is on doing, but may need some form of hand controller.

### Location Familiarisation (e.g. onboarding, health & care)

Photosphere: Good, as can create photosphere walkthrough with audio narration.

3D Model: Good, but probably more expensive.

### Games (inc 'serious games')

Photosphere: Poor, can only really do treasure hunt type games.

3D Model: Good fit, full scope of interactivity, including non-player characters/bots.

### Data visualisation

Photosphere: Poor – just 3D 'infographics'.

3D Model: Good fit, full ability to use as a visual analytics tool.

### Passive 'Film' Entertainment

Photosphere: OK, and being seen as the next thing after '3D glasses' – but may be about as successful in the near term.

3D Model: Poor – having created the space you may as well make it more of a game.

### Documentary/News Reporting

Photosphere: OK, and getting a lot of hype, but small current audience and needs a relatively high level of user commitment.

3D Model: Not really feasible unless turned into more of a game/educational experience.



photosphere or 3D models, smartphone or integrated headset.

There are of course blurred edges between the categories, for instance:

- Stereoscopic images / video give a better 3D effect, but still offer minimal agency;
- 3D objects can be displayed or animated against a 2D photosphere background;
- A 2D photosphere can be made of a hi-res 3D rendering in order to reduce file size, but with constrained movement.

In the future there may also be a case for the splitting out of the integrated category into 'tethered' – as are all the current consumer systems (both by cable and computer) – and 'untethered'; or even wired / wireless and independent from any local computer.

### The Benefits

The benefits of using VR very much depend on the use case. The key benefits for now are likely to be:

- Brand Identity / Awareness – A lot of initial use of VR is going to be about brand identity – showing that you 'get' new technology and can see how it can be applied within your sector.
- Direct Sales – For some sectors (e.g. real estate, architecture, manufacturing) there can be a very real and direct link between showing your customers your products in full 3D and getting increased sales, in some cases there and then.
- Communicating Messages – For other sectors the power of immersion can help to get a message across (e.g. education, health, safety), and make that message far more memorable.
- Organisational Learning – Increasing your own organisation's knowledge about the potential (and challenges) of VR in order to better prepare you for future developments.

And given that the investment can be comparable to video or more conventional 3D animation then there can be a clear argument for return on investment.

### Costs and Practicalities

What does a VR project cost? All projects will have three key elements – the headset, the content and the application.

- Headset – In most cases the cost of headset may well be borne by the user, but we've seen some companies (e.g. New York Times) giving away branded Cardboard headsets (less the phone of course) – a reasonable move as they cost only about £7 in quantity and can be an ideal stand give-away. If you're buying your own integrated headsets then reckon on at least £500 each, plus the high spec PC to run them on.
- Content – The big factor here is 2D

photosphere or 3D model. 2D photospheres using static images can be made using an ordinary camera or a dedicated 3D camera, and cost little more than an ordinary photoshoot. So maybe just a few thousand pounds. Moving to video can put the price way up, with dedicated camera units costing up to £40k or more, although they are available for hire. With 3D models the cost will be more than the photosphere, but they will allow more agency for the user, more interactivity, and give you greater flexibility to change the experience. Reckon on anywhere between a couple of thousand pounds for a few manufacturing-type 3D models to £10k or more for extensive building models.

- Application – This is all about how the user chooses and interacts with the models, changes their viewpoint, moves around, interacts with objects and supporting information. It is possible to build in analytics so you can track what people do, what they look at and so on. Costs can be anywhere from £2k–£5k for a very simple app, to £40k or more for something very complex.

So in total you can be looking at anything from just £5k–£10k for a simple photosphere (or very simple 3D model)-based VR app, to around £20k for something with a bit more content and interactivity with proper 3D models, to £50k–£100k for a very sophisticated and extensive VR experience.

### The Coming Years

So if that is the outlook for most of 2016, what's it looking like into 2017 and onwards? Realistically, we still think that Smartphone approaches will dominate into 2017. However, for corporates that are interested in using VR for training, education and operational uses, then that is an area where integrated headsets may begin to get a foothold. But for most consumers (except hardcore gamers) integrated devices will be just too expensive, whereas a simple smartphone headset will allow them to leverage their existing smartphone investment, and only needs an outlay of £10 – and so is ideal to view more incidental content.

Going beyond 2017, we're really looking for one of two things. Either a good reduction in integrated headset costs (to £100–£200), with performance well surpassing smartphones, and compelling content or social VR environments to match, or the arrival of a game-changing piece of technology, possibly related to Augmented Reality/VR integration, or maybe something that begins to get close to the holobands of science fiction!

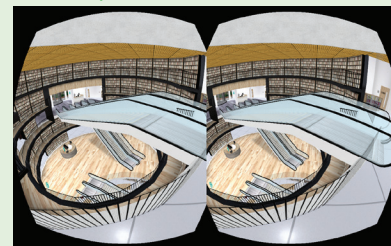
**bit.ly/IE24-VR**



David Burden studied Electrical Engineering at Imperial from 1979 to 1982. He was an active member of the Officer Training Corps and when he left Imperial went straight on to the Royal Military Academy Sandhurst, spending 10 years as an officer in the Royal Corps of Signals. David left the Army in 1992, and after 10 years working for Severn Trent Systems, set up Daden in 2004 as a 3D immersive environment and visualisation solution provider.

## Some real-life VR projects developed by Daden

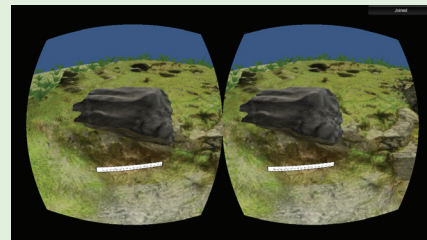
### VR Library



One of our first projects on the Oculus Rift was the Virtual Library of Birmingham. Back in 2011 we'd created the new Library (which didn't open physically until 2013) in full multi-user 3D on a virtual world platform. Once the Rift DK1 was released we could use it to go into the same virtual world and explore the Library in fully immersive 3D.

The experience was already quite overwhelming, particularly in the central core of the structure where escalators seem to criss-cross up to the sky, but seeing it in VR was quite awesome. Mind you, people did get vertigo when they started leaping from the top of the virtual Alpha Tower on the other side of Centenary Square!

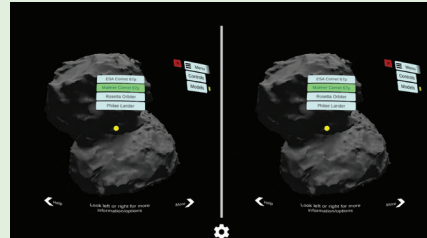
### Virtual Skiddaw



We developed Virtual Skiddaw as a geology virtual field trip for the Open University. Originally designed for use with 2D screens it was a relatively painless exercise to create an Oculus Rift-compatible version.

In one section, the user can lift up a rock – which then just hangs there in space, as a huge boulder, in front of the user – who almost always then starts to peer around, under and over it – to the bemused looks of everyone watching!

### Rosetta VR



Our first Google Cardboard project was a visualisation of Comet 67P and the Rosetta orbiter and Philae lander.

Within the application, the user can select which object they want to view, and then control the rotation and zoom of the object so that they can look all around it. Placed in a ring around the user are a further set of information screens, telling them more about the comet and Daden, with links to relevant websites.

You can download a copy of Rosetta VR for Android phones from the Google Play Store.

# CivSoc 2015 Tour: Romania

A report of the visit to Romania by Fiona Walport, International Tour Officer CivSoc Committee

## Day 1

On the 29th of March at 4.00 am, 70 Civil Engineers across four years from the Department of Civil and Environmental Engineering took off to Bucharest, the capital of Romania, for the annual CivSoc International Tour. The students had been looking forward to the event all year and the excitement amongst those going was felt throughout the journey from the Imperial College Union to Bucharest - even with the incredibly early start!

Upon arriving in Bucharest at about 2pm, CivSoc made their way to the X Hostel in the centre of the city via an arranged coach journey. The accommodation was a great, cosy, and fun hostel with very affordable prices and group discounts. The rooms were of varying sizes with almost every room including people from multiple years and acting as a fantastic opportunity to intermix and socialise within the years. The hostel had lots of break out spaces and a spacious common room providing the students with an excellent opportunity to socialise in the mornings and evenings after the eventful days. It also included an escape room which proved very popular, with one group breaking the record. The evening was spent getting accustomed to the area and the Romanian culture, and Professor Tudor Bugnariu kindly came to the hostel to give myself and Dominik a quick overview of the plans for the university and site visits. The hostel was well located with everything that the students could want within walking distance.

## Day 2

After another early morning start and an improvised breakfast provided by CivSoc, the group headed off in coaches across the city to the Technical University of Civil Engineering, Bucharest. We were greeted by Professor Tudor Bugnariu and six other members of the Civil Engineering Faculty. The content of the morning's first presentation was focused around the Metro Project that we were going to see the next day. The first lecturer was a consultant on the site itself, and was able to give us a detailed summary of the history of metro lines in Bucharest, as well the layout of the current project. Subsequently, Professor Tudor Bugnariu focussed on Bucharest One, namely on the complex geotechnical engineering required on the site. The main difficulty of this project lies in that the two buildings forming Bucharest One are constructed above two Metro line tunnels. Careful consideration must therefore be taken in designing the pile group beneath the building, as well as predicting the settlement of the soil that can occur on the tunnels.



Similarly to the London Underground Ltd requirements, the tunnels have a very low allowable movement. The Professor showed us the detailed steps of finite element analysis they undertook in order to analyse/measure the stresses acting on the tunnels along with the relative displacements. It was extremely interesting, giving the first and second years a great appreciation of the importance of finite element modelling on real construction sites, and providing a practical example to the third and fourth years who were more familiar with the use of this type of analysis. Finally, the third presentation, also geotechnics focused, gave us more insight into how the site investigations were carried out. This was also an opportunity for the lecturers to tell us about the seismic activity in Bucharest, which directly related to the University walking tour that followed the presentations.

We were shown around the university campus and then taken outside to their "seismic testing ground", where the university had set up a seismograph to measure the seismic activity in the city. We were told that there had in fact been an earthquake felt in the city three days before our visit. The University has an educational exchange partnership with a Japanese university that contributes to developing Romanian seismic design. This includes building small scale framed/braced/carbon-reinforced structures to understand the structural capacity offered by these different designs.

Finally, to finish off this very interesting tour, we were led to the main structures laboratory of the campus, where the lecturers were proud to show us the main feature, a very impressive load cell imported directly from Japan. This was the main tool to analyse the strength of various structural members, made predominantly of concrete.

Following the morning's university visit and free lunch period, the group then met up again to participate in the walking tour of Bucharest. For logistical reasons, we were once again split into two groups, but both guides were incredibly cultured and offered us a very interesting tour around the major Bucharest landmarks, whilst filling us in on

Romanian history. This provided great insight into a city and country that we did not know much about. Romania had always been a buffer zone between various empires until the 19th century when it gained its independence. The 20th century proved very difficult for the country however, between World War II and their years as part of the Soviet/Eastern block throughout the Cold War. The communist regime of Ceaușescu in the late 20th century pushed the country into poverty. Since the fall of the Soviet Union and the Communist Party in 1991, Romania has been trying to rebuild its economy and reaffirm its identity as a country with a long history and important heritage.

The main conclusion of this fascinating walking tour was that Bucharest is a very surprising city of contrasts both culturally and architecturally, with a mix of newly built '16th century Parisian-style' buildings, closed down buildings in ruins and flamboyant landmarks from Ceaușescu's rule and the revolution, such as the Palace of Parliament and the controversial 'Potato on a stick'. This walking tour provided a great end to a busy and insightful day, which was brought to a close with further discovery of the Bucharest nightlife and more bonding between years.

## Day 3

Day 3 started off with the group split in two. Whilst one of the groups headed west in the city to a large metro project site, the other half headed to the north of the city to the site of Bucharest One. The first site gave





the students the opportunity to see first-hand what a tunnel boring machine (TBM) looks like, and to appreciate its full size.

The tour started with a trip down two levels in the station to see the TBM and the tunnel. The tunnel had just been completed and they were at the stage of shotcreting the walls of the tunnels to prevent flooding within the station. The site was a great chance for the students to see how complex the engineering can become when working in a location with a high groundwater table. It was a topical site visit considering the amount of tunnelling that is currently going on in London with Crossrail.

The Bucharest One site contrasted with the metro project and allowed the students to see how buildings are constructed in near proximity and on top of tube lines. It was fascinating to see the site having had the talk on it at the Technical University the day before. On completion, the office building will be the second tallest building in Romania. Students were first given a short presentation by the site manager and it was impressive to see that the work was, unusually, ahead of schedule! From the site office, the students were then led around the site, first going down into the basement levels and then up to the sixth floor from where there was a surprisingly good view of the surrounding area. Some particularly interesting features of the site were the methods that were incorporated to account for the location of the building over the metro lines. Large movement joints and uncoupling of the walls were observed and it was great for the students to see things that they have learnt at university put into practice.

After lunch, the whole group went to the Romanian Palace of Parliament for a group tour of the magnificent yet controversial building. Even with the knowledge that it is the second largest administrative building in the world, the group was overwhelmed by the sheer size of it and the space inside. It was a fascinating tour led by a very enthusiastic tour guide, and enabled the students to learn even more about the history of Bucharest and the communist leader, Nicolae Ceauşescu. The dictator ordered the construction of this building as a monument to his communist rule, but never saw it finished as it was completed in 1994, three years after his decapitation. This impressive and imposing building, which was valued at \$4 billion at the time of its construction, is extremely controversial, as the marble and lavish ornamentation does not reflect the situation of poverty into which the entire country had declined during the late 1980s. The sheer size of the Palace and the visiting restrictions meant that we were only able to visit 5% of the building, but the group was allowed to go out onto the balcony of the palace from where they enjoyed a fantastic view of the city.

### Day 4

For the final full day in Bucharest, the students were given a free and relaxing day with nothing planned and the participants were allowed to visit the different attractions as they

liked. One of the main activities of the day was visiting the North of Bucharest, which had a number of parks and green areas where the students could enjoy a picnic and make the most of the weather. This was also the location of the “Romanian Arc de Triomphe”, a smaller version of the famous Parisian landmark, depicting Bucharest once again as the “Little Paris”. The freedom and flexibility of the day was received with positive feedback as each individual was able to do what they liked and not be limited to what a group of 70 can do. The students were able to experience



the broad attractions that Bucharest had to offer according to their likes and dislikes. In the evening there was a group meal that had been planned in advance at the City Grill Restaurant.



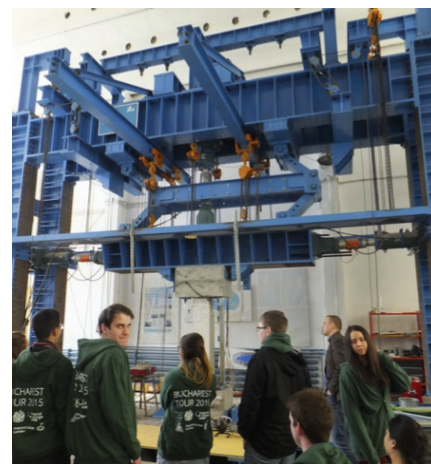
The restaurant was highly accommodating and the food and atmosphere was greatly enjoyed by all. It was a fantastic opportunity for the students to share the week's experiences and to sample the local cuisine one last time.

### Day 5

Sadly, the final day of the tour came about and the group made their way to Bucharest Airport via coach for the bittersweet moment of returning to London. The coach journey provided a safe and easy transportation



and gave the students a chance to reflect as we drove past the sites one last time. The CivSoc International Tour 2015 was a highly successful event and it achieved above and beyond the goals set out by the committee. There were no serious issues that occurred, everything went according to the plan and the budget that was set was followed. The tour provided the students with a perfect balance between an educational and relaxing week away. Not only did the Tour achieve its main goals for the event allowing students to experience Civil Engineering in a foreign country, but the students were also given the educational experience of history, culture and technical knowledge. The social aspect of the tour has enabled the students from all years to come together and form great friendships. The feedback received from the participants was incredibly positive and it has been seen since that there is more integration within the years and an excitement for other upcoming CivSoc events. The great success of this year's tour has certainly built excitement and enthusiasm for CivSoc International Tour 2016 and whatever it may hold.



Thank you...

CivSoc Tour 2015 would not have been able to happen and most certainly would not have been such a success without the generous support from our partners. At this point, I would like to thank BP, IC Union, the OC Trust (CGCA), CCC, Vinci Construction and the Civil Engineering Department of Imperial College London. Thank you so much on behalf of all the students and I hope we can continue this collaboration in the future!

# Nuclear Power – Looking to the future: preparing for the decommissioning legacy

CGCA President Roger Venables reports on the talk by his wife, Jean, at the Christmas Seminar

With all the talk of one or more new nuclear power stations being needed in the UK, it is very important to recognise that they are needed in major part because the existing fleet of stations will be coming to the end of their useful life over the next 20 years or so. That means an increasing level of activity in decommissioning, and that needs a significant sum of money to be available to fund that work.

Jean Venables' talk at the CGCA Christmas Lunchtime Seminar in December explained how nuclear decommissioning is funded in the UK, described the challenges of balancing politics, funding, technical issues, and a wide range of people's roles, concerns and skills, to secure appropriate solutions over the long-term.

But first, Jean indicated that – perhaps surprisingly – her previous work in flood risk management had provided a sound base for her new role in providing a significant set of transferable skills: strategic risk management, especially over the long term; long-term asset care; ensuring long-term funding; careful and efficient use of the funding one has available; extensive charring experience and expertise; the influence of politics; and the challenge of dealing with the multiplicity of organisations involved. Alongside these non-nuclear skills and experience, the nuclear decommissioning learning curve has been – and continues to be – fascinating.

The Nuclear Liabilities Fund (NLF) was set up in 1996 under a Scottish Trust to fund the decommissioning of the EDF Energy fleet of seven advanced gas cooled reactor stations (AGRs) and one pressurised water reactor station (PWR) – see Sidebar for further details. The fund, recently valued at almost £9 billion, is not only there to pay for decommissioning when needed. Clearly, a principal role of the Fund's Directors is to use the available funds to best advantage.

The NLF operates alongside a wide range of other organisations, the key ones being the Nuclear Decommissioning Authority, EDF Energy, the Department for Business, Innovation & Skills and the Department of

Energy & Climate Change, the Shareholder Executive, and the National Nuclear Laboratory.

EDFE is the operator of the 8 Power Stations, and is responsible for bringing forward proposals of qualifying work needed for the responsible management of their nuclear wastes, as well as decommissioning activities when they arise. The NDA approves those proposals, and the associated payments for decommissioning for NLF to pay.

NLF work closely with the Government's Shareholder Executive (ShEx) who monitor NLF's activities on behalf of the Government. ShEx was moved from BIS to HM Treasury in Summer 2015 after the May election. The responsible minister is now Secretary of State, Amber Rudd.

The Fund now has approximately £7.5bn invested in the UK's National Loans Fund, with a further £1.3bn directly invested in a range of assets. Whilst a regular activity of the Fund's Directors/Trustees and its advisers is to review the size of the fund against the forecast liabilities, the arrangements underpinning the Fund provide a Government guarantee if the funds are insufficient.

The forecasting of the pattern of expenditure can be readily seen to have many uncertainties but, through the regular reviews, updated from a range of sources and factors, it is possible to keep a running estimate of any shortfall or surplus against expected liabilities.

However, one major influence on these forecasts arises when there are extensions of life of one or more station in the fleet. Sizewell B has recently been given a 20-year extension of life, with an average of 5 years across the rest. On the one hand these extensions give an opportunity to grow the Fund more than would have been the case if the original lives had not been extended, but there is no additional contribution to the Fund from

EDFE during these extensions of life, so there will be a challenge to match anticipated inflation in decommissioning costs over these extended periods.

One example of the costs that are eligible for NLF funding is the design, construction and commissioning of the Sizewell Dry Fuel Store (formally inaugurated on 31 March this year). This is a 115m x 60m x 20m high storage facility to house spent fuel that has until now been kept in storage ponds – as the 'wet' store nears capacity, the new facility will allow spent fuel to be placed in the storage casks in the dry.

A Geological Disposal Facility would complement such stores, and it is very regrettable that, as a country, we have not yet made a decision about when and where, nor on the geometry of the facility. This is particularly important bearing in mind the long-term nature of decision making, design and fabrication and storage facilities. The fact that such a facility may now become a matter for our devolved governments also complicates matters, with the Scottish Government declaring a strong preference for low depth stores that are close to the power stations generating the waste, rather than a single deep facility for the whole of the UK.

So, overall, it can be seen that the existence of the NLF and its long-term view of its responsibilities are very positive aspects of the nuclear decommissioning arena. Yes, there are significant uncertainties – technical, timing and cost – but with suitable scrutiny of and challenge to the waste management and decommissioning plans, plus appropriate research and development, dealing with these long-term liabilities is not being left to chance.

The Nuclear Liabilities Fund (NLF) is based in Scotland, with a recent valuation of almost £9bn. It was set up for the purpose of providing funding to meet the decommissioning liabilities of the eight nuclear power stations of EDF Energy Nuclear Generation Group Limited (EDFE), formerly known as British Energy Group plc.

It is the EDFE nuclear power station fleet existing at March 1996 that is the responsibility of the fund, comprising seven advanced gas cooled reactor stations and one pressurised water reactor station.

The Fund is owned by The Nuclear Trust (the Trust), established by deed in March 1996 (amended with effect from 14 January 2005), between EDFE, the Secretary of State for the Department for Business, Innovation and Skills, and five trustees, of whom three are appointed by the Secretary of State and two by EDFE. The Trust is a public trust under Scottish Law and its trustees are also directors of the Fund, the ordinary share capital of which is owned by the trustees. More details at <http://nlf.uk.net/>

Our Speaker, Dr Jean Venables CBE FREng FICE, was appointed in mid-2014 by the UK's Department of Energy & Climate Change to be Chairman of the Nuclear Liabilities Fund, which was set up some years ago to provide the finance for the decommissioning of the EDF Energy fleet of nuclear power stations in the UK. An alumna of Imperial's Department of Civil and Environmental Engineering at undergraduate and masters level, Jean has had a distinguished career in flood risk management, which has provided – and has continued to provide – what to some may seem surprisingly helpful experience for her nuclear decommissioning role.

In addition to her NLF role, Jean is a Director of Venables Consultancy and a Non-Executive Director of HR Wallingford. She was President of the Institution of Civil Engineers for 2008-9.



Photograph courtesy of EDF Energy

**The Dry Fuel Store at Sizewell B on opening day, with groups of visitors having its various features explained**



# Volcanoes and disastrous storms

During February 2010 two successive disastrous East Atlantic winter storms, with torrential rain and high winds resulting in severe flooding and heavy death tolls, were exacerbated by the Soufrière Hills eruption in Montserrat, Caribbean on February 11th.

The best time for achieving a better understanding of climate change is surely the present, because we have both instrumental records and satellite records for verification. It is therefore somewhat surprising that relatively few Earth scientists are involved in 'modern' climate change research.

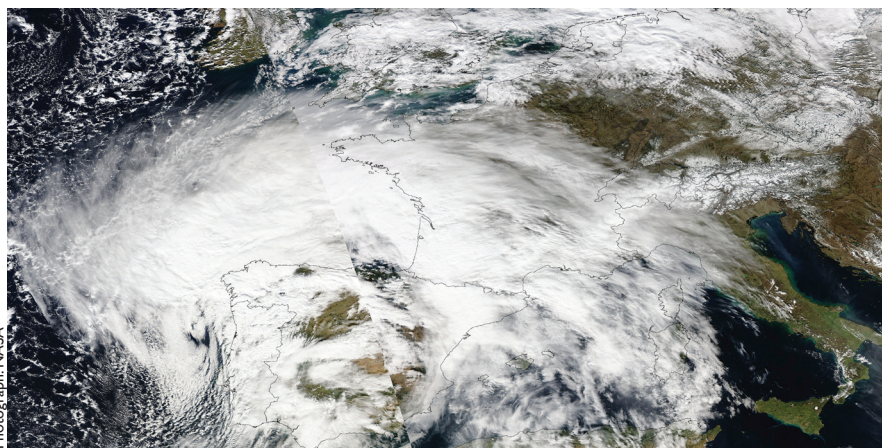
Recently a state-of-the-art computer model study published in the journal *Science* by M.A. Bender and colleagues predicted that the number of strong storms in the western Atlantic could double by the end of the century through anthropogenic warming. However, the natural variability of volcanic eruptions, which are difficult to predict, has not been taken into consideration.

In the present study, evidence is presented on a relatively minor volcanic eruption during early 2010 in the generation of frontal activity winter storms causing severe flooding and heavy death tolls in the East Atlantic based on the study of satellite records and media reports.

Sub-aerial volcanic eruptions release hot air, gases and tephra into both the troposphere and stratosphere, the latter provided that the cloud height is sufficiently high. The volcanic explosivity index (VEI) provides a relative measure of the explosiveness of volcanic eruptions. For determination, the volume of products ejected, eruption cloud height, and qualitative observations are used. The scale is open-ended with the largest volcanoes in history given magnitude 8 and a value of 0 is given for non-explosive eruptions. For example, the 1991 eruption of the Pinatubo volcano in the Philippines, the largest in the past fifty years has a VEI scale of 6.

On February 11, 2010 1635 UTC/GMT the Soufrière Hills volcano (latitude 16°43'N longitude 62°11'W) on Montserrat in the East Caribbean Sea erupted, sending an ash plume reaching 15.2 km above sea level. The VEI scale of the eruption was estimated to be 3.

On 12 February at 1200 UTC/GMT, Meteosat SEVIRI Channel 7(8.3-9.1µm infrared, available from [sat.dundee.ac.uk](http://sat.dundee.ac.uk)) shows the ash plume from the eruption was caught up within the warm sector of a frontal system spreading in a northeasterly direction



**Satellite image of Cyclone Xynthia acquired on February 27, 2010.**

towards Western Europe. This has provided insight into how volcanic eruption clouds become involved in generating East Atlantic winter storms.

Within the same month there were two successive disastrous East Atlantic winter storms accompanied by torrential rain and high winds. Both were associated with active cold fronts and low pressure areas in the southern part of the North Atlantic Ocean moving northeastwards. These storms were bolstered by an usually strong temperature contrast of the sea surface across the Atlantic Ocean. Abnormally warm waters were widespread off West Africa and extended into the eastern Caribbean Sea through the modification of surface wind circulation by the eruption plume. To the north of the warm surface water and air, relatively cold surface waters stretched between Western Europe and the northeastern United States.

On the morning of February 20 a severe storm from the southwest passed over the island of Madeira (maximum elevation 1862m, total land area 741km<sup>2</sup>). This frontal activity was exacerbated by the orographic effect of the mountainous island, as well as the volcanic ash and aerosols arising from the eruption about eight days earlier (which provided condensation nuclei). Between 0600 and 1100, torrential rain occurred on the

northwesterly slopes of Madeira, with 165mm recorded at Pico do Areeiro. This is almost double the average rainfall for the whole of February at the weather station of the city of Funchal. Damage was confined mainly to the south of the island with widespread floods (picture) and mudslides, resulting in at least 48 fatalities and severe damage to infrastructure at a total estimated cost of 1.4 billion Euros.

On February 26-28, yet another violent windstorm (named 'Cyclone Xynthia'), with maximum wind gust of 241 km per hour, minimum pressure of 967mb and torrential rainfall, crossed Western Europe (picture) causing at least 63 fatalities and an estimated damage within the range of 1.3-3 billion Euros. In France where damage was most severe, one million homes were left without power and cities like La Faute-sur-Mer, L'Aiguillon-sur-Mer and La Tranche-sur-Mer were flooded with water up to 1.5m deep.

In conclusion, the two disastrous East Atlantic storms were exacerbated by the Soufrière Hills eruption of VEI scale 3. Without the naturally-induced atmospheric warming contributed by the eruption the temperature contrast between the warm and cold air masses would have been significantly reduced. The storms are merely nature's way of removing such temperature imbalances driven initially by solar activity and ocean circulation.



**Flooding in the city of Funchal on February 20, 2010**



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



# Travels in Russia

Sergiu Iliev (final year student in Aero) kept a journal during his unforgettable journey to Russia, a trip that was made possible with a travel award from CGCA. This article is based on his report.

First of all, I would like to thank the City & Guilds College Association for making this expedition possible. These two weeks formed a truly unforgettable experience. This adventure on the territory of the Russian Federation allowed me to hone my engineering skills in a real international context and to make new friends from 10 different countries. However, without the generous financial support offered by the CGCA, for which I am forever grateful, none of this would have been possible. The following report will present my experience in chronological order, accompanied by pictures taken during the journey.



**Sunrise over Bucharest**

My first day in the 'Samara State University – Advanced technologies for nanosatellite's experiments in space' programme was preceded by a 20 hour-long trip from my home in Constanța, Romania. Although it was quite long, the journey was enjoyable, having flown with two planes designed and built in Russia and having seen both the sunrise and the sunset in two different countries on the same day.



**Sunset in Moscow**

Following the opening ceremony I met the fellow student with whom I would spend the next two weeks. Furthermore, I had a serendipitous moment when I met again with a friend I made in a similar programme, organised by the European Space Agency the previous year. Having collaborated during the past year to create a scientific paper, it was great to see him in person again. Reputable universities in the field of aerospace engineering and space studies were represented by students from more than 10 countries. Many of these

were to become my friends in the weeks to follow. Although Imperial College has a varied international body of students, I did not have the opportunity to meet people in my field of interest from Eastern European and former USSR countries.



**With my friend from ESA**

Marking the end of my first day was a visit to the Samara Space Museum, which has a full-size Soyuz Rocket, standing more than 40 metres tall.



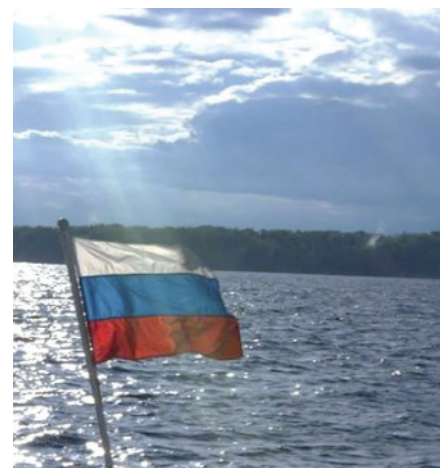
**Me and a Soyuz rocket**

This is the symbol of the city and represents the might of the Russian Federation in the space industry. It is also the specialisation of the city, the primary revenue coming from the construction of rockets and satellites.



**The group at the Samara Space Museum**

The following days included many other organised activities such as experience-exchange classes in the use of various engineering software suites (such as Pro Engineer and Atrium Designer), visits to a multitude of non-classified space research laboratories in the campus (there are a number of restricted ones as well, we only had special permission to visit one of these – a 'clean room' for the construction of nanosatellites), social events with students from Russia and their professors. All these events had as a primary focus the development of engineering skills for creating nano and microsatellites at university level. This, with the purpose of biomedical research and developing affordable ways to test novel space engineering ideas. Each evening, we went out from the university campus to explore the city and here there are many stories to tell, yet the most concise way would be to show a couple of pictures from each day.



**Russian flag on the Hydrofoil crossing the Volga**

Saturday: we took a hydrofoil boat and travelled on the river Volga to the natural reservation in Samara, which can only be accessed by boat due to its remote location. We saw the village museum, with items from the Middle Ages up to the late XX century, some of which belonged to the poet Pushkin.





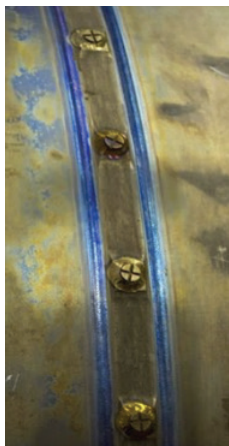
Sunday: we travelled to the city of Togliatti located 200km north of Samara, to visit the War History Museum. This is one of the biggest war museums in the world, including a diesel WWII submarine.

During our visit, a live-war simulation was carried out by the Russian army as a demonstration. We also received a very interesting tour of all the military equipment of the museum and a small lecture, on how all of them were used to assist the Allied force win the Second World War, from a war veteran through the help of a translator from the university. Russian people refer to WWII as 'The great patriotic war'.



Although the first week was amazing, the second one managed to be at least as good. The usual daily programme of the first week was augmented by video conferences with universities from Japan, China and the US during which we learned more about the global effort, at university level, to achieve significant progress in mankind's pursuit to conquer the last frontier.

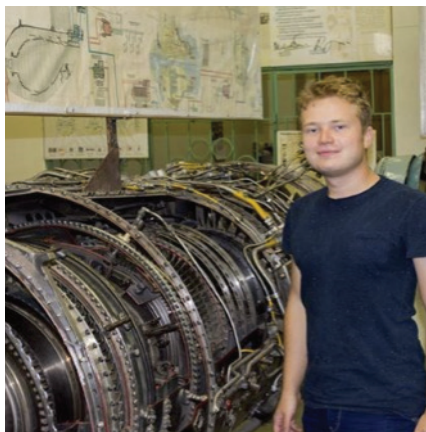
We had the chance to gain work experience with jet and rocket engines at the Samara University workshop/engine museum. I spent many hours learning as much as I could about these wonderful engineering marvels.



**Demonstration of vacuum titanium welding**



**With the workshop supervisor next to a rocket engine designed for the trip to the moon**



**Near the T50 Russian 5th generation stealth fighter**



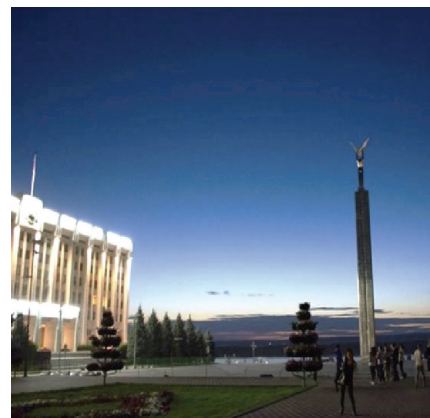
**The group**

We also visited a military landmark that was secret until recently: a bunker located in the centre of Samara City, 12 storeys deep. This was designed for Stalin to use in the eventuality of Moscow falling into Nazi hands. The entire country could be ruled from that location and it could resist a direct nuclear blast.



**The command centre, located 12 levels underground**

In retrospect, this experience has greatly enhanced the value of my formal studies for the first two academic years. I am truly grateful to CGCA for their assistance in my undertaking this expedition on the territory of the Russian Federation.



**The White House of Samara, and the tall monument dedicated to flight**

The history of City & Guilds spans more than a century and I hope I can contribute to its future so that others who might be in my situation can be helped.

Thank you very much for your support!



**Jumping in front of the 200m long Russian submarine**



## DIARY

**Saturday, 7 – 8 May 2016**

Imperial Alumni Weekend  
Alongside Imperial Festival

**Wednesday, 8 June 2016****CGCA****AGM**

Venue: Read Lecture Theatre,  
Sherfield Building  
17:00 for 17:30  
President's Evening  
Venue: Queens Tower Rooms,  
Sherfield Building  
19:00

**Thursday, 23 June 2016****RSMA****AGM /Final Year BBQ**

Venue: Garden Room & Terrace,  
58 Princes Gate  
18:30 / 19:00

**Friday, 25 November 2016****RSMA****132nd Annual Dinner**

Venue: The Rembrandt Hotel,  
11 Thurloe Place, Knightsbridge,  
London SW7 2RS  
19:00 for 20:00

**Saturday, 26 November 2016****CGCA**

2016 Decade Reunion Luncheon  
Venue: tbc

**London Walks**

Next walk details not yet finalised.  
Please see the website at:  
[bit.ly/LondonWalks](http://bit.ly/LondonWalks)

**For more information****or to book, contact****Teresa Sergot****[t.sergot@imperial.ac.uk](mailto:t.sergot@imperial.ac.uk)****or 020 7594 1184**

was the Designer's Project Manager in the Kap Shui Mun Bridge project, tackling the most difficult rail-road cable-stayed bridge ever to be built. For his work he was named British Consultant of the Year in 1997. He pioneered the design of the 1418m main span Tsing Lung Bridge, a third generation suspension bridge with structural supremacy and aerodynamic superiority. His design overcame severe constraints, and defied conventional suspension bridge theory for a viable solution.



**Robin Sham (Civ Eng 1985-89) receiving his medal from Maggie Philbin (R) and IET President Naomi Climer (Chem 1983-86) (L)**

Photograph: The Institution of Engineering and Technology

## Alumnus Charity Trek in aid of Wellchild

One charity that seems to get less coverage than most is WellChild, a national UK children's charity dedicated to helping and supporting chronically sick children.

WellChild, in which Prince Harry takes an active interest, was founded in 1977 and has already invested more than £20 million in ground-breaking health research projects, ensuring that the increasing number of seriously ill children and young people in the UK have the best possible quality of care. However, WellChild didn't even appear in The Guardian's 2012 top 1000 UK charities.

One major supporter of the charity, however, is RSM alumnus Grant Budge (Min Eng 1989-93), Director of a number of clean energy businesses under the banner of 'Millennium Group'. Grant Budge has been raising funds for WellChild since 2006, motivated by the loss of his and his wife's first child to a genetic disorder in 1999. So far he

has raised over £15,600 completing the London marathon twice and climbing Kilimanjaro, and has also done the Inca trail with his family, his children leading the fund raising that time, raising £1300.

For 2016 though, he set his sights higher, planning an eight day trek to cover the final degree of the earth's circumference, in sub-zero temperatures, pulling his sled over pressure ridges and around open water leads. This would be his biggest fund-raising challenge to date. He declared, "Some may say, including my wife, that this challenge may be a step too far, but you never know until you try and this cause is worth trying for."

In order to achieve his £15,000 sponsorship target, he has been leading a number of support initiatives including offering corporate sponsorship options, as well as auctioning off his much loved horror, fantasy and thriller movie poster collection on eBay.

However as the date of the planned trek came closer Grant suffered some setbacks. He says "Due to loss of expedition members below the minimum four threshold required to do the North Pole expedition (we got down to just me), I have had to switch challenges to the Everest Base Camp trek."

As we are writing this, Grant is heading to the Everest Base Camp. Any and all help that fellow Alumni can give Grant to raise his £15,000 target will be greatly appreciated by him and Wellchild. Children are our future and they, each and every one, deserve the best chance that life can offer them. Likewise, their carers and support teams need help to ensure that aim can be achieved. Wellchild does a fantastic job in supporting both these aspirations. Please help Grant raise awareness and support for the charity and this challenge. If you would like to donate, the easiest way is through his *JustGiving* page at the URL below:

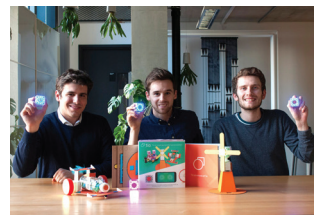
<https://www.justgiving.com/Grant-NorthPole2016>

### IET Achievement Medal

In November 2015, the Institution of Engineering and Technology (IET) presented its Achievement Awards to the 'stars of industry'. Among them was Dr Robin Sham (Civ Eng 1985-89) awarded for pioneering innovations in bridge engineering, having created the longest and most monumental of modern bridges worldwide. He has made profound contributions, including to motorway construction in the northwest of England, in the all-weather Second Severn Crossing between England and Wales, and in the Aberfeldy Bridge in Scotland, the world's first glass fibre reinforced composite cable-stayed bridge. He

### Imperial Alumni launch invention kit to inspire kids

A team of Imperial alumni have launched an invention kit that allows children (and adults!) to make remote controlled toys from everyday objects. Tio is a kit to create toys and inventions, transforming any combination of objects and materials – drink bottles, 3D prints, old toys, gadgets – into app-controlled machines with moving parts.



The Tio team is Peter Spence and Ashley Wiltshire, both Innovation Design Engineering (IDE) alumni, and Mario Morello. Their goal is to inspire tomorrow's inventors with a new way of inventing, playing and learning together.

The versatile Tio kit allows the user to animate objects using motorised building blocks with built-in LEDs, magnetic mounts and colourful wheels. It is supported by a free iOS and Android app which enables wireless communication with the creations to customise and program them. The app controls features like motor speed and direction as well as LED colours, rotation and patterns.

The idea for Tio originated in 2014 when co-founder Peter Spence was a student on the Imperial and



RCA IDE course. As part of his project work he decided to create a product to fuse craft and tech with the aim of inspiring a new generation of designers, engineers and inventors.

Peter said: "I've always loved making my own creations. As a kid I spent most of my time making with anything I could get my hands on, whether that be Lego, cereal boxes or old toys.

"This passion naturally evolved into the goal of transforming one of my ideas into a product to enable kids to imagine, create and reinvent with anything. I remember building a wooden racing car with my grandpa and the urge to get it moving and racing like a real car. This got me thinking... what if I was able to make anything move? What if there was a magical engine to do that?"

Tio won the National Association of College and University Entrepreneurs Varsity Pitch competition to find the greatest college and university entrepreneurs in Britain. It was judged by a panel of technology industry leaders who were positive about the impact Tio could have in enthusing young people about engineering and STEM.

You can find out more about Tio at:

<http://totoys.com>



# Imperial Alumni Weekend

The Alumni Weekend will be 7-8 May at the Imperial Festival. At last year's Alumni Weekend, Desmond Kearns (Mining 1965) and Norman Price (BSc Physics 1964) re-enacted their starring roles on the cover of a 1965 Imperial College Carnival record.

Produced to help raise funds for the Notting Hill Housing Trust, the back of the record proclaims: "You are now the proud possessor of a rare and valuable collector's item, the third Carnival Record (worth at least 9d. in the Portobello Road). This disc, which has been carefully coated with black plastic for lasting protection has been cut in the new exclusive Morrophonic Sound (with the extra added ingredient, BSc)."

Desmond, former President of the Royal School of Mines Union, and Norman, former President of the Imperial College Union, were joined in the original image by Dave 'Yogi' Bishop, President of City & Guilds Union at the time, and Kish Sadhvani, former President of the Royal College of Science Union.

Dave was sadly unable to attend



Photograph: Imperial College

the Alumni Weekend as he was holidaying in Italy, and the group were unable to get in touch with Kish, so Peter Chase, current Treasurer for the CGCA and Serena

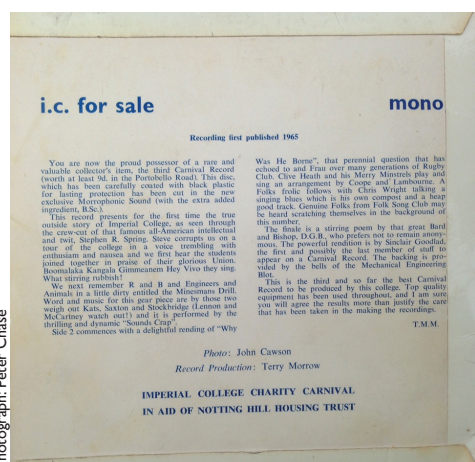
Yuen, current President of the RCSU were drafted in to represent their organisations. Desmond said: "Norm and I enjoyed being able to out-jump our 50-years-younger

successors, and only wish that Yogi Bishop and Kish Sadhvani could have participated as well. Of course, they may have feared that we would be too much competition for them!"



Photograph: Peter Chase

**The 'rare and valuable' 1965 Imperial College Carnival Record, recorded in Morrophonic Sound, with the then Union Presidents featured on the cover**



Photograph: Peter Chase



7-8  
MAY  
2016

## ALUMNI WEEKEND at the IMPERIAL FESTIVAL

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By registering for the Alumni Weekend, you will get to be part of the very best of the Festival.

- Access to the [Alumni Zone](#) for you and your guests
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**→ For more information and to book your place, visit:**

[www.imperial.ac.uk/alumni-weekend](http://www.imperial.ac.uk/alumni-weekend)      **T: (0)20 7594 7355**

# 46th Triode Reunion 8th January 2016

Again twelve Triodes (i.e. Electrical Engineering graduates of 1973) appeared at the George; as it was the latest date we meet (i.e. the Friday after 1st January) most of us were back at work! We eventually took over the Fleet Street end of the pub and after much conversation we moved on to have dinner at the Thai Square. As tradition dictates we stopped at the Triode Loo to convince some poor passers-by to photograph us! The result is attached. At Thai Square we were overcharged but great sleuthing by Philip resulted in Martyn negotiating £75.75 refund! By unanimous decision we decided it was impractical to divide by 12 (due to lack of suitable denomination notes and change) and we would invest it in next year's kitty – definitely an incentive to come then!

Those that came on the 8th January (there were 12 of us!):

*Addy Adesara*

First time for Addy; he was made very welcome and told us that he has been working in telecoms for most of his career. He seemed very happy and has a wife and two children who are grown up and successful in their own rights. We hope to see him again next year.

*Geoff Banks*

Great to see Geoff back after missing us for a few years. He is still happily married to Pat (42 years now!!) and their two girls are now 37 and 33! The elder, her husband and two sons (10 and 6) are in Guildford so they see them infrequently (3 or 4 times a year) as it's a 440 mile round trip. But their younger daughter and Geoff's youngest grandson (just 6) live just around the corner from them so they see them most days as they do the school run! Add to this the need to keep an eye on elderly parents (91 and 87) who are becoming increasingly infirm and we can appreciate that there isn't much time for Geoff and Pat to get bored!

*Steve Glenn*

Steve continues to work for DSTL, but is seriously thinking about retirement (so he says), he has lots of DIY to do on the house and of course there are the granddad duties. But recently he has been investigating Binary Robotic Trading, "Not made too much yet," he says, "you'll know when I do." Hopefully he'll buy the next round!

*Phil Harris*

Phil has been retired 12 months now and says he is really enjoying his relaxed lifestyle. He does some DIY, baking and housework and threatens to take up something more organised next year. His wife Lina is also retired and they have



**L to R: Steve Glenn, Hari Singh, Addy Adesara, Dave Mansfield, Richard Lewis, Peter Wright, Geoff Banks, Peter Marlow, Phil Harris, Nick Hiscock, Rut Patel and Martyn Hart.**

had several short holidays this year, which he says is the real advantage of the free time. They also enjoy watching their grandson develop – he's now 16 months old and a real character.

*Martyn Hart*

Martyn is still working three days a week in the public sector, mainly in the commercial area (large outsourcing/framework contracts). He has just moved to Ingatstone in Essex, where he is renovating a triangular house – it's certainly the only one of its kind, we call it Toblerhome, he says.

*Nick Hiscock*

Nick continues to enjoy retirement. His main hobby is antique weapons, specialising in British and Austrian cavalry from 1750 to WWI. Following a find during a WWI battlefield trip he has recently added unexploded WWI shells to his collection! His wife Sue is still vetting, daughter Jenny has a research fellowship at Kent University (and rides her horse at UK Battle Proms) and other daughter Pippa just got her maths PhD and now works at Roke Manor.

*Richard Lewis*

Richard moved in the autumn from the London Academy of Excellence to The John Fisher School in Purley, working part-time as before. His remit expanded from teaching purely A-level pure/applied maths to also include Key Stage 4 maths with a top-set Year 11 class and FPI further maths with a small Year 12 group. Unfortunately around half-term his Crohn's disease became very active and as a consequence he gave up teaching from December 2015. On the home front, the house bought a couple of years ago in the foothills of the Pyrenees (66720 Cassagnes) is now a second home. Richard only has to step out of the door to go on a variety of walks in the surrounding hills and

mountains plus there is a large lake very near on which he hopes to get permission for sailing one day.

*Dave Mansfield*

Sadly Dave's father died last January and since then he has spent many months sorting out probate and tax on the estate. He says that it's proved a bigger challenge than expected because of the lack of paperwork on his finances and the very poor state of his properties. Dave is only now getting over the worst, having parted with many thousands to Polish builders on renovation projects, but still has more to do – so real retirement seems a long way off! But not all is bad as he and his wife have enjoyed a couple of relaxing cruises between building projects.

*Peter Marlow*

Peter is actually retired now, since June 2015, but he says he is not watching daytime TV or playing golf (yet). He has started a new mentoring scheme for project managers in the developing world which he told us about when we met. It's a great idea and you should look at [www.pmapmentoring.org](http://www.pmapmentoring.org).

*Rut Patel*

Rut decided to retire following bowel cancer back in 2014. He has no regrets as he spent last year recuperating and playing with his grandson. Since then another grandson has arrived so he's even busier with granddad duties. He walks locally to places like Nonsuch Mansion and Epsom Racecourse and enjoys his membership of the RHS by visiting Wisley regularly. To keep his mind active he runs a number of properties and he is just about to go to India for a holiday, see his guru and do some lion spotting on safari. He says that he enjoyed the reunion thoroughly.

*Hari Singh*

We were concerned if he would make it because of his ankle (bad fracture last year) but he came! He's

still enjoying his holidays and family and, just to rub it in, his golf handicap has been down to 7 (now 8). Well done!

*Peter Wright*

Peter is still with the Scouts – he is District Secretary, Appointments Chair, and various other roles. A lot of his year was spend attending funerals (with most of the casualties, including several in Scouting, being younger than us) and with being a will executor (new career perhaps?). At home, Peter went through a marathon kitchen refit in which he acted as an apprentice to the installer in exchange for a few pence off the final bill. He did a walk with Peter Marlow on one of the Munros (Beinn Sgritheal?) near Skye and probably one of the wettest times he's ever been walking (a trend here perhaps?).

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

*Graham Castellano*

Graham says that he is seriously making an effort to retire for a second time. He has closed the electrical business now, through a 'Members Voluntary Liquidation' (meaning he could get his hands on most of the capital!), and he has just a handful of outstanding 'private' jobs to complete. "I will then be powerless to resist the necessary decorating, holidays etc." Luckily his wife still works 2 days a week, so there is some relief available!

*Peter Cheung*

After serving as Head of EEE for seven years, Peter has finally stepped down from that role (but not retired). He says that it is customary for someone having done a long period in a major administration role to take a sabbatical. So he is away from January until April 2016, meaning that regrettably he missed this year's gathering.

*Joan Clemow*

Joan continues to enjoy her retirement and finds that she is always busy. She has a wide variety of interests at home, plus she really enjoys travelling, but actually it turns out that most of her time is spent volunteering for the National Trust and the best time (of course) is spent with her grandchildren.

*Martin Clemow*

Martin is still running the start-up company that provides recorders which are specifically designed for use in Air Traffic Control. Being based in Somerset, and living near Wells, means it really wasn't practical for him to get to London after work on Friday but he is quite close to three of his four children so he gets to see his grandchildren regularly.



*Hugh Culverhouse*

Hugh is now a German pensioner and a French pensioner but has to wait another year to become a UK pensioner (almost an EU pensioner). He is still working a bit in Munich as a teacher of Business English, plus a little consultancy work for his former employer, but a large chunk of what is earned simply reduces the pension! He remains very active on the sports front and tried this year for the first (and last) time to combine running and cycling by attempting a marathon double in Melbourne; he finished both, but it wasn't without some pain!

*George Gabrielczyk*

George says that, looking back at what he wrote last year, at first sight it would seem that this year there has been lots of motion but that it has not been accompanied by much quantifiable progress. Modest George!; he had his first novel published at the end of November, although under a nom de plume. It is moderately voluminous, 900+ pages, set in the times of Constantine the Great and written in Polish – so a bit of a challenge for us. It is titled *Thy Kingdom Come* (*Przyjdź Królestwo Twoje* in Polish). Also the manor house rebuild is progressing, albeit incredibly slowly. It seems that he has been unable to take seriously any efforts to retire and is still non-exec chairman of two companies quoted on the Warsaw Stock Exchange. Plus he is building his special off-road Land Rovers (well, they were originally Land Rovers before he attacked them with angle grinders and a MIG welder), followed by not many hours spent racing and breaking them. Lots of quantifiable progress we think!

*Chris and Daphne Giles*

Chris has written again this year; he and Daphne are well. Although Chris retired in 2015 (for the 3rd time!) he is doing some work for a small company which builds aircraft refuelling vehicles. He says he is dealing with hydraulics and pneumatics as well as fuel, a long way from EE – but remember we all did the common first year so maybe it was helpful?

*Tony Godber*

Tony continues to work for Rio Tinto's iron ore rail operation in Western Australia, developing future strategies and projects. The large family home in Perth is getting emptier with only one child still at home (and she is actively looking to build a new house with her fiancé). But downsizing may prove difficult as they still need somewhere big enough to host family social events.

*John Harding*

John is still working as a managing consultant with CACI. He's been working with the two biggest mobile operators in the UK, helping them

roll out their operational support systems. His wife Anne has retired and is now a lady of leisure.

*Patrick Mason*

Patrick reports that he is still working on growing his internet foreign exchange company and is now contemplating moving to a more eco home as he wants to downsize. He is looking forward to a time when he can do some journeys of exploration rather than more usual two week get away from it all. It's called retirement Patrick!

*Sid Seth*

Unfortunately Sid had a problem with his heel (following heavy New Year dancing). He says that he is still busy working on some inventions (all secret) and he is learning how to trade stocks effectively.

*Alice Spain*

Alice has told us that the work on the Norfolk house continues and she is just putting in the first bathroom. It will be a significant milestone to have some water in the house! The insertion of steels into the structure isn't finished yet which has prevented her from starting on the kitchen. It doesn't sound much like great progress has been made this year however the garden is looking as though someone actually owns it, with the leaning wall rebuilt and a greenhouse in the vegetable area. They've also got some gates across the drive which has improved security.

And those that couldn't make it and we haven't heard from: (Can anyone help?)

- Jacquie Buzzard
- Tim Dye
- Ian Heap

*The next two Reunions*

The next Triode reunion (it will be our 47th as we had two meetings in year one, two in 2003, and two in 2013!) will be on Friday 6th January 2017 at The George, Fleet Street, from 7 pm-ish.

The following year's reunion (48th) will be on Friday 5th January 2018.

Have a great 2016  
Martyn, Arch Triode

## WE WANT YOUR NEWS

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

# An inspirational mentor

Emeritus Prof COLIN BOWDEN BESANT (Mech Eng 1962-64, FEng)

Prof Besant obtained his PhD from Imperial in 1966 for research in the field of Nuclear Reactor Engineering. He subsequently worked on pressurised water reactor design for nuclear submarines for Rolls Royce and Associates, then joined the UK Atomic Energy Authority as Senior Scientific Officer, working on the development of a Steam Generating Heavy Water Reactor. He returned to Imperial as a Lecturer in Mechanical Engineering in 1968, researching, amongst other things, fast breeder reactors.

He was one of the first engineers in Europe to become involved in Computer Aided Design and Manufacture. His CAD work pioneered the use of mini-computers in design applications and he built up a large research group working on engineering design and manufacturing systems. He was also deeply engaged in the work on industrial robots, CNC machine tools and flexible manufacturing in general. His group's research gave rise to the commercialisation of several spinout companies specialising in CAD and robotics.

In the early 1990s, Prof Besant

initiated new research into high-speed permanent magnet electric machines with applications in hybrid electric vehicles and distributed power generation. This technology was developed through a series of research projects and commercialised through a spinout company producing advanced electric machines and power electronics.

He was made a Fellow of the Royal Academy of Engineering in 1997 and Professor of Computer Aided Manufacture in 1998.

After becoming the Emeritus Professor, he worked to support new British engineering companies. Passionate about Imperial, he continued to support and encourage new research in various Departments. Throughout his career, he was an inspiration to numerous young engineers and researchers, and had the ability to help both those starting out in their careers and more established staff.

Born on 4 April, 1936, Prof Besant died in 2014, at the age of 78. His enduring optimism, wisdom, good humour and support is deeply missed by many in the Department and across the College.

With thanks to Claire Soual.

# An energetic life in renewables

ROBERT FREER (Civil Eng 1954-55)

Robert was born in Manchester on 3 February, 1932. In 1949, his family moved to Australia, although Robert returned to the UK in 1953.

Robert developed his interest in engineering, gaining a BSc in Engineering, from Melbourne University and, later, a Diploma in Hydroelectric Power from Imperial College. His career began in Scotland, at Sir William Halcrow & Partners, where he was based in the hydro-electric department. Robert received the Miller Prize from the Institution of Civil Engineers (ICE) for his technical paper on Scottish hydro power.

He next worked at the UK Atomic Energy Authority, before returning to London to work at Sir Alexander Gibb & Partners, where he carried out studies for hydroelectric power stations in Iran and East Africa. He also designed a 24 MW diesel power station for a Ballistic Missile Early Warning System radar installation. Robert joined Mouchel & Partners as resident engineer in 1963, and in 1966 moved again, to the British Aluminium Company, London, where he was responsible for technical advice on the operation of the hydroelectric power stations for the aluminium smelter works.

In the 1970s, Robert worked as Team Leader for an innovative design study for an array of offshore wind turbines connected to the

Grid.

In 1982, Robert returned to London to work at the Sand and Gravel Association as a technical adviser. From 1987-91, he managed a series of research projects at the Construction Industry Research and Information Association. This included a project on energy research, and a publication on the maintenance and inspection of concrete dams.

In 1992, Robert joined the ICE as Technical Adviser. He was a member of the ICE Energy Board, and Secretary of the Reservoirs Committee.

Robert attended energy conferences worldwide, presenting papers on hydroelectric power and the connection of renewable energy to grid systems. ICE awarded him the George Stephenson medal in 2002 for his paper on the Three Gorges (Yangtze River) Project.

From 2000, Robert sat on committees, boards, and panels at ICE. He also became a member of the Worshipful Company of Engineers in 2008.

Robert's hobbies outside of work were rowing, sailing and Scottish country dancing.

A life member of CGCA, Robert died aged 82, on 11 August 2014, leaving one son, Jeremy, his other son, Alex, having died in an accident in the Alps in 1997, when aged just 19.

## Three careers and two families

THEODORE WILLIAM LAKE PARKER (Mech Eng 1941-43)

Born 9 July 1921, Theodore Parker was a life member of CGCA and his own exciting life included three careers and two families.

Graduating from Imperial during WWII, Theo worked at Metropolitan Vickers in Manchester, until he felt he had a higher calling, and went to retrain to be a vicar. He married a parishioner and had a son with whom he unfortunately lost touch after a divorce. Fortunately, however, Theo had an Internet-savvy friend who put him back in touch with his son, Charles, some forty years later.

After his divorce, Theo felt he should not continue as a vicar, so he went to work for the Post Office. He became a sorting office manager in his native North-West and eventually married his second wife, Olga.

Theo was mentally sharp even as he became physically frail, studying Einstein's theory of relativity when he was 91 to stimulate his mind. He liked to visit the steam engine preservation site at Carnforth and could be relied on to send greeting cards with images and copious hand written details of steam locomotives.

Theo died in 2014, leaving a son, three stepdaughters, and a godson. He will be sadly missed.

## Entitled to a Young Person's railcard - at 40!

DEREK FLETCHER (MSc & DIC, Control Systems, EEE, 1987)

Derek was born in Leeds on 9 September, 1946. At 18, he joined the Royal Navy as an Artificer Apprentice, specialising in Weapon Control Systems. He met his wife, Caroline, whilst completing his apprenticeship and they married in 1969, moving to Cornwall in 1973.

Throughout his time in the Navy, Derek was planning for the future and was an early student with the Open University. He studied at sea over a period of seven years in very cramped conditions, finding study spaces wherever he could and reliant on mail being dropped by helicopter to receive his study booklets and assignments. He overcame all difficulties and was awarded a First Class Honours degree prior to retiring from the Royal Navy in 1986.

He gained a place at Imperial, to take an MSc degree in Control Systems, and he thrived in the academic environment. As a full time student, at the age of 40, he was entitled to a Young Person's railcard and he would often recall how ticket inspectors, checking his train ticket, would give him a quizzical look. Derek joined CGCA whilst at college, and remained a member ever since.

His Masters Degree and excellent RN Apprenticeship enabled him to take up a post with Sauer Sundstrand where, as a Control

Systems engineer, he was the English member of a European team. Within the industry of mobile hydraulics and controls, Derek was widely admired for his comprehensive technical knowledge and competence in overcoming problems.

His sense of humour was a most useful gift, not only helping him to remain focussed on the task while the problems whirled maddeningly around him but also enriching his conversation with just the right amount of light-heartedness.

On retirement, Derek was an enthusiastic member of the Plymouth U3A Italian Conversation Group. His love of things Italian led to Derek and Caroline having annual holidays in Bologna.

He was an inspirational member of the Liskeard Model Society for over twenty years, fellow members saying that his knowledge of matters electrical and mechanical was unsurpassed in the Society. He was a regular presenter of talks on a variety of subjects and an exhibitor at the annual exhibitions, often displaying automata presented to the Society which he had repaired and updated.

Throughout his retirement, Derek was a member of the Royal Navy Engineers Benevolent Society, becoming President, and latterly Managing Secretary and a leading member of its Executive Council.

Derek died on 29 January 2016, aged 69.

## Built his own house - to accomodate a Wurlitzer!

MICHAEL ST JOHN CANDY (Elec Eng 1952-53, '55-57)

A life member of CGCA, Michael also served for twenty years on the Committee of Convocation, the London University Alumni Association.

Michael was born on 12 March, 1934. After graduating, he took up an apprenticeship with the BBC Engineering Division, and subsequently worked with the corporation for twenty years, often travelling the country, extending BBC2 coverage. From 1978, Michael worked for nine years with Marconi Underwater Systems on the Sting Ray project. From 1988 until retirement, he worked for BSI Testing, Hemel Hempstead checking applications for patents.

Michael was a keen member of the Magic Circle and the Cinema Organ Society. He constructed his own home in Hemel Hempstead on a self-build basis so that it could house the American Wurlitzer organ he acquired. This had previously been in the Gaumont Cinema, Northampton. His sister, Ruth Neal, wrote: 'Michael never married, but he had a strong sense of family, thinking imaginatively for his nephews and niece, and maintaining wider family links and friendships. He will be greatly missed.'

Michael died on 22 December 2015, aged 81.

## "City & Guilds is the place to go for Engineering"

STANLEY ERIC RANDALL (Mech Eng 1935-38)



Stanley was born in Sussex, on 26 January, 1917, youngest child of George and Annie Randall.

At Tonbridge School, he both played rugby as a wing-forward in

the 1st XV and set a new school record for 220 yards in running.

From 1935, he studied Mechanical Engineering at City & Guilds College, having been advised by a friend's father that 'City & Guilds is the place to go for Engineering!' He managed to skip the first year by gaining his Intermediate BSc whilst still at school.

He graduated with first class Honours in 1937 and undertook a year's research for ICI. In August 1938, he took up work with ICI at their Central Laboratory in Widnes, Lancashire, as a design engineer. He very quickly joined the Territorial Army (Royal Artillery), but within a year became a full-time soldier, serving initially as Second Lieutenant in the 70th (3rd West Lancs) Anti-Aircraft Regiment. In 1940, he transferred to the Royal Army Ordnance Corps, becoming Captain in 1941, then to the Royal Electrical & Mechanical Engineers in 1942, being promoted to Major before he

was de-mobbed, in June 1946.

In 1940, Stanley married Kathleen Mabbett in Tunbridge Wells. They had three children.

After the war, he re-joined ICI and, in 1960, he became a senior project engineer in the ICI Plastics Division. The family settled in Harpenden, where Stanley and Kathleen were to live for forty-six years, whilst Stanley continued with ICI until his retirement in 1973, after thirty-five years' service.

The picture (below right) shows Stanley in 1940, at the wheel of his father's 1934 long chassis Aston Martin, his elder brother, Lewis, in the passenger seat. Stanley was so impressed with the car that, in 1954, he bought

himself an identical model which he tended lovingly for the remainder of his life.

In 2006, Stanley and Kathleen moved to East Sussex, to be nearer to their family. It was here that Kathleen died in 2009 after nearly seventy years of marriage.

Stanley died on 14 February, 2016, at the age of 99.

In addition to his three children, Stanley leaves four grandchildren and three great-grandchildren.





# A Keen Motorist and Aviator

JOHN FINLAY ALEXANDER (Elec Eng 1934-37)



**John standing next to his Darracq Special**

John Alexander, was born 20 March, 1917, graduated from Imperial in 1937 and was a life member of CGCA. At various times, he worked for the Aluminum Union Limited, British Geco Engineering Limited and the APV Company.

His lifelong friend, Stanley Randall, whose own obituary appears here on the page opposite, said the

following: of John:

"John and I first met in winter 1935, searching for a warm place to eat our lunchtime sandwiches at City & Guilds College, where John, after school at Winchester with his radio under the bed, was taking a degree in Electrical Engineering. The only real winter comfort in the College was the boiler-room that opened onto a passage lined with benches, and that's where we sat. Very short of money, we were both running cars that we could barely afford. John had an Alvis 12/50 of 1928 vintage which he drove into College every day from his parents' house in Sevenoaks.

"He was a keen motorist, and drove his cars very hard. On one occasion he set out to cover 60 miles in one hour on a trip to Bath. He was on target at 55 miles before a breakdown brought that mission to a halt. He described taking roundabouts at speeds high enough to produce tyre squeal and make the pedestrians scurry for safety!"

In 1939, John was lucky enough to fly in a Short S Class Flying Boat from Persia, where he had been working on the oil wells, back to UK.

He joined the RAF and flew missions for 233 squadron, Coastal Command, before joining the newly formed 621 squadron at Haverford West which flew Wellington bombers. They flew out to the Middle East and John was posted to the Island of Socotra. From there, he flew maritime patrols over the Indian Ocean.

In 1945 he flew an Anson, landing

at Cannes airport and having to avoid the many sheep grazing on the sides of the runway.

John spoke little of his flying career but, after his death, his family found out that he had been mentioned in despatches and in his desk was the citation signed by Harold MacMillan.

John died 22 June, 2010, at the age of 93.



**John (at the wheel) takes on a rough hill climb, in his 12/50 Alvis**

## NOTICES IN BRIEF

ALAN G GOWERS (Civil Eng 1935-38, 38-39)

Born on 24 April, 1917, Alan was a life member of CGCA.

JOHN WILLIAM CLAUD HILTON (Elec Eng 1956-59)

Born on 21 May, 1937, John was a life member of CGCA.

EDWARD FREDERICK OSTERLOH MASTERS (Elec Eng 1937-40), born 16 November, 1916.

ADAM STANISLAW MARJA MALHOMME de la ROCHE (Aero 1952-57)

Born on 15 February, 1930, Adam was a life member of CGCA.

RAYMOND ALFRED WOODROW (Elec Eng 1950-54)

Born on 11 November, 1925, Raymond was a life member of CGCA.

TERRENCE FRYE PURDIE (Mech Eng 1952-55)

Born on 25 November, 1932, Terrence was a life member of CGCA.

ARTHUR LAWRENCE BAYLIS (Civil Eng 1940-42, 46-47), born 24 May, 1921.

GEOFFREY MARKHAM PINFOLD (Civil Eng 1957-60, 60-61), born in 1936.

CHARLES GEOFFREY HOLT-HOUSE (Mech Eng 1941-44)

Born on 26 January, 1922, Charles was a life member of CGCA.

JOHN RAYMOND MAUNSELL (Chem Eng 1936-37, 37-40)

Born on 30 April, 1920, John was a life member of CGCA.

WALTER EDWARD LANHAM (Mech Eng 1942-43, Elec Eng 1947-49), born 27 May, 1924.

REGINALD STANLEY COLLINGWOOD (Mech Eng 1959-60)

Born on 09 June, 1934, Reginald was a life member of CGCA.

JUDAH FELIX LEVY (Civil Eng 1946-47 DIC), born 19 March, 1921.

GUY DORRINGTON STEPHENSON (Mech Eng 1940-43), born 19 December, 1922.

NORMAN ERNEST LOCH (Mech Eng 1959-60), born 13 July, 1936.

KENNETH EDWIN BETT (Chem Eng 1948-50 DIC)

Born on 14 July, 1925, Kenneth was a life member of CGCA.

Dr SUKHENDU CHATTERJEE (Civil Eng 1972-77 PhD), born 25 July, 1935.

Dr JOHN PARTRIDGE (Mech Eng 1974-77)

Born on 12 December, 1934, John was a life member of CGCA.

RAYMOND CHARLES GOODBURN (Elec Eng 1948-52), born 1 June, 1924.

## Industrial Chemist and Polymath

Dr ISRAEL LEO HEPNER (Chem Eng 1948-52, 52-55)

Born in Leipzig, 26 April 1930, Leo arrived in Britain just three days before Hitler's invasion of Poland.

He learnt English quickly, while German was spoken at home. In time, Leo would become fluent in a total of six languages. After attending a grammar school, he obtained a degree in engineering and then, in 1955, a doctorate in chemical engineering from Imperial.

As a renowned scientist and technologist, Dr Hepner worked in Israel and, in 1970, launched a management consultancy organisation which won plaudits worldwide for its business and technological advice. He was the go-to man in his field, writing and advising on the emerging area of bio-technology and fermentation and its impact on human and animal healthcare.

He created and edited 'Process Biochemistry', the first technical journal devoted to biotechnology and biochemical engineering. He was a true pioneer in an important field.

Even after he had officially retired, people still came to him, seeking his knowledge and advice. Even just a

couple of weeks before his death, he was answering questions from the food industry.

However, chemical engineering was only one of Dr Hepner's fields of expertise. He was a polymath who excelled in many different areas. He developed a deep knowledge and appreciation of Art and Architecture. He was also an accomplished viola player, and he and his wife encouraged young musicians to produce progressive chamber music compositions.

Dr Hepner was influential in the rebuilding of shattered Jewish communities in post-War Europe, acting as the chair and vice-president of the European Union of Progressive Judaism.

In 2012, he received the Israel Jacobson award.

Leo met Regina Neupert, a builder of pianos and harpichords, at a concert marking a conference on Reform Judaism in Germany. The couple married when Hepner was 76. Deeply happy, they shared an interest in the poetry of TS Eliot, spending hours dwelling on particular lines, poetic paradox, and Eliot's strain of mysticism.

Dr Leo Hepner, died on November 25, 2015, aged 85.

