Imperial ENGINEER

GEOPHYSICS IN INDONESIA

AUTONOMOUS VEHICLES

ANNUAL DINNERS

ARCTIC SEA ICE

BOTTLE MATCH

RED BORNEO

REUNIONS

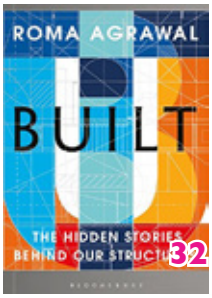
BOOKS

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

ISSUE 28 *SPRING 2018*

ISSUE TWENTY EIGHT
Spring 2018

In this issue…



Front Cover photo:
Driverless PODs in Greenwich used for a trial public shuttle service. read more about autonomous vehicles in John Routledge's feature article on pages 14-17.
Cover image courtesy of the GATEway Project.

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Richard Kitney

Well, you may have been expecting a message from my predecessor Dame Judith Hackitt. I was due to take over the Presidency of the CGCA this spring. However, the Grenfell Tower fire intervened. Dame Judith, because of her extensive experience and knowledge as Chair of the UK Health and Safety Executive, was appointed by Government to lead an Independent Review of Building Regulations and Fire Safety following the fire. Consequently, I took over the Presidency in October, rather than around now. First, let me say that Judith did an absolutely splendid job as President, so it has been easy for me to take up the reins.

For those who don't know me, I am an alumnus of Imperial College and an engineer. I was Head of the Department of Bioengineering (first as a Centre, and, subsequently, as a Department) for a period of 10 years. Over the last 12 years I have worked with my colleague Prof Paul Freemont (a structural biologist) to develop what is now one of the leading international centres in the relatively new field of synthetic biology (or as it is now being called, particularly in the United States, Engineering Biology) – but it is internationally recognised as a new field of engineering. Basically, the field is about modifying DNA (the instruction set of the cell) to instruct the cell to produce substances according to human design – for example, new vaccines and new materials. It is now generally recognised that this new field will have major economic impact. What is important to understand, from an engineering point of view, is that this really is a new field of engineering. It applies engineering science and practice directly, including many aspects of industrial translation that are familiar in a wide range of other areas of engineering. I will be talking about this at the AGM in June and I very much hope that you will join us on that occasion.

An important item on my agenda, as President of the CGCA, is to get more young people, including undergraduates, heavily involved in the Association. This is a theme that my predecessor started and I very much intend to continue. In this context, I have already contacted a number of departments in the Faculty of Engineering and I am in discussions with their student and academic representatives. The plan is for this to lead to a much more integrated approach to the membership and operation of the CGCA – with much greater student participation at all levels and support for students and young graduates in terms of their careers and other advice.

One recent event that was highly successful was the CGCA annual dinner. This year's dinner was held at the Ironmongers' Hall on Friday, 23rd February, with over 150 people in attendance (see page 7). There was very good student involvement and attendance and I would hope that we can significantly improve on this next year. I would like to offer my thanks to all those members who participated in the organisation and execution of the event for their hard work in making the dinner not only successful, but highly enjoyable.

Prof Richard Kitney OBE, FREng

PRESIDENTS REPORT

Tim Cotton

The winter months have been busy for RSMA and RSMU and there have been a number of memorable events since I last wrote, in September last year. The 133rd annual dinner was held on Friday 24th November at the Rembrandt Hotel in Knightsbridge and saw 119 guests join the Committee and me, of which 32 were current RSMU students. The mood was festive and although all the diners were in good voice throughout the dinner, Rob Tomkies, current RSMU President, was unable to harness that power when leading the group in the Mines Song at the end of the evening! At the dinner we were able to award in person the Peter Harding Memorial to Lorraine Craig and the Professor Rees Rawlings Award to Danny Hill. In addition we drew the first winner of the 100 Club Draw and this went to Bryan Bowden in Western Australia; Bryan has very graciously re-donated the prize back to the Association. Our speaker for the evening was Steve Potter, Head of Strategy for Vale SA, who entertained us with a view on how his experience at the RSM has been put to use over his career. I am sure that students and members alike found some of his anecdotes both amusing and useful. Once again the members of the RSMA were extremely generous and sponsored all students attending. This level of support is very much appreciated by the students and I would like to personally thank all those members who supported the students. See page 5 for a more detailed report of the evening's festivities including pictures.

Late afternoon on Saturday February 24th 2018 in land far away, a tragedy. The CSM triumphed 35-5 to win the 116th Bottle Match. The RSM visiting side put up a brave fight but succumbed to a defeat with the score line not entirely reflecting the closeness of the whole game. The weekend was host to a number of other sporting events and in these RSM fortunes were somewhat improved. The lacrosse team fought through a heavy pitch and tough challenges to heavily beat CSM 13-3! Hockey carried mixed fortunes for our teams; our women's battled well but fell to a loss, but our men battled back from 1-3 down to draw 3-3, saving a penalty flick at the very end to retain the Sharply trophy! Friday was all Cambourne with Netball ending 31-14 to CSM, in football it was the same story with CSM coming through to win 3-1 and in badminton Cambourne again triumphed. Great effort from everyone who played and supported. Next year we go again and have the home advantage! See pages 8-9 for a more detailed account of each and every game.

Following the success of the last three years' events, in March the committee will again give a presentation to the students on the history, aims and membership of the RSMA in order to get students to join the RSMA whilst studying. The committee continues to maintain a very active relationship with the RSMU, the challenge going forward is to better embrace the Materials Department students and seek a staff representative on the Committee. The involvement with ESE remains strong and the Committee is looking to further the links in ESE and Materials by engaging with the key societies within them such as De La Beche, MatSoc and GeoPhysicsSoc.

There are a number of upcoming events for your calendars. Planning is already under way for the 2018 Summer BBQ for Final Year Students and this will be occurring on Thursday June 28th at a venue to be announced soon. Also a date has been confirmed for the 134th Annual Dinner as Friday November 23rd 2018 – the Friday before Mines and Money London starts. (continued overleaf)

Tim Cotton's President's report (continued)

2018 is set to be a challenging year for the RSMA as the UK Privacy laws are changing and are becoming very prescriptive on how associations may, or may not, contact their members. This impacts the College as a whole and we will be working with College's Development Department in the Faculty of Engineering and College Alumni Relations team in managing the transition to these new privacy laws. The Committee has a good working relationship with these two departments and it hoped that the membership will see minimal interruption.

To add insult to injury the Association's bank, HSBC, has changed all of RSMA's Sort Codes and Account Numbers with immediate effect for no apparent reason. Even with lobbying HSBC tell us that they will only redirect funds for the next few months before closing the accounts and rejecting the standing orders, so please don't delay. We are in danger of losing income through the bank's unexplained (aka crass) action so please also check with any RSMA members you keep in touch, to make sure they have changed theirs. Please find details for annual subscriptions and RSMA Trust Donation:

RSMA annual subscriptions :
Payable to: Royal School of Mines Association
Account Number: 60461296
Sort Code: 40-11-60

This account is just for the annual subscriptions and just in case your Standing Order was a bit out of date, don't forget that this should be £15 per year for all members.

RSMA Trust, 100 club and additional donations :
Payable to: RSMA Trust
Account Number: 80204544
Sort Code: 40-11-60

Both these new accounts are already in operation, so do change your Standing Orders as soon as you can.

Many thanks for your support it is truly appreciated. In the coming months we are looking to showcase how the Association has used your support in helping the students and staff at the RSM. Remember you can all still use the email address rsma@imperial.ac.uk to contact the RSMA at any time. Please send us your news and we will look to share it with the wider RSM Community.

RSMU Regalia now available

Need more RSM branded clothing and trinkets? Well, lucky you, the RSM Students Union has updated its regalia and these can be purchased at any time from the RSMU. Please contact RSMU Regalia rsmregalia@imperial.ac.uk to find out more and order, they can work out the best postage option for your items.

Formal Wear – Ties and Cufflinks

Navy tie with silver RSM embroidery, an essential staple for formal events or, for the James Bond types, a bow tie. Both priced at £25 each. To finish, cufflinks also £25.

To keep the cold out – Bobble Hats and Scarves

The beacon of a Royal Miner, you'll need one of these to survive London's harsh weather on general goings about. Embroidered black and yellow scarf, adding a comfortable and welcome splash of colour through the British gloom. Each of these a snip at £15.

Photos: RSMU

For your favourite tipple a medium sized (6oz) steel engraved hipflask for £30. Lastly a fun bottle opener and key ring. Very useful for only £3

RSMA Annual Dinner, November 2017

– and the award goes to …….

The 133rd annual dinner was held on Friday 24th November 2017 at the Rembrandt Hotel in Knightsbridge. This year saw 119 members and guests join the Committee, of which 32 were current RSMU students. As is always the case the members of the RSMA were extremely generous and sponsored all students attending. After pre-dinner drinks, members and guests were treated with an excellent dinner of a fish starter, roast lamb and chocolate dessert. One student was overhead to say "we love the RSMA Dinner as there is never any chicken as the main course!". Once again testament to theory that good food and good company are key to a successful event. The mood was festive, in part due to the Christmas decorations around the hotel, and although all the diners were in good voice throughout the dinner, Rob Tomkies, current RSMU President, was unable to harness that power when leading the group in the Mines Song at the end of the evening!

Entertainment for the evening was from our speaker Steve Potter Head of Strategy for Vale SA who entertained us with a view on how his experience at the RSM has been put to use over his career. Steve battled the PA system but managed to chart his time from a Learner Official with Goldfields in South Africa to his current senior corporate role with one of the world's largest mining companies. His journey covered the friends and places that have influenced him and anecdotes of college life that seemed all too familiar to the current students. I am sure that students and members alike found some of his anecdotes amusing and useful.

At the dinner the Association was able to hand out in person the two RSMA awards announced at the June AGM. The Peter Harding Memorial Award was given to Dr Lorraine Craig for her tremendous efforts in supporting students as Academic Tutor to the Earth Sciences and Engineering Department and support to the wider RSM. Her role has been recently expanded to enhance the student experience, with an emphasis on learning and teaching across the whole Faculty of Engineering. Whilst this has meant that Lorraine has moved away from ESE in her new role of Associate Dean for Learning and Teaching she is still heavily involved in the student experience with the RSM. Rees Rawlings was in attendance to personally give Danny Hill the Professor Rees Rawlings Award for his tremendous support to the RSM as a younger RSMA member. Danny's efforts as the RSMA Honorary Treasurer for the past four years and ongoing commitment to the RSMA Committee have been very welcome.

In addition the Association drew the first winner of the 100 Club Draw and this went to Bryan Bowden in Western Australia; Bryan has very graciously re-donated the prize back to the Association. The support of the 100 Club members is tremendous as they have allowed the Association to form a plan to award three £1000 bursaries to penultimate year students to assist them in completing their final years at RSM. The goal is to award these at the AGM in June 2018 for the 2019 academic year. All in all an excellent event and good times were had by all, and after the speeches and songs the members and guests stayed a while before heading to the Union Bar to run the gauntlet of getting in and being able to buy a drink!

Professor Dick Kitney CGCA President with Lorraine Craig

Danny Hill receiving his award from Tim Cotton RSMA President

All photos courtesy of Matthew Hayward RSMU

Data Protection, Privacy, and your CGCA Membership – Update

The 2017 Autumn issue of Imperial ENGINEER was sent by post to every member* of CGCA because it carried a request for you to tell us about your preferences for processing your personal data for the purposes of managing your membership and for receiving electronic communications from us that may contain details of events, products and services that are associated with CGCA.

Just shy of one thousand members have contacted us to express their preference at the time of writing. However, that still leaves a large number of members that have not yet expressed their preferences.

In the case of electronic communications, if you do not tell us your preference, then we must assume you do not want to have details of CGCA or CGCA-related events, such as the Annual Dinner, sent to you electronically so you will not receive our regular email newsletters from May 2018 onwards, as such material is considered electronic marketing under the new GDPR and PECR regulations.

If you want to express your preferences, or change the preferences already on record, please use the form on the back of the address sheet in the packaging of Imperial ENGINEER or to do so electronically, please go to our website, http://cgca.org.uk and follow the link under the 'Journal' tab.

Please note that you are only consenting to receive details of events, products (such as regalia) and services from CGCA or in which CGCA is heavily involved. We will not be promoting any third party events, products or services.

Thank you for your support,

Nigel Cresswell
CGCA Hon Sec

* Every Life, annual and honorary member. Student members will be able to declare their preferences when they upgrade to Annual Membership.

Visit the new look CGCA website at

http://cgca.org.uk

CGCA AGM 2018 and President's Evening

The CGCA Annual General Meeting, AGM, will be held on Monday, 11th June in the Queen's Tower rooms at Imperial College, South Kensington Campus. As is traditional, the AGM will be followed by the President's Evening which will include a hot buffet supper, served with wines and soft drinks. Refreshments will be available in the room before the AGM from 17:00 onwards.

The AGM will start at 17:30 and the agenda will be available from our website in the near future. It will include the President's review of the past year, presentation of the 2017 accounts and the election of Officers for 2018 – 19. Nominations for officers will open shortly. If you wish to stand for a post, please visit the website for details:

http://cgca.org.uk

The President's evening will start shortly after the talk has finished. This is an entirely social event and will include a wine and soft drinks reception, followed by a hot buffet supper, served with wines and soft drinks, finishing with tea or coffee. Members and their guests are very welcome. If you wish to attend the supper, then please visit our website events page to make a reservation using the EventBrite service.

After the AGM, your President, Professor Richard Kitney, OBE, FREng, FRSE, PhD, DIC, DSc (Eng), FCGI, will deliver a talk entitled "*Synthetic Biology/Engineering Biology – A rapidly growing area of the bioeconomy*".

From vaccines to waste water treatment and new sources of energy, techniques to re-engineer DNA could revolutionise vast areas of global industry. Already America's fastest growing sector, Biomedical engineer Professor Richard Kitney will explain why the UK government describes synthetic biology as one of its Eight Great Technologies for future economic prosperity.

Attendance at the AGM and the talk are free.

A flyer covering the AGM and President's Evening is included in packaging of Imperial ENGINEER or can be downloaded from the CGCA webpage that the electronic version is hosted on.

Grenfell Tower

In the early hours of 14th June 2017, a fire spread through Grenfell Tower in North Kensington. Seventy-one people died, many homes were destroyed and countless lives affected. Initial reports suggested that the building's exterior cladding accelerated the fire, leading to a call for widespread testing of cladding on other high-rise buildings.

As a result of the tragedy, a Public Inquiry was immediately established by the Prime Minister under Sir Martin Moore-Bick, to investigate the construction and subsequent maintenance of Grenfell Tower, the fire and safety measures within the building, the cause and progress of the fire, the emergency services' response and the aftermath. In November, Sir Martin announced that three assessors, with specific expertise and experience of value to the inquiry, had been appointed to assist him. One of those assessors was Professor David Nethercot, a recent President of CGCA. He has been appointed to assist the chairman in considering technical issues relating to the design and construction of the building and

its refurbishment. David said, "Like others, I was deeply shocked and saddened by the loss of life at the Grenfell Tower. I hope that my scientific background and technical objectivity will assist the Inquiry team in its current task and play a part in reducing the possibility of such a tragedy ever occurring again in the future. This is no small undertaking but the importance of the Inquiry's work cannot be overstated; it is a privilege to be able to contribute to this process."

The concern that the cladding material used on the tower may have accelerated the fire, and subsequent concerns about cladding on other high-rise building led the Secretary of State for the Department for Communities and Local Government (DCLG) and the Home Secretary to ask Dame Judith Hackitt to conduct an Independent Review of Building Regulations and Fire Safety with a particular focus on their application to high-rise residential buildings. Dame Judith, who was Chair of the Health and Safety Executive for almost a decade, was the President of CGCA at the time the review was established – she stepped down in order to concentrate on the review, handing over the presidential reins to Professor Richard Kitney. Her review delivered an interim report in December 2017, which concluded that the current regulatory system for ensuring fire safety in high-rise and complex buildings is not fit for purpose. In it she wrote, "I have been shocked by some of the practices I have heard about and I am convinced of the need for a new intelligent system of regulation and enforcement for high-rise and complex buildings which will encourage everyone to do the right thing and will hold to account those who try to cut corners." The final report is due in May.

The Grenfell Tower disaster and the ensuing investigations are together one of the most significant recent Engineering-related news stories in the UK, likely to have far-reaching repercussions world-wide. That two recent presidents of CGCA are involved in such significant roles in these investigations is certainly noteworthy, and they surely know that they can count on our support.

CGCA Annual Dinner, February 2018

The Association's annual dinner took place at Ironmongers' Hall on Friday 23rd February, our first visit there since 2008. The Ironmongers' is one of the 16 Livery Companies which, in 1881, along with the City and Guilds of London Institute, founded the Central Technical College in Exhibition Rd, the forerunner of Imperial College, so our return was particularly fitting.

Although Ironmongers' Hall is a relatively new building, having been constructed in 1924, it was built in the gothic style, using many of the materials and features of the earlier hall, including flagstones, ironwork and oak panelling. In this way, it makes a feature of its history and of the craftsmanship which was the hallmark of many of the Guilds during the middle ages. When set out in its finery, with chandeliers and stained glass windows in the banqueting hall and William Morris tapestries in the Drawing room, it presents a wonderful setting.

The attendance of 122 included the President, members and their guests, officers of CGCU and students. The principal guest, Professor Nigel Brandon, the Dean of the Faculty of Engineering at Imperial, addressed the diners, taking the opportunity to inform us about the Faculty's current educational and research activity. He stressed the importance of ongoing links between the Faculty and the Association, making particular reference to the Old Centralians Trust and its work of supporting students financially, to attend conferences, to undertake extracurricular activities and during times of financial hardship. This year, we were particularly pleased to have an overseas guest, Dr Paulina Chan (EEE), a prominent member of CGCA Hong Kong Branch.

Professor Nigel Brandon, Dean of the Faculty of Engineering

Dr Paulina Chan with her mentee, Jack Lee

Catering was provided by the in-house team at Ironmongers' and was widely considered to be a great success. We had sole, Angus beef and a delightful bread-and-butter pudding, served in a way which combined traditional quality ingredients with a real flair for modern culinary techniques and presentation. As ever, wines were provided from our own cellar. The claret, Pagodes de Cos, St Estephe 2005 and the port, Dow vintage 1991, were both excellent, and were supplemented by a clean, tangy English white wine, Midsummer Hill 2016, from Gloucestershire.

After the speeches, a number of presentations and awards were made:

Max Naylor Marlow (Dyson School of Engineering Design) received the John & Frances Jones Prize, commemorating the first Registrar of Imperial College.

Gareth Brinn (Mech Eng), received the Holbein Memorial Award, as 'Sportsperson of the Year' for his work with the Hockey Club, in addition to his all-round contribution.

Eleonora Sailer and Giulia Ghiadistri (Civil) jointly received the Centenary Enterprise Award, for their work in promoting and organising alumni events.

Matthew Homburg (Mech Eng), received the Peter Moore Memorial Award, made each year to the Bo Driver, though we all noted with regret that Bo was not able to attend this year, due to a massive engine failure. The good news is that repairs and replacement are well in hand.

Sergiu Iliev (Aero), a recent winner of the Jessel Rosen Graduate Overseas Experience Award was also present and recognised for his achievement.

To close the evening, the President invited all the diners to return to the Drawing room for a traditional 'Stirrup Cup' and a chance to mingle, mix and chat with friends old and new, over a 'wee dram' or a cold beer. All in all, a splendid and successful evening.

We are already thinking of the arrangements for next year and it has been suggested that we might return to the Ironmongers' in view of how well everything had gone. In the recent past, we have tended to mix things up a bit and go to different halls each year, but perhaps we may break with this practice for 2019. If any members, whether or not they attended on 23rd February, have thoughts on this, or any other matters concerning the dinner, please let me know.

Colin J Kerr
c.j.kerr@imperial.ac.uk

Photos: Ziyuan Mao

Giulia Ghiadistri, Eleonora Sailer, Sergiu Iliev, Chris Lumb, Matthew Homburg, Gareth Brinn, Max Naylor Marlow

116th Bottle Match Report

The bottle match weekend, held down in the depths of Cornwall over the weekend 23rd-25th February 2018, went ahead successfully despite uncertainty over its future earlier in the academic year. Below are the match reports from a great weekend!

Badminton

Following a glorious victory of 8-1 over CSM at last year's bottle match RSM were looking for a repeat performance. However it became apparent that the 'true' CSM badminton team did not venture to London the previous year, and hence the 1-8 loss of CSM was effectively a forfeit, with the CSM lacrosse team press-ganged into action. This year, the players put forth by the CSM side were highly skilled and possessed flawless abilities heavily punishing the weaker abilities of the RSM side. As quickly as the impressions of an easy victory were shattered, they were replaced with the good spirits and sportsmanship of the RSM side, who persevered against the unstoppable force of the CSM team, clutching points where possible. Although the trophy was lost, with the final score 9-0 to CSM, all of the players thoroughly enjoyed the experience and a high level of badminton was displayed for both the RSM team to improve and spectators to enjoy; leaving all the more motivation to win it back next year (if CSM bothers to send their actual team).

Netball

An indoor court was more than welcome against the cold Cornish weather but it meant contending with some very loud supporters. RSM won the coin toss, however the CSM support proved to be just as intimidating as their shooters and RSM finished the first quarter with a disheartening 10-0 score line.

The late arrival of Charlotte, the RSM goal keeper, straight from her final exams, along with some extra supporters (and our trusty RSM Netball flag) did wonders to boost our morale. This new-found energy produced a wild swing in the scores that proceeded to throw off the CSM support and the CSM team themselves. The RSM supporters more than made up for their lack of numbers by providing more than enough cheer to encourage our shooters. Before CSM knew it, RSM stepped up the game and fought back their advances with incredible finesse. The score in the second quarter was a thrilling 7 all, bringing the score at half time to 17-7. In the third and fourth quarters, RSM recognised that they had lost the element of surprise. Although the RSM team fought valiantly, CSM remained the victors and the Netball win eluded RSM for one more year. However, with a score of 31-14, it is exciting to mention that this is the closest RSM Netball has come to winning the Netball so far. Year on year RSM continues to narrow down that goal difference. Maybe next year is the year that RSM Netball will be crowned champions of the Netball Bottle Match!

Football

In sunny, but cold, conditions on the infamously boggy Dracaena Centre pitch CSM kicked the game off a little cautiously. With the pitch immediately proving the biggest problem for both teams, it was clear that the surface was too uneven to play any building football. RSM decided to pack the middle with a diamond playing two up front. This worked to their advantage as they started strongly setting up camp in the opposition half. Corner after corner, free kick after free kick, RSM wasted a couple of clear opportunities to take the leads – missed chances they would come to rue. On the 35 min mark CSM went long from a free kick within their own half. A lapse in concentration from RSM left the CSM striker straight through on goal to calmly poke past the keeper. 1-0 CSM completely against the run of play but RSM heads didn't drop, determined to fight back. RSM stuck to the game plan and setup camp in the CSM half. Possession was rewarded with a free kick which whipped into the second post, missing everyone in the box to nestle just inside the side netting. RSM were right back in it and went into halftime hungry to get the win. The match being very much a game of two halves, CSM came out for the second half on the better side of the pitch and the better team. The pitch really told in the second half as RSM started to come out second best on the duels and this translated on pitch to CSM dominating the second half. A miscommunication at the back and fluky header later CSM were 3-1 up and kept the trophy. RSM football whilst scoring the second goal in seven years remain on the hunt to end the 13 year drought.

All photos courtesy of Matthew Hayward RSMU

Women's hockey

The match began with the roar of the RSM crowd rightly drowning out the half-hearted CSM attempts at making a noise. The girls fought hard for the first 7 or so minutes with the defence putting up an amazing fight. Unfortunately CSM managed to get through and RSM conceded our first goal. Not to let anyone's spirits get low the older girls yelled out encouragements and kept everyone's heads up. CSM were quick and strong on the ball, making fast runs which kept our wingers on their toes. Not much (ish) could get past the RSM defenders and they put pressure on the CSM attackers, channelling them into the corners where the glorious RSM spectators voiced their approval. In the second half we played our best hockey yet and went a full 15 minutes with good possession and a strong attack. Our defence made us extremely proud fighting hard right to the very end. Sadly we lost the game, but we worked hard and (most importantly) had more fun.

Men's hockey

RSM won the toss and chose to play with the sun behind them. It did little good. Four minutes into the game and all the meticulous game day preparations seemed to be in vain, as CSM scored the opener. This only proved to spur on RSM, who created a well worked goal to raise RSM spirits both on and off the pitch. Celebrations were short lived though, as a quick counter-attack from CSM cancelled out the comeback effort and brought the game to 2-1 with ten minutes remaining in the first half. A frantic end to the half saw a stray cross diverted in off RSM defender to gift Camborne a 3-1 lead at the half time whistle.

Rousing words from the older lads rallied the side, and RSM went into the second half with nothing left to lose. A goal-line scramble ended in disappointment as the RSM comeback was denied once more. This led to yet another swift counter attack with four Cornish players breaking free before a last ditch interception salvaged any hope RSM had. RSM then drilled home a short corner to bring the game to 3-2 with 15 minutes remaining. Sensing the game was getting away from them, CSM held the ball in an attempt to run the clock down. This only served to motivate RSM more and RSM managed to level the match at 3-3 with just five minutes left to play with a shot that almost broke the back board.

Knowing a draw would be enough to retain the Sharpley Cup, RSM dug in and defended with their lives to see the game out. As the seconds ticked past 70 minutes, the ball found its way back into the RSM circle and a late tackle awarded CSM's Callum Fraser a penalty stroke with the final hit of the game. It seemed the comeback was wasted, but the RSM first year goal keeper had been given a different script. A diving save to the right denied the CSM striker his moment of glory, and ensured the Sharpley Cup would return to London for a fifth consecutive year.

Lacrosse

The lacrosse team were spurred on by the efforts of the hockey squads and soon found themselves at the end of the first quarter 4-1 up, with the crowd going wild. Going into the second quarter the game became much scrappier, and the conditions of the pitch did not help with the ground balls – in fact the game saw more grounded players than picked up ground balls. None the less RSM stuck it out and were rewarded with another goal.

With two quarters remaining, CSM stepped up their play (and fouls) and scored at the start of the third quarter. The CSM spectators went crazy as the idea of a come-back swept through their minds. After all, no Lacrosse match is decided until the final whistle, right? In response to the CSM cheers, RSM scored once again bringing the score to 2-7, silencing the CSM chants, and igniting once again the spirits of the RSM! Entering the final quarter, with a 2-7 lead, the RSM went all out with goals left, right and centre bringing the final score to 3-13.

Rugby

RSM felt confident going into the game following last year's comfortable win over CSM. Unlike the mud bath two years ago, the pitch was dry and well suited to the free-flowing game of the RSM. The start of the match saw RSM receive the kick-off and, following a poor exit, CSM went over the line within the first few minutes. The worst possible start. The RSM did however fight back with strong phase play leading to a number of penalties. This drove RSM deep into CSM territory, where the forwards bundled over for a try from a driving maul to take the score to 5-5. RSM continued mounting pressure but couldn't convert this to points and eventually CSM turned over the ball and momentum shifted to them. Numerous line breaks took CSM into the RSM twenty-two; although the defence was strong, CSM managed to score again to take the score to 12-5. Again CSM piled on the pressure but the RSM defence held on and CSM had a couple of disallowed tries. A late penalty from CSM meant the half-time score was 15-5.

RSM came out in the second half still confident of turning around the deficit. However another poor start led to an early second half try from CSM taking their lead out to 22-5. RSM knew they had to score next to get back in the game. The next part of the match saw RSM play some quality rugby. Strong carrying from the RSM forwards sucked in CSM defence and created space out wide however a forward pass stopped the momentum. This didn't, however, dampen the RSM spirits and more quality hands led to more chances, but as has been seen throughout the season, the chances couldn't be converted into points. As time began to run out, CSM regained the ball and took their chances. Two tries and a penalty in the last twenty minutes put the game to bed with a final score of 35-5, making it two unsuccessful away trips to Cornwall in a row.

Final results

Badminton	*9–0*	***CSM win***
Netball	*31-14*	***CSM win***
Football	*3–1*	***CSM win***
Women's Hockey	*13–0*	***CSM win***
Men's Hockey	*3–3*	***Draw – RSM retain Sharpley Cup***
Lacrosse	*3–13*	***RSM win***
Rugby	*35–5*	***CSM win***

Alumni.
We want your news!

(Contact details on page 2)

Students.
We want your news too!

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

AI will transform higher education and science

Delivering the keynote address at the Times Higher Education Asia Universities Summit, 'Pursuing the Endless Frontier in the Era of AlphaGo,' in February, Professor Gast said: "Artificial intelligence is already demonstrating its promise to advance research.

"At the same time, it presents challenges because of the pace of its advance and the disruptions that it will create."

Professor Gast noted the many ways AI is being deployed in Asia: "In China, hospitals use virtual doctors to read CT scans. In Thailand, AI is being used to improve the care of cancer patients. In Singapore, room service robots powered by AI assist in customer service. In Vietnam, the potential of AI to help farming is being explored. And in Indonesia, AI is used to improve customer telecommunications services."

"We are already beginning to see the revolution in action", she said. "AI is beginning to demonstrate its promise to be a transformative tool for researchers, students, businesses and society."

One of the most exciting developments came in 2016 from the UK AI company, Google DeepMind, Professor Gast said. "DeepMind's AlphaGo defeated Lee Sedol, a professional Go player of 9 dan rank, in 2016.

"The play drew the attention and admiration of the global Go community. And it captured the imaginations of academics throughout the world."

AlphaGo's 4-1 defeat of the great Korean Go player was so surprising because Go is an especially complex game that "requires intuition and subtle thinking."

"Players spend years studying strategy, playing and learning from a master. It is impossible for a computer to play by brute force due to the 10^{170} possible moves" – more than the estimated number of atoms in the observable universe.

Professor Gast explained that "AlphaGo studied thousands of amateur games to learn the rules and then played itself millions of times, learning from each mistake and refining its moves. This reinforcement learning with neural network algorithms is a very effective way to optimise machine learning.

"The creative moves that AlphaGo made came from being free from biases passed down from generation to generation by Go masters. It is an astonishing thought that computers can be 'creative'."

DeepMind's work "to remove the constraints of human knowledge" is "both exciting and a bit frightening," Professor Gast said.

"This ability for machines to learn from their mistakes is especially interesting. Rather than simply performing routine, non-dynamic tasks, machines have demonstrated their capability to deal with non-routine, complex matters.

"This opens a broad, new range of potential future applications...The ability to start with basic rules and not learn from human examples poses an interesting question about how humans should collaborate with such machines."

Imperial is collaborating with DeepMind to improve clinical data sharing, task management and quality care in the NHS, as well as to diagnose diseases by analysing medical images.

Other researchers, including Professor Maja Pantic's team at Imperial, are using AI to "help address societal issues and enhance lives on a personal level," Professor Gast said. [*See item in next column*]

The group are using AI with "audio, visual and facial recognition technologies to help children with autism improve their learning and emotional understanding".

The team's technological platform "can decipher sounds and visual clues. It is connected to an off-the-shelf robot called Zeno that interacts with the children. Those with autism spectrum disorder find the robot easier to interact with than another human. And because of that the robot can conduct simple lessons that a human cannot."

In addition to these leaps forward, Professor Gast drew attention to the challenges caused by the "pace of change and the disruptions" created by AI and the fourth industrial revolution: "What will its impacts be on the future of the workplace? How will it affect teaching? Will universities be able to respond effectively to the technological revolution?"

Professor Gast argued that "university leaders have important roles to play in helping to manage the changes that define these times. These changes will affect our students. They will affect our staff. They will affect our neighbours. And they will affect society as a whole. What is the role of universities in the age of AlphaGo?"

"We need to be leaders, not just participants, in these times of change. Our students and our research must be more than simply relevant to the times. We should steer the way forward," she concluded.

bit.ly/IE28-AI

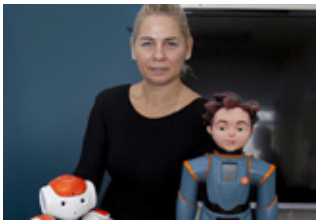
Science Minister praises 'brilliant' Imperial robotics

The recently appointed Science and Universities Minister Sam Gyimah chose Imperial for his first official visit to a university and announced a £70 million funding boost for UK medicines.

The extra funding, through the Industrial Strategy Challenge Fund, will support projects including new manufacturing centres to speed up the production of medicine and new virtual reality projects to help patient recovery.

The Science Minister, and Sir Mark Walport, the Government's Chief Scientific Adviser, met with Imperial academics to witness firsthand cutting-edge research projects into artificial intelligence, robotics and medical innovations.

Professor Maja Pantic, from the Department of Computing, demonstrated her team's work using a robot, called Zeno, which can improve learning and emotional understanding in children with autism.

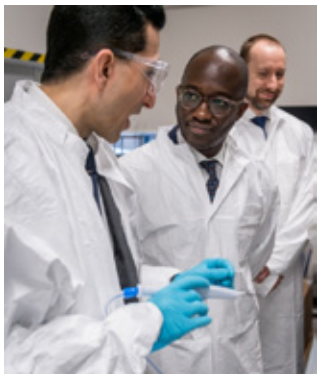


After testing the technology himself, the Minister described the robot as 'brilliant' and asked what sort of impact it could have on helping people with autism.

Professor Pantic explained that children with the condition sometimes struggle to show facial expressions but became really engaged with the robot. Professor Pantic also told the Minister that the work depended on working collaboratively with a 'big network' of European partners, including four other European universities plus autism charities and industrial partners.

Professor Daniel Rueckert, Head of the Department of Computing, then explained his research into using AI to help radiologists interpret and analyse data from brain scans. Professor Rueckert said that tools they were developing will 'give clinicians richer, quantitative information' and will measure biomarkers – making diagnosis of conditions such as Alzheimer's easier.

The Minister moved on to visit the Department of Surgery and Cancer where he met Professor Zoltan Takats who demonstrated the innovative iKnife which can tell surgeons immediately whether the tissue they are cutting is cancerous or not. The iKnife is based on electrosurgery and the first study to test it revealed a 100 per cent accuracy for the technology.



The Minister then visited the Hamlyn Centre to see the progress being made with surgical robotics.

Dr Robert Merrifield, the Director of Operations, explained how the Hamlyn Centre plays a key role in UK robotics. They are developing small, handheld tools to 'augment surgeons' skills'. Dr Merrifield said they are 'focusing on the next generation of surgical robots', some of which are the 'width of a human hair'.

Imperial's Provost, Professor James Stirling, said: "Imperial were proud to welcome the new Science Minister on his first official trip to a university and share with him some examples of our exciting and world-leading research. The Minister saw how our scientists and engineers are developing new technologies to improve outcomes for patients and help save more lives."

bit.ly/IE28-Robotics

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

New Year's Honours

Helen Sharman, Operations Manager for the Department of Chemistry and the first Briton in space, has been made a Companion of the Order of St Michael and St George for her outreach work, while **Professor Michele Dougherty** and **Professor Christl Donnelly** have both been awarded CBEs. **Michael Levin**, of the Department of Medicine, has been awarded an MBE. **Professor Derek Bell**, chair in acute medicine within the Faculty of Medicine, has been given an OBE.

Fourteen Imperial alumni were recognised in the New Year Honours list.

Professor Robert Sparks (Geology 1971, PhD 1974) was awarded a Knighthood for services to Volcanology and Geology with **Professor Terence Stephenson** (Electrical Engineering 1980) receiving the same honour for services to Healthcare and Children's Health Services.

Stephen Speed (MBA 1998) was awarded a Companion of the Order of the Bath for services to the Oil and Gas Industry and **Robin Sham** (PhD Civil Engineering 1989) received a CBE for services to the Civil Engineering Profession.

Five alumni received an OBE: **Francesca Hegyi** (MSc Humanities Programme 1997) for services to Culture in Hull, **Professor Christopher Liu** (MBBS Charing Cross Hospital Medical School 1985) for services to Ophthalmology, **Clive Meux** (Westminster Hospital Medical School 1983) for services to People with Mental Ill Health, **Professor Andrew Shennan** (St Mary's Hospital Medical School 1985) for services to Maternity Care and **Joanne Wade** (Chemistry 1987, MSc Environmental Technology 1988, PhD 1994) for services to Energy Efficiency.

Three Imperial alumni were awarded an MBE: **Michael Barrett** (MSc Geology 1990) for services to Transport, **William Dunning** (MBBS Medicine 2001, PhD National Heart and Lung Institute 2013) for services to Clinical Research, and **Jacqueline Gerrard** (Mathematics 1976) for services to Education.

Two Imperial alumni were awarded a BEM: **Ann Browning** (MBBS Charing Cross Hospital Medical School 1957) for charitable services and **Michael Speight** (Chemical Engineering & Chemical Technology 1981) for services to the community in Rotherham.

bit.ly/IE28-Honours

Seminar for Aeronautics and Mechanical Engineering

The Departments of Aeronautics and Mechanical Engineering at Imperial held a seminar together on 7 March to encourage increased collaboration.

The event began with a joint lunch and was followed by presentations held by Professor Ricardo Martinez-Botas (Mechanical Engineering) and Dr Mirko Kovac (Aeronautics).

Professor Martinez-Botas talked about "Low carbon vehicles and emissions", providing a brief introduction to the different factors involved in reducing car emissions and improving air quality, as well as an overview of his own research area in the field of turbocharging technology.

The talk also mentioned the Dieselgate scandal, as Professor Martinez-Botas was the independent expert who oversaw the Vehicle Emissions Testing Programme initiated by the British government in the aftermath of the scandal.

In the second presentation, Dr Mirko Kovac explained his vision for the role drones could play in the cities of the future, more specifically focusing on "Bio-inspired Drones for Smart Cities".

Dr Kovac described how drones could be used for tasks such as building diagnostics, and how the mechanics of movement in animals such as spiders, bees or the flying squid can serve as inspiration in creating robots.

The two departments are now sharing the City and Guilds building of the South Kensington campus at Imperial.

bit.ly/IE28-Joint

2018 – Year of Engineering

In a new campaign launched in January by the UK government, 2018 is officially the Year of Engineering and will see a national drive in all corners of the UK to inspire the young people who will shape our future. It forms an important part of the government's Industrial Strategy which is committed to boosting engineering across the UK, ensuring everyone has the skills needed to thrive in a modern economy.

Engineering is one of the most productive sectors in the UK, but a shortfall of 20,000 engineering graduates every year is damaging growth. There is also widespread misunderstanding of engineering among young people and their parents and a lack of diversity in the sector – the workforce is 91% male and 94% white.

From spaceships to ice skates, the bubbles in chocolate bars to life saving cancer treatment, engineering touches every part of our lives. However, not enough young people – especially young girls – think it's a world for them. As a result, the industry is struggling to recruit future talent. What's more, young people are missing out on the chance to make a positive difference to both their futures, that of the planet and everything that calls it home.

Over the course of 2018 the campaign intends to to shake-up people's ideas about engineering, inspiring the next generation of innovators, inventors and problem solvers by showing them what engineers actually do.

As a leading Engineering Faculty, Imperial is committed to joining the celebration. From students to staff and alumni, we're all responsibile for helping to celebrate engineering and inspire future generations.

The UK has the lowest percentage of female engineering professionals in Europe, at less than 10%, while Latvia, Bulgaria and Cyprus lead with nearly 30%. Meanwhile, 15.1% of engineering undergraduates in the UK in 2017 are women. Imperial bucks this trend though, as women make up 26% of our engineering undergraduates and over 36% of our MSc students.

bit.ly/IE28-YOE

Smart devices hackable

Two new reports, published by the Royal Academy of Engineering, warn that well-connected smart devices at home and in healthcare are vulnerable to hacking. The reports had significant input from Professor Nick Jennings, Vice Provost, and Professor Emil Lupu, Associate Director of Imperial's Institute for Security Science and Technology.

Although taking personal responsibility for safety is important, many smart device users don't necessarily know the best way to do so. Manufacturers and the government therefore have a greater duty to protect device users from hacking, and the burden of cyber security should not lie solely with device users.

The authors highlighted several ways hackers could harm people and their homes. Pacemakers, which regulate heartbeat, use wireless signals to give doctors medical data without surgery. Other vulnerable devices include MRI machines and medical pumps like those used to treat diabetes.

In the home, devices such as smart thermostats learn home occupiers' schedules to know when to turn on and off, which could tell burglars when the home will be empty. Voice activated light bulbs could be used to eavesdrop on conversations, and smart plug sockets could be turned on remotely, potentially causing fires.

Professor Jennings warned: "If the government and manufacturers don't keep on top of smart technology, wrongdoers could cause people genuine harm, and even death in extreme circumstances."

The reports recommend that governments impose regulations on manufacturers to ensure legal compliance with modern cyber security standards. "Internet enabled devices are and can be hugely beneficial, particularly to the elderly or disabled. However, we are now in a transitional period where manufacturers must take responsibility, or be made to by the government."

The authors also say good cyber hygiene should be taught from primary school. This includes turning off smart assistants when they're not in use, separate 'Home' and 'Guest' WiFi connections, and installing updates.

"*Internet of Things: realising the potential of a trusted smart world*", by PETRAS & the Royal Academy of Engineering.

"*Cyber safety and resilience: strengthening the digital systems that support the modern economy*", by the Royal Academy of Engineering.

bit.ly/IE28-Hack

DEVELOPMENTS AROUND THE ENGINEERING FACULTY

Engaging with Alumni at the Annual Alumni Weekend

In the last issue of Imperial ENGINEER we featured the first part of our conversation with Nic Katona, Head of Development for the Faculty of Engineering, which ranged across development, advancement and alumni engagement. Here we present more of that conversation with Nic and Andy Cox, a Development Manager in Nic's team, which especially focussed on the Alumni Weekend. Meanwhile, Nic has left Imperial to take up a position at the University of Leicester (and we wish him well).

IE – One of the things that was interesting at this year's Alumni Weekend was finally persuading the departments to have an open afternoon. That made a massive difference, certainly to me personally.

NK – And I think that that's another example of the work that having an embedded team allows us to do. The best part, I think, of working within the Faculty of Engineering, is that all the heads of department, the senior academics, the dean, et cetera – view us as part of the Engineering family. That we're not outsiders coming in. They view us as them. So imagine, the ask is a lot easier when my team come to the heads of department and say "Alumni relations would like to do this opening of the departments to provide an hour, and …", and we validate the idea to them. We let them know we will be there. We saw six of our ten departments open – it would've been more, but because of various construction going on we couldn't get all of them involved this time – but they said "Oh, okay".

IE – It's quite impressive getting academics to come in on the weekend.

NK – It's little things like that that people sometimes forget, that our alumni sometimes forget – that is a big ask, you know, of our academics who are here working long hours to come in on a weekend, to give up their time to talk about things. But what it has shown to us, is that no longer do our heads of department or our academics view their role as just teaching and research – that's their core role and they will never step off of it, don't get me wrong – but there's this kind of third prong which is the alumni engagement or the ambassadors of the department. And that's where we've helped to augment the internal culture, which we hope has then started to fan out to the external culture, of welcoming alumni back in. And it's very uncomfortable for some of our academics, they aren't sure what that means, what do I have to do, what kind of questions am I going to get, or…

IE – Well it's a different relationship with an alumnus or alumna than it is with an undergraduate or post graduate.

NK – It is, very much. When we do some of these, and we start providing some of the academics with lists of who's coming, you sometimes can see in their eyes "Oh my god, I haven't heard this name in years", but sometimes, which we slightly love, is when they look and go "Oh, this student didn't like me" or something like that, and it immediately flashes them back twenty or thirty years. And it's so great to watch the interaction, because the alumnus or alumna will usually be kind of cheeky about it.

IE – At the computing department session, there was a guy who had only been gone from college a few years, and one of the lecturers was talking about his research. And this guy said "You were my favourite lecturer, but…" and then he questioned what he was saying. He wasn't quite sure how to react.

NK – It's a new experience for them, but they usually come out of it chuckling a little bit, because the alumnus or alumna will say something kind of cheeky at some point in the conversation of "Oh, do you remember when you did this to me?" and stuff like that, and it's a moment for both of them and then they kind of connect and start talking about various things. But that's a new element for our academics here, so imagine someone who's been here for decades, and all of a sudden these new people come in and start saying "We want you to do research and we want you to teach, but there's this new thing we want you to do" and they're looking at us thinking "What?" So there was a lot of building those relationships internally also, so that they knew we were never going to put them in a position that was uncomfortable for them – you know, we are there to shepherd the alumnus or alumna, but we're also there to kind of guide and advise the academics as well. And if things start getting hinky we quickly know how to move in and go "Ooh let's take you over here and look at this" type of thing, which they've learned. They appreciate that, of how we gently move people through the process. But it's good, I'm glad that you were able to experience it, you were able to come back and see that, because we can promote it all day long, and say how great it is and how we think it's wonderful and how Imperial thinks its great – it's your voices I think that are most important. You know, you're validating this to other alumni, you are the alumni voice saying "Yeah, we had a nice time", so next year, instead of having thirty-five people at that, maybe we get up to sixty people. And it's just that word of mouth that I think is so important.

IE – One of my friends from CGCA came along at the last minute – he hadn't realised it was happening.

NK – Well, its the first time we've done it, and it was a later add-on, because we had to do our work of liaising with the departments and saying "yes or no" and all these things, and it was the first year. We felt we communicated quite effectively. But we also heard from some alumni 'Oh we didn't see that' or 'Wasn't aware of it' or whatever, and that's where we do have the alumni feedback. Next year it'll be right there at the outset, we've already started having the conversations about it, we now know which ones are willing to do it, et cetera. So the second that Alumni Weekend goes live, it's usually in January, we'll have that right up front and say "You know, hey, seven of ten departments are doing it" or eight of ten. Design Engineering probably won't do it because their building won't be ready, but at least we'll be having the majority of them being represented this year and allowing alumni to quickly just kind of catch up.

IE – Alumni have a great pride in Imperial. But at the same time the university has grown so much, so there's concern about how they relate to the college now. The open days give them a reason to come back.

NK – It does give them a reason to be there. It's an event that's not intimidating.

IE – I saw a lot of older alumni who were bringing their grandchildren to show them around and saying "This is the university you want to come to!" "Want to do music? No no, come here! Music, maths, same thing!"

NK – No that's exactly it, we want to offer them that opportunity to be able to do that. One of the biggest things I always joke about is that our team, and the alumni relations team and the college in general has started to give permission for Imperial alumni to kind of fly or wave the Imperial flag. And you see it at other institutions here in the UK, you see it in institutions in London – they sometimes fly the flag for no reason, whereas we have tons of reasons and our alumni are kind of just like 'Uuh...'. But it's interesting because we have alumni who will come back, we'll kind of be the facilitator of bringing them back in or what have you, and they'll see one another or they'll see a colleague of theirs from work and be "Oh, I didn't know that you went to Imperial"

AC – We have an evening event and they've been on the same train or on the same tube on the way.

NK – It's this really interesting thing about Imperial alumni. First, they're spread everywhere. Some of the highest echelons, across industry, even from the Faculty of Engineering alone, across the highest echelons – but, so humble. And I think that maybe that's another difference from my American experience. In America you wear your CV on your chest and you're just like "This is where I came from" immediately. And you could go to the most small low-level school, and you'd be "This is where I went". But here, this is an amazing institution, but our alumni are like "Yeah... I went to Imperial", and I'm thinking "Jeez, yell it". So we're trying to softly allow them to wave the flag, and things like that, and if that is all that our alumni want to do that's fine. And I think that that's the other piece that I'd love to get out the message is, we're not saying that all our of ninety-two thousand alumni have to come to alumni weekend or come to a lecture, or mentor a student, or even give at all. What we are saying is, at minimum, we just want them to know that the college is here and the college is open to them if they want to come back and experience it. If it's as simple as walking through Beit Quad to the union to get a beer.

IE – They don't stop being part of the college.

NK – Right, and that's the overarching message. And then for those who want to do more, we're here to help. The alumni relations team are here to help, we now have teams in place to be able to facilitate that – sometimes on a more bespoke level, sometimes more as a 'here's a big event you can come to' – maybe its just reading the alumni e-newsletter – fine! Do what is the area of interest for you! We just want to make sure those opportunities are afforded to them, and I think we're doing a better job than what we had before.

IE – That's a good note to end on.

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What, exactly, is an

The field of autonomous vehicles (AVs) is a rapidly evolving area. Even a decade ago the idea of a car that could drive itself belonged within the realms of science fiction; now, today, they are science fact. Over the next few decades AVs have the potential to change the world in a way not seen since automobiles themselves displaced horses as the primary mode of transport, over a century ago. In this article, John Routledge (IDE 2016) provides a brief introduction to a complex and fast-changing field of endeavour, one with many exciting engineering challenges, but also challenges that will require collaboration with a great number of other disciplines.

Put simply, an autonomous vehicle is a car, or other similar machine, that is capable of driving itself without human intervention. In practice however the terms 'self driving' and 'fully autonomous' have been used to describe many different vehicle features and capabilities. To provide a meaningful structure, the SAE institute has defined 5 levels of autonomy (see chart below).

Levels of autonomy

Level 1 is a very basic form of control. An example of this would be cruise control, where the vehicle can partially regulate one parameter (e.g. speed) but a human is responsible for everything else, and must give their full attention to the road at all times.

Level 2 is where most new cars are now. A typical Level 2 vehicle can control steering and speed in some limited situations but still requires human oversight; this encompasses ADAS (Advanced Driver Assistance System) features such as adaptive cruise control, lane keeping assist, parking assistant and automated emergency braking. Tesla's Autopilot system also firmly fits into this category, despite the connotations the name affords. A Level 2 car can essentially drive itself in limited circumstances, but it can't be relied upon to deal with everything. This means the human driver needs to remain alert, with potentially deadly consequences if they don't[1].

A Level 3 vehicle can control itself under certain conditions; enabling the driver to take their eyes off the road. However, the driver must remain relatively alert as they may be required to retake control if the vehicle encounters an unusual situation. In terms of capability, a Level 3 AV has a similar level of competence to that of a learner driver. It can handle most normal driving events with no problem. However in new, unusual or difficult situations it doesn't know what to do and a qualified driver has to step in.

A big concern with Level 3 is the 'handover period': the time between a vehicle telling the driver there's an issue and the point when the driver has to retake control. The current minimum handover period is 5 seconds; if the driver has been paying attention to the road ahead this time does not pose a significant concern. However, if the driver has been distracted it's barely enough time to retake the wheel, let alone comprehend the situation playing out on the road ahead. During their own testing Ford found their test engineers falling asleep at the wheel of their Level 3 prototype vehicles, which led to Ford's decision to skip Level 3 vehicles entirely[2]. This view is not shared by the whole industry, most notably Tesla, who have made no secret that every vehicle they've made since October 2016[3] has the hardware to facilitate Level 3 autonomy. All that's required is a software update.

Assuming Tesla deliver on their promise, the concerns around Level 3 autonomy will very soon move from theoretical to practical considerations. Used properly, Tesla argue,

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Autonomous Vehicle?

increased autonomy will improve vehicle safety, not put people at greater risk. Tesla vehicles on the road today have a 40% lower crash rate than they did before the deployment of Autopilot[4]; a clear demonstration, they say, that autonomy will improve safety.

However, while it is probable that Level 3 AVs will be involved in fewer accidents, it is possible that vehicles operating in the manner described previously (car driving, human watching) could lead to the driver paying less attention and subsequently being less prepared in the event of an unexpected event. In other words, Level 3 AVs could crash less frequently, but the crashes they do have could be more severe as drivers are less prepared to deal with the situation. The 'individualist' argument is that this will lead to people being killed by these vehicles who would not have died in a normal car; the 'utilitarian' argument is that this may be the case but the overall number of deaths caused by cars will be reduced.

Safety expert Chesley "Sully" Sullenberger suggests that "when we assign technology as the doer and the human component as the monitor, we're doing it backwards. Humans are inherently poor monitors."[5] Sully's argument is that the driver should retain control and the system should only intervene at the points when their concentration wanes; an idea similar to the 'Guardian mode' proposed by Toyota[6]. This highlights that the development of autonomous vehicles is not homogenous across the industry; different companies have and will take different approaches. The Level 3 autonomous experience could vary significantly between different makes of vehicle, and the way an AV behaves may become as much of a unique selling point in the coming years as infotainment systems and heated seats are now.

It's not until we reach Level 4 that cars will really be capable of operating in a way that most people would actually consider autonomous. Level 4 vehicles are capable of driving completely unaided within a fixed geographical area. This area could be something as small as a building site, or as large as a continent. However, mass implementation of Level 4 vehicles will probably start with a geographic area based around specific cities.

If a Level 3 AV is like a learner driver, then a Level 4 AV is like a driver who has recently passed their test: confident driving on familiar roads, but still a bit nervous on roads further afield. While Level 4 AVs won't come supplied with P plates, there's still the potential for a human to need to take control if the vehicle goes outside the known or 'fenced' geographic area. If it stays in the control area, these vehicles should be able to drive around with no human involvement.

The first Level 4 vehicles will be slow moving 'pods' such as those being trialled in Milton Keynes and Greenwich (see pictures, above and below); these will have no direct user controls (pedals or steering wheel) and will only be able to operate in a small area. Specialised full-sized passenger vehicles capable of driving around a specific city will come next. Ford has already committed to produce a Level 4 vehicle for use in a 'ridesharing fleet' by 2021[7]; other manufacturers have made similar commitments. Ridesharing vehicles or 'Robo-Taxis' are likely to be introduced ahead of privately owned AVs as the cost of Level 4 AVs will initially be quite high (less of a problem for fleet operators with high levels of

Image: UK Autodrive

A self-driving 'pod' vehicle built by UK Autodrive partners RDM Group. Up to 40 of the pods are being trialled in central Milton Keynes in 2017-2018 as part of the UK Autodrive programme. More details at http://www.ukautodrive.com

"when we assign technology as the doer and the human component as the monitor, we're doing it backwards. Humans are inherently poor monitors."
Chesley Sullenberger

Image courtesy of the GATEway Project

GATEway, a ground-breaking government funded research programme, was the first project of its kind to explore the public's hopes, fears and attitudes towards autonomous vehicles, through inviting them to be part of trials with prototype technologies and services. Research streams included: simulation trials; observations of pedestrian behavioural interactions with driverless vehicles; automated grocery delivery trials and a public shuttle service at the Greenwich Peninsula (shown in image). Early results indicates broad support (78%) for the idea of driverless vehicles on urban streets, provided they are safe and resistant to cyber attack. For more details visit https://gateway-project.org.uk

utilisation) and their city-sized 'fence' makes them more suited to shuttling people around a city than commuting into it.

While 2021 seems very soon, it is entirely possible that this could be achieved. Google's AV subsidiary Waymo have clocked up over 4 million miles of driving in Level 4 AVs[8] and will very soon be launching a trial ridesharing service of Level 4 AVs in Phoenix, Arizona[9]. Cruise Automation (a startup acquired by General Motors), are already running a ridesharing service for their staff in San Francisco[10], and nuTonomy have been running a trial service in Singapore for over a year[11]. In a recent debate Cruise Automation's CEO Kyle Vogt stated that "there's a path to a solution for all the technical challenges"[12] currently facing AV development. Such sentiments are echoed by many within the field, with most stating the ability to scale to mass production, cost and public acceptance as the main limitations on the speed at which Level 4 AVs can be deployed. Time will tell how much of this is hyperbole and attempts to grab media attention, but the truth of the matter is that Level 4 AVs are already among us, albeit in limited numbers. The important question now is how fast these vehicles will roll out, not whether they are physically possible.

Level 4 though is still just a stepping stone on the way to the holy grail: Level 5, a vehicle which is able to drive itself with no human interaction in almost any situation. While this may sound clear, the point at which Level 4 ends and Level 5 begins is up for debate. If a vehicle can drive across an entire continent, but no other continents, it is still technically Level 4; and yet to the average American (who is unlikely to ever take their car to a foreign country) a car that could do this would never need their intervention. Personally, for now, I define Level 5 as a vehicle that is capable of driving as well, or better, than a good human driver. This shouldn't just encompass the ability to control the vehicle, but the ability to operate in new and unusual situations. It is important to stress here that it is unlikely that any autonomous vehicle will ever be able to handle absolutely every situation, just as it is highly unlikely that any person will ever be able to handle every extreme situation. I for one am pretty sure I would not be able to navigate the death road in Bolivia by car (see below left) on my first attempt, and similarly Level 5 AVs will still occasionally get confused by a few new, unique and highly unusual situations, or 'edge cases' as they are commonly referred to.

Image: Waymo

Waymo's fully self-driving Chrysler Pacifica Hybrid minivan on public roads

That said Level 5 AVs will most likely have the ability to communicate, so an awkward situation for one vehicle could become a learning experience for the rest of the fleet. In reality Level 5 AVs will probably be less likely to get caught out than their human counterparts, but people will be far less forgiving of these machines than they would of human beings. One issue that has yet to be resolved with regards to AV driving performance is how good is good enough? What unit of measure should be used to define how capable and how safe an autonomous vehicle is? How do you compare this measure to the performance of human beings? How much better than a human being does an AV need to be before people will feel confident enough to use it?

The ambiguity surrounding Level 5 AVs make it difficult to evaluate claims relating to their development. At the optimistic end of the spectrum, BMW suggested that they would be producing Level 5 AVs by 2021[13]. Meanwhile Gill Pratt of Toyota's Research Institute thinks it may be decades before it will be possible to make Level 5 vehicles a reality[14]. This dramatic disparity is partly due to different interpretations of what Level 5 means; if we use a strict definition of Level 5 then Gill Pratt is almost certainly correct, it will take decades to develop an autonomous vehicle that is capable of driving in all conditions across the entire world. However, as stated previously, it is entirely plausible that within the next decade a vehicle could be developed that could traverse a continent unaided, which is probably what BMW are using as a definition.

Such ambiguity will likely be addressed by subdividing or refining the Levels of Autonomy as the technology matures. Regardless of where the lines are drawn, there will be a point (probably within the next decade in the developed world) where we will be able to get into a car and the only input we will need to make is to specify the destination. This is what I refer to as 'functional autonomy', the point at which a vehicle can act entirely autonomously for a normal human journey. This doesn't mean that every car on the road in 10 years will be functionally autonomous, it could take decades for AVs to become the dominant road vehicle, but it will happen.

The drive for autonomy

So far we've covered the 'what' of AVs, and 'when', but we haven't explored 'why'. The primary reason most people cite for this endeavour is safety: according to the World Health Organisation road accidents are the 10th largest cause of deaths worldwide[15]. In some countries, like America, the number of road accidents and associated deaths are actually on the rise again, after many years of decline[16]. It is widely reported that more than 90% of road accidents are caused by human error[17]. The main reason experts think accidents are on the rise is because people are getting more distracted with devices like smart phones. So it would seem we are generally not as good at driving as we'd like to think, and some would prefer to check their phones more than concentrate on the road ahead.

These issues are alarming, and a clear mandate for change, but many articles greatly oversimplify the situation. Autonomous cars are often touted as a panacea that will solve this problem overnight. However to realise a 90% reduction in vehicle accidents would mean removing all human error from driving, which would mean replacing all driven vehicles with functionally autonomous ones. Frankly this isn't going to happen soon (if at all), with even optimistic projections seeing only about 85% of road traffic replaced by AVs by 2040[18]. AVs will most likely reduce the number of accidents and road deaths, but it will be a gradual downward trend, not a massive sudden drop.

Image: Ilosuna (via Wikimedia)

The North Yungas Road (also known as Death Road) in the Yungas region of Bolivia connects La Paz to Coroico, 56 kilometres away, winding through very steep hillsides and clifftops. Most of the road is the width of a single vehicle, alongside a sheer drop of up to 600 metres with no guard rails. In 1995 the Inter-American Development Bank named it as the "world's most dangerous road".

While safety is a clear reason to implement AVs, it is not the primary force that will drive adoption. As outspoken automotive expert Alex Roy recently wrote, "Does anyone really care about safety? Nope."[19] The harsh truth is that Alex is right, as a society we are more than happy to accept the deadly cost of cars in return for the freedom they afford, and a large number of people will very vehemently defend their right to operate driven vehicles if anything threatened that. More people are killed by cars in America each year than by guns[20], and we all know how strong the opposition to gun control is in the United States. Imagine the backlash if someone attempted to introduce legislation that sought to curtail human operated automobiles from the roads.

While some countries will be more receptive to the safety argument, the simple fact is that extolling the safety benefits of AVs is not the way to 'sell' them to the world. People need to trust these vehicles (which they currently don't[21]), and see that they will provide an actual benefit to their lives. In some ways the industry is not helping itself here, with the rush to beat the competition to market perhaps overtaking safety concerns for some; a criticism that has been levelled at a number of companies like Tesla and Uber. Reporting on AVs has already become surprisingly polarised, with a wealth of articles over-hyping the technology and its capabilities, and an equal number extolling catastrophic future predictions. If all the articles are to be believed AVs are going to solve all traffic problems, give everyone more leisure time and save our cities from congestion and pollution, whilst simultaneously destroying the fabric of society as we know it, killing innocent people and putting millions of people out of work.

There are lots of articles that attempt to address all the ethical questions raised by autonomous vehicles and their potential impacts on the future of society, but many of these articles are far more opinion than fact. The truth is that no-one really knows how it's all going to play out; autonomous vehicles are a new tool and it depends how that tool is used as to how our future will be shaped by them. The key going forward is to focus debate on how these tools can genuinely help improve our lives (not a company's bottom line), and design effective systems to ensure that this sort of usage is encouraged and supported.

For me, the potential wins for AVs are the fact that they can give elderly and disabled members of our society (approximately 30% of our population) a level of independence they have never experienced before; they could improve traffic flows making it much quicker and easier to travel; they could trigger infrastructure changes with efficient traffic flows allowing more space to be given to pedestrians and cyclists; and they could create more sustainable transport systems. Most importantly though, they'd allow me to take a nap on my regular commutes up and down the M1, and I really can't wait for that.

Image: Uber

Uber have been testing autonomous driving using Volvo XC90 SUVs in Arizona

Fallout from the Uber accident

Not long after this article was written we heard the news of the tragic death of Elaine Herzberg after she was hit by an autonomous Uber test vehicle driving on the streets of Arizona. While unfortunate, for many in the industry this day was seen as inevitable; and while that is probably true (there will always be unpreventable accidents), the circumstances around this particular accident are particularly troubling as both the vehicle, and the 'safety driver' meant to monitor that vehicle, failed to spot Mrs. Herzberg. While I would argue against some of the more extreme reactions that have been aired since the accident, calling for AVs to be banned, I think this event has brought to a head many issues that have not been adequately resolved. Now should be the time to pause and consider them.

The words of Sully Sullenberger ring truer now than ever, and highlight that the companies developing these vehicles could be doing more to safeguard them. Some organisations have been too quick to put these vehicles on public roads without enough evidence to show that they can operate safely. Beyond this though we also need to think more critically about the rules governing autonomous vehicles; it's time we defined what 'safe' is for a self driving car, and how we measure it. We need more rules in place to be sure that a vehicle is not a risk to the public before it is deployed on a public street. We also need to make sure that companies are really considering how they design these systems, and are implementing autonomy in a way that genuinely improves safety.

What we must remember though, is that the same day Elaine Herzberg was killed, over 3,400 people across the globe were killed by regular human-driven cars. The potential to save that many lives is a worthy goal, but it has been made clear now that we cannot assume that the safety element of AVs is a given, we need to do more to make sure Elaine Herzberg's death was not in vain.

more than 90% of road accidents are caused by human error

Want to know more?

If you want to find out more about AVs, John has provided the following background reading (linked to footnote numbers in the text).

1. As a well publicised Tesla crash last year showed: http://bit.ly/IE28-AV-TeslaCrash
2. As discussed in this article: http://bit.ly/IE28-AV-Ford
3. See Tesla's announcement here: http://bit.ly/1E28-AV-Tesla-HW
4. http://bit.ly/IE28-AV-Tesla-Autopilot
5. http://bit.ly/IE28-AV-Sully
6. A video demonstrating Toyota's Guardian mode is available on YouTube: http://bit.ly/IE28-AV-Guardian
7. http://bit.ly/IE28-AV-Ford-2021
8. http://bit.ly/IE28-AV-Waymo-4M – this does not include the many miles Waymo vehicles have travelled on private roads at their 'Castle' research centre, or the billions of simulated miles driven in their 'Carcraft' simulation software: http://bit.ly/IE28-Waymo-Testing
9. http://bit.ly/IE28-AV-Waymo-Taxi
10. http://bit.ly/IE28-AV-Cruise-SF
11. http://bit.ly/IE28-AV-nuTonomy-SG
12. http://bit.ly/IE28-AV-Vogt – Kyle Vogt talking on a panel discussion hosted by Alan Ohnsman, Senior Editor, Future Mobility, Forbes Magazine
13. http://bit.ly/IE28-AV-BMW-2021
14. http://bit.ly/IE28-AV-Pratt
15. http://bit.ly/IE28-AV-WHO
16. http://bit.ly/IE28-AV-US-roads
17. http://bit.ly/IE28-AV-Human-Error
18. http://bit.ly/IE28-AV-Trends – see exhibit 2 in this report for AV adoption projections
19. http://bit.ly/IE28-AV-Roy
20. The annual average is 33,000 firearm related deaths per year: http://bit.ly/IE28-AV-US-Guns compared to around 40,000 car related deaths: http://bit.ly/IE28-AV-US-Traffic
21. http://bit.ly/IE28-AV-Distrust – Public opinion is shifting, but even the most recent surveys still see more than half of respondents stating they would not use an AV

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ES&E Geophysics Society

Both RSMA and CGCA contributed towards the costs of the Department of Earth Science and Engineering Geophysics Society trip to Indonesia in the summer of 2017. This 'diary' is based on the students' report of their experience.

1st to 2nd July 2017 – Days 1 & 2

Today we flew from London Heathrow to Singapore via Dubai. The flight with Emirates was very nice, and a lot of films were watched. We landed in the morning at Singapore so there was no time to sleep or let jet lag hit us, we went straight into tourist mode (consisting mainly of complaining about the humidity!) and made our way to the hostel which was in Little India. After leaving our bags we went to a local street food market where we could get a huge platter of Indian cuisine for only 3 dollars (about £1.50)! After this we all walked down to the harbour front where the Marina Bay Sands hotel is located, a huge 3 tower hotel with a 'boat' supported on the top. Around the base of this is an area called the Gardens by the Bay, which is a conservation effort by the Singapore government to integrate wildlife into a city environment. We wandered around the gardens and sat on the grass and within less than 5 minutes almost everybody had fallen asleep. Steve somehow managed to fall asleep in a crunch position?! At some point, we found some motivation to go look at a statue of a giant baby and get some dinner in a nearby restaurant as we were waiting for a light show that uses the artificial trees in the garden. The light show was good, it was done in time to songs from musicals. Just before the light show however, there was another display to behold, the bats in the garden came out from their hiding places and were swooping down scarily close to where we were sitting. (Robbie was least pleased with this, having his flip flops on his hands in case any flew too close to him, so he could bat them away!). After the light show we had to walk back to the hostel, and go a long way round as the normal route was blocked off due to Singapore celebrating their independence with a concert on the bay front. Our feet all ached, our eyes were heavy, so when we made it back to the hostel we fell asleep instantly! A remarkably successful first day considering how sleepy everybody was!

3rd July 2017 – Day 3

Today it was raining very heavily in the morning, and we all breathed a sigh of relief in the hope that it meant the humidity would drop. Unfortunately, however, it didn't. It was somehow still as humid after the rain as it was before. We had planned to go to the national museum as we knew it had a section on the geological history of Singapore. When we got there it had great air conditioning and was also a very well laid out and descriptive museum. We learnt a lot about Singapore's history, which most of us had never had the opportunity to learn about before. It highlighted how Singapore has such a diverse range of cultures and lifestyles.

After this the rain had stopped so we walked back to the Gardens by the Bay and went inside one of the large conservatories that they have. They have two but we were mostly interested in the cloud observatory as it highlighted how the meteorology affects animals, flora and fauna as the altitude increases. We made sure to pay attention so that we could try to recognise things when we were climbing Mt Sibayak. After this we went to Little China for lunch and wandered around the area.

Today was Ed's birthday, so in the evening we went to Clarkes Quay which is a pretty area with restaurants on the water. We went for Vietnamese food in a place called Little Saigon. It had great food and an even better live band, (they also learnt *Country Roads* for us so we were happy!). The day was a great success. Tomorrow we leave for Indonesia!

4th July 2017 – Day 4

We started the day early to catch our flight from Singapore to Indonesia; everyone was very excited to move onto somewhere new! We arrived in Beristagi after a couple of hours drive and a pit stop for lunch where we first encountered some traditional Indonesian cuisine. We ordered some lovely Nasi Goreng and Mie Goreng, little did we know this was all we'd be eating for the next two weeks… Once we got to Beristagi we decided to walk around the town to visit the local market and go in search of a local hot spring. Unfortunately Google lied and 'Hot spring Nicole' did not exist, so we headed back to the hotel for a dip in the pool and some more Nasi Goreng.

5th July 2017 – Day 5

After a lovely night's sleep in our fancy hotel room we had another early start in preparation for an action-packed day. Following breakfast of Nasi Goreng at 7:00am we were

Photo of Lake Toba by Emma Pearce

trip to Indonesia 2017

picked up by our tour guides at the hotel and transported to the base of Mt Sibayak. The walk to the top of the 2,200m mountain took about 3 hours with quite a steep initial ascent through a forest. Once we were an hour from the top, the forest thinned out and the views were amazing, we could catch a glimpse of Mt Sinabung, currently Indonesia's most active volcano. As we walked up to the summit we were met with active fumaroles and sulphur crusted rock fragments. The scramble to the summit was worth it, the views of the crater on Sibayak, Mt Sinabung and the forest-filled valley were breathtaking. After we were back at the hotel, we were bundled into taxis and headed on our way to Sipisopiso waterfall. This was a quick journey, just enough rest after our active morning. Sipisopiso waterfall is located on the tip of Lake Toba and the view we were initially greeted with was again amazing. The view of the lake didn't look real, a beautiful setting for lunch! After refuelling we began the walk down to the bottom of the waterfall, this took about 45 minutes and by the end we were cooled off by the spray of the water into the plunge pool. After only staying there for about five minutes we were drenched, at least it kept us cool on the journey back to the top! Once we'd all arrived at the top we continued our journey onto our accommodation at Lake Toba.

6th July 2017 – Day 6

Lake Toba is Southeast Asia's largest freshwater lake, and the largest caldera lake in the world. It was formed about 80,000 years ago by a volcanic eruption: the caldera that was created eventually collapsed in on itself and the high-sided basin that remained filled with water to form the lake. This eruption is believed to be the largest in history. A second, smaller volcanic eruption, 50,000 years after the first, created an island the size of Singapore in the middle of the lake. This island is Pulau Samosir. Today we got the ferry across to Samosir to learn about Batak culture and visit the volcanically active region of the island. We were taken around by a lovely tour guide who took us to a traditional Batak village and to interesting geological sites on the island, such as a volcanic rock formation, the hot springs and the new active volcano that is forming at the edge of the island. The day was topped off by a quick dip in Lake Toba itself, which was an incredible chance to take in the sheer scale of the lake and how big the volcano would have been.

7th July 2017 – Day 7

Today we went on a jungle trek into an area of protected rainforest near Lake Toba. The hike enabled us to learn about the flora and fauna of the region, visit 'Tarzan's house', see a gibbon and swim in a waterfall. In the afternoon, we jumped into our transport just before the tropical heavens opened and drove to Medan.

8th July 2017 – Day 8

Having awoken at an ungodly hour, a fleet of taxis dropped us off at Medan airport to commence our 18-hour journey to Bandung. The audacious and adventurous group beelined past local vendors to Starbucks for a caffeine hit before proceeding through security with our full beverages in hand to the plane. A short island hop from Sumatra to Batam and then back to Sumatra gave great aerial views of the landscape and displayed the blatant human impact on the environment below. After landing we boarded a coach that would become our temporary home for the rest of the day, driving down to the southern tip of Sumatra before catching a ferry to Java then driving on to Bandung.

I use the word coach lightly, perhaps it should have been called a roving hotbed due to the infestation of militant mosquitoes forming a resistance against their unwelcome new co-inhabitants. The first hours spent on the peripatetic breeding ground were an almighty struggle between human and pest, successive waves of mosquitoes originating from every recess fought off valiantly by the explorers

as we approached the sea port.

Little respite was to be had on the packed-out boat either as the only place with enough spare oxygen to breathe was the front deck. However the views were spectacular and found their way on to many an Instagram feed. After a frantic disembarkation, we settled in for a long ride to Bandung. Having suffered major losses in the initial clashes on the bus, the federation of assorted winged insects resorted to guerrilla warfare, however small-scale skirmishes were resolved quickly with the use of repellent and improvised swatters.

The humans, triumphant, regrouped and we decided to toast our success with a succulent KFC just past Jakarta. In the queue for the moist and zingy chicken we discussed a great deal of things: does Singapore really have the tallest indoor waterfall? Has Charlie instagrammed the Colonel's iconic logo yet? Would we have won the battle with the bugs earlier had we not been asphyxiated by the DEET?

As we chomped down on the crispy fillets we reflected on our favourite memories from Sumatra and pondered on what Java had in store for us. The trip so far had been astounding and suffice to say we couldn't wait for a comfortable bed to rejuvenate us for the next part of the trip.

9th July 2017 – Day 9

Today we explored Bandung, walking into the centre of town from our accommodation. Unfortunately as it was a Sunday there wasn't a lot open so we decided to try to visit a nearby waterfall and volcanic hot springs. Although on arriving back at the hotel we were told that this was not possible either. However, all hope was not lost when we discovered a nearby sculpture museum. The museum itself was really fun and there was a lot to see. As we were walking around we actually bumped into the artist who had made the majority of the outside sculptures and he gave us a guided a tour around them. We were then taken down into his workshop where he is in the process of completing a currently 20-year-old project for a sculpture that will be bigger than the statue of Liberty! This statue is being transported in parts to Bali where he will assemble it next year (hopefully!). Our tour guide at the museum then took us to one of his favourite restaurants in the city where we had a lovely selection of Indonesian and western food to choose from.

10th July 2017 – Day 10

An early start today to check out of our hotel and head to the Centre for Volcanology and Geological Hazard Mitigation (CVGHM) for presentations and a tour around their geological museum. This was a very interesting and formal experience. The presentation topics included volcanic hazard mitigation, landslide monitoring and earthquake monitoring. All of which our group has studied so we had lots of questions at the end leading to long discussion with those from the centre. We were able to gain valuable insight into some of the things we had seen on Mt. Sinabung like previous eruptions and landslides. The tour around the geological museum was lovely, they had a range of exhibits from fossils to an earthquake simulator. Although I think Charlie's favourite bit was the gift shop where he picked up a plethora of souvenirs. Afterwards we were promptly picked up by a tour guide and taken out of the city to visit the Tangkuban Perahu volcanic crater. Tangkuban Perahu is a stratovolcano about 30km north of Bandung so we thought the journey was going to be one of the quicker of the trip, however the vast extent of the traffic anywhere in Indonesia never failed to surprise us. So we arrived at the crater about 2 hours after departing. We were dropped off near the top, so the walk to the crater rim was not too strenuous. Once at the top the views were brilliant and we wandered around to all the viewing platforms. After a long day we once again hopped on our coach, this time not mosquito-infested, and headed to Jakarta.

11th &12th July 2017 – Days 11 & 12

It was the day we had all been waiting for – the boat trip to Krakatoa! Krakatoa is a set of volcanic islands around 50km off the West coast of Java which were formed due to the eruption of a much larger island in 1883. Bronwen and Sophie were throwing up before we even got on the boat (something they had eaten the night before) and were swiftly joined by other members of the team who weren't huge fans of the 1.5 hr boat ride! The journey was a more beautiful experience than we could have ever imagined. The boat chugged its way through the deep blue waters of the Indian Ocean, past steep-sided islands smothered in rainforest and volcanoes blackened by recent eruptions. The island we were visiting, Anak Krakatau, was only 90 years old and was uninhabited – except for a few giant monitor lizards which we spotted later on (thinking at first they were deadly komodo dragons!). We set up camp on the beach in the shade of the jungle. That afternoon was spent snorkelling, hiking and eating freshly cooked food (plus Oreos and funky Indonesian biscuits – these were always on the menu). In the evening we hiked up to the volcano to watch the sunset, which was out of this world! To top off an incredible day, the guides even brought out Bintangs at dinner (along with some tasty freshly-caught seafood)! The following morning we were promised that a 5.30am wake up was worth the beautiful sunrise we would apparently be able to see with a short hike up out of the rainforest. This was a lie – it was probably the worst sunrise I have EVER seen – the sun didn't actually become visible and was hidden the whole time by a curtain of cloud. To apologise for the early

Photo of Krakatoa by Charles Braham

wake up, the guides decided they would take us to climb the volcano – insisting that the top really would be worth it! And how right they were! It felt like being on another planet, with sulphur plumes and yellow stained rocks rising up against a stunning backdrop of the other volcanic islands. After a climb back down, breakfast and a pack up of tents, we left to explore another island. This was just as jaw-dropping as the first! After a morning exploring and snorkelling we really saw the impact of climate on the coral reefs with widespread bleaching opening up before us. After tucking into some more funny food, it was time to head back to mainland Java. Next stop Jakarta!

13th July 2017 – Day 13

After only just arriving in Jakarta we were up early for a full day of activities. Deciding that we were sick of sitting in taxis and cars and coaches and any other form of motorised vehicle we decided to walk to our first destination, The Meteorological, Climatological and Geophysical Agency (BKMG). This was a mere 50 minute walk, not much further than most commutes into university every day. However, what we didn't account for was the lack of infrastructure available for the mere pedestrian. Needless to say we had many strange looks whilst 20 seemingly lost students trundled their way along the streets of Jakarta. We did eventually make it to our destination bang on 9am and were greeted by a lovely group of people who were very keen to show us their earthquake simulator; obviously we all had to have a go. After the initial fun we got down to business and the people at the institute gave presentations on different techniques they use to assess and monitor Tsunami and earthquake hazard in Indonesia and the wider reaches of the Indian Ocean. We were also given a whistle-stop tour of their Tsunami early warning centre systems. Again we had lots of questions to ask about the techniques and technology they were using. To top the day off they showed us around their seismometer museum where they held some of the oldest seismometers in South East Asia. We had a great morning and everyone there was so welcoming. Again, we set off on foot in search of some lunch, and we ended up at a nearby shopping centre on the recommendation of the people at BKMG. Initially we were quite sceptical of the legitimacy of the claim that there was a food court at this place, however after searching 5 floors of the deserted self-storage section of the building we eventually stumbled upon the hustle and bustle of the lunch-time traffic in the food court. There was a big selection of food so we all managed to find something we liked, even in the form of deep fried ice cream…? I'm still confused. The day had gone all to plan, and we had plenty of time to get to our next destination, Pertamina University, on time. However, we did not factor in the fact that this shopping centre was not a regular stop off for taxis, so sourcing transport for our half an hour journey began to prove very difficult. Over an hour later we were all safe in Ubers on the way to the University, now racing against the clock with only 30 minutes exactly left to get there. Unfortunately, some of the Uber drivers didn't know the streets of Jakarta as well as they initially thought and took many a wrong turning causing two groups to arrive 40 minutes late. Luckily the people at the university were very understanding and insisted that we wait for everyone to begin. We were given a presentation on Geothermal energy production in Indonesia and the research going into how to extract energy from their plethora of volcanoes on the Islands. Afterwards there was a lengthy Q&A session with the speaker, not only due to the Imperial students but also students from Pertamina university who attended the talk. Once the official talk was over, the organiser of the event asked us if we could share our experience as a society that we have had on our trip and also the day to day workings of the society. This was to aid the geophysics students of Pertamina to set up their own equivalent society soon, as the university is only one year old so no such societies exist. It was really good to interact with the students and academic staff, we were able to share our experiences to help them to become a successful society. The people at Pertamina were absolutely lovely and I think we have made a good grounding for future relations with them, whether it be an exchange of some kind or research collaborations. After this a PhD student actually studying at Imperial, originally from Indonesia, took us out for dinner to a local mall. It was again great to chat with him and talk about his research links between Imperial and Pertamina. Since this was our last night in Indonesia and we had barely a chance to buy any souvenirs we headed to the night market in the centre of town. This really didn't disappoint, it was full of everything and anything you could think of, from food to tattoo artists. It was nice to wander around and see the city at night.

14th July 2017 – Day 14

Sadly, today was our last full day. After a very early start and an early morning flight from Jakarta, we arrived back in Singapore. We dumped our stuff at the footprints hostel before heading off to lunch. A group of us headed to the Hill Street Tai Hwa Pork Noodle stall, a Michelin star street food stall. After almost an hour, we got served and sat down to really tasty noodles. Whilst the others got dinner, we made a stop off at the Harbour front, for lots of touristy photos, and iconic Fort Canning Park before joining everyone. Once we had all regrouped we decided to go to little Saigon, as we had had such a great time last time. We did the eagerly awaited group awards and had a few cocktails then moved to Cafe Iguana for a late night Mexican snack and margaritas. Once again we went back to Little Saigon for the live music, where we stayed for the rest of the evening before heading back to the hostel for a few hours sleep before the long trek back.

15th July 2017 – Day 15

After all the excitement, it was an emotional goodbye to South East Asia. We'd all had an unforgettable trip with plenty of once in a lifetime experiences! We were able to see four volcanoes. Two of those infamous for causing the largest eruption, and the largest tsunami, ever. These experiences couldn't have been had in Europe, let alone the UK, and were inspiring for all. We all learnt a great deal about the Pacific ring of fire, and what the Indonesian government are doing to mitigate against the risks of living on it.

Photo: Robbie Churchill

On Anak Krakatau

Photo: Geophysics Society

On Mt Sibayak

RED Project

In the Spring 2017 issue of Imperial ENGINEER we featured an article by Jana Tian, one of the volunteers on the pilot expedition for the Rural Education Development (RED) Project, a student-led project established at Imperial in 2015, that centres on sustainable educational development in rural and marginalised Bornean communities. Founded in the department of Civil and Environmental Engineering, the primary focus is on the development of educational infrastructure in communities to which they reach out. With a strong aspiration to integrate engineering and education in the project, they collaborate closely with a local project partner, Life Empowerment Berhad (LEB), to realise educational development in Borneo. Below is an article based on the summer 2017 expedition report from the RED project team. Find out more at https://www.redprojectborneo.com

We encourage the application of skills and knowledge learnt by providing Imperial students avenues to develop transferable skills and gain practical experience.

During the academic term, students participate in college-wide fundraising and devise strategies for project development. Over the summer, students volunteer in Borneo to build an education centre for the underprivileged.

Fundraising

In addition to grant applications, we organised fundraising and publicity events such as college-wide sales and a charity dinner. Our members dedicated themselves to the design of Christmas cards, which were sold to college members and staff.

Our major fundraising event was the joint charity dinner with student societies at Imperial: namely Enactus Imperial, Raincatcher Imperial, Engineers Without Borders and TedEx Imperial. It was an end-of-term event in December 2016 which allowed members across different societies to share their volunteering experience whilst indulging themselves with exquisite Malaysian cuisine at Melur London.

We managed to garner support from the Imperial College Malaysian Society (ICMS) for college outreach programmes and publicity. We foresee that this will in future enable RED to gain greater exposure among freshers for recruitment, which would help expand RED's membership and increase participation from Malaysian students.

Student engineering

From the successful 2016 pilot project, we drew on invaluable engineering experience in Borneo to improve on the current expedition whilst upholding RED's core values. To enhance the environmental sustainability of this project, RED innovated on green technologies such as off-grid solar panel system and rainwater harvesting technique.

Solar panel system

A 7-member project development team explored an off-grid solar panel system. The solar panel system has the flexibility of tapping into an existing 230 V power grid, allowing maintenance on the solar panel system to take place without interrupting power supply. In addition, occupants can also resort to the power grid for electricity when the power output from the solar panels is unable to meet electrical demand.

This project was developed under the invaluable advisory of Dr. Ekins Daukes from the Imperial College Department of Physics. With kind support from Dr. Julie Varley and Mr. Vim Patel, a prototype was built in the mechatronics laboratory at Imperial.

With the functional prototype assembled, it provides a solid groundwork for future project expansion and adaptation. We envision potential collaborations with other societies in the Community Action Group (CAG) to take place.

History

Summer 2015 feasibility studies

Founded in 2015, RED's first overseas outreach dates from the summer of the same year when founders Edrea Pan, Chole Detanger and Jack Wilkinson embarked on a 3-week Bornean expedition to Kampung Indarasan in Sabah.

The expedition aimed at gauging the feasibility of volunteering in rural Sabah by assessing the region's climate, geological conditions and availability of local sustainably-sourced construction material.

Furthermore, needs assessment was also carried out to channel essential input into the 2016 summer expedition. The needs assessment was crucial in planning social services that address educational demands from the underprivileged in Borneo.

Summer 2016 pilot project

Building on the 2015 feasibility studies, RED launched its pilot project in Ranau, Sabah with fourteen Imperial students. Strong partnership with LEB enabled RED to complete a single storey 6 m by 9 m kindergarten in 6 weeks.

This project was the culmination of dedication from RED members and generous support from the Institution of Civil Engineers, City and Guilds College Association, Imperial College Union, IC Trust and the Department of Civil and Environmental Engineering at Imperial.

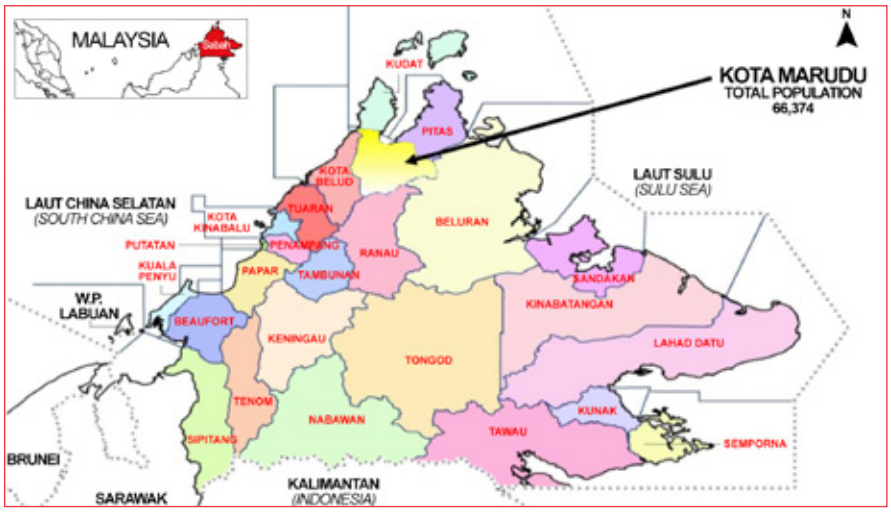
Once again, our 2017 project received returning support from all those institutions. Together with immense financial sponsorship from the Happold Foundation and the Victoria League for Commonwealth Friendship, we successfully touched the lives of rural communities in Kampung Palipikan through a 5-week expedition in summer 2017.

Summer 2017 second project

Background

A group of eighteen volunteers from Imperial travelled to Sabah in Malaysian Borneo for five weeks, to construct a kindergarten for a native Dusun community in Kampung Palipikan. A tranquil village in the Kota Marudu district, Kampung Palipikan is in the northern region of the Sabah state and houses about 500 people.

Two rivers, namely Sungai Palipikan and Sungai Kanarom, isolate Kampung Palipikan from the nearest town, Kota Marudu, making the village geographically less strategic for trade and infrastructural development. The village is accessible by vehicles through gravel roads that cut through a commercial palm oil plantation. Alternatively, a shorter path passing through hanging foot bridges that span over the two



Summer Expedition 2017

The completed kindergarten

rivers can be taken.

According to the head of the village, Mr Metto bin Mositoh, most of the villagers in Kampung Palipikan are rubber tappers and farmers. To shorten travel distance, the hanging bridges are used for transporting agricultural produce to Kota Marudu. With monthly income per household of the village averaging at RM 450 (about £80), which is well below the regional mean of RM 4879 (Department of Statistics Malaysia, 2014), the villagers lead a frugal lifestyle to ensure that their children have access to education.

A stalwart supporter of good education, Mr Metto bin Mositoh had been relentless in lobbying for support to equip the village with an education centre. In the past, a community centre was used to conduct elementary classes.

However, the community centre needed expansion to meet the growing number of students in the village and from the neighbouring Paliu Sumbu village.

This was when RED stepped in, with the objective of constructing a multi-purpose infrastructure serving not only as an education centre for children, but also as a learning area for teenagers and adults. In collaboration with LEB, RED worked together with the villagers to bring the project to fruition.

We believe that working together with locals in championing educational equity is integral to sustainable development. Involving the Palipikan villagers in the construction gave them ownership of the project, thus ensuring that the kindergarten will be put to good use and maintained after handover.

In continuation of our effort in educational empowerment, LEB sponsored teachers to teach in Kampung Palipikan after the kindergarten was constructed, allowing students in the rural community to receive educational support essential in fulfilling their scholarly pursuits.

Photos courtesy of RED Project

We were always in the company of the Palipikan children, whose boundless enthusiasm, admirable conduct and great optimism coloured our expedition.

From project initiation to completion, we made sure that the following core aspects were upheld:

1. Educational Infrastructure

With the nearest public schools located an hour away on foot, remoteness of the Kampung Palipikan fuelled the need for an education centre. To attend classes, the Palipikan children trekked treacherous terrains and crossed wobbly hanging bridges. By bringing an education centre into Kampung Palipikan, travel time for the local children reduces. According to Mr Metto bin Mositoh, there is a significant number of neighbouring villages that are deprived of basic educational infrastructure. Thus, the education centre also offers children from more remote villages opportunities to pursue elementary education.

2. Safety

Locals that we worked alongside on the project are seasoned builders, adept at building traditional wooden houses. Reliant heavily on past construction experience with timber structure, most of the existing traditional houses were built with no fixed guidelines. To introduce safe building practices to the Palipikan villagers, together with LEB, we implemented building designs that were in compliance with the Eurocode regulations. This is also to ensure that the education centre functions throughout its design life in a serviceable state. Moreover, the structural designs were also given considerable adaptations so that they were well suited for the tropical climate in Kampung Palipikan.

3. Sustainability

To achieve effective project implementation, we put great emphasis on functional, safe and sustainable design solutions. Construction material and equipment were sourced locally to ensure that the project contributes to the local economy. As the supply chain shortens, delivery times reduce, thus saving logistical cost and avoiding delay in material supply.

To boost the project's environmental sustainability credentials, solar panels and a rainwater harvesting tank were installed. The green technologies give the locals exposure to harnessing the solar and water resources that are in abundance in tropical Borneo.

4. Learning experience for volunteers

During the expedition, volunteers gained first-hand project planning and construction experience, thus allowing them to not only consolidate engineering knowledge acquired at Imperial, but more importantly hone their transferable skills and problem-solving techniques.

As the volunteers stayed in Kampung Palipikan throughout the expedition, exploring local culture and interacting with the local communities also enriched their volunteering experience.

5. Exchange of knowledge

The usage of pre-fabricated materials aligned with our pursuit of sustainable building solutions and eliminated the need for intensive labour. Pre-fabricated components such as cement wall panels and gypsum boards were incorporated into the construction of interior and exterior walls, while pre-manufactured steel frames were used for roof truss assembly.

With simplified building processes, inherent construction hazard was minimised, thus creating a safer environment for volunteers to apply their engineering skills. Working alongside skilled Palipikan villagers promoted technical skills exchange, allowing volunteers to learn practical construction techniques. In return, the locals gained greater appreciation for sustainable construction and development.

English Curriculum Design

To ensure a sustained impact to the rural community that we work with, we continued the English teaching initiative in the Palipikan village, which was first started in the 2016 summer expedition. Apart from participating in construction, student volunteers also assumed teaching roles in evening English classes. These classes took place bi-weekly during the 5-week expedition. In our effort to better structure the English classes, we had a team of 11 members who dedicated themselves to designing an English curriculum suitable for the Bornean children in the Palipikan village.

The curriculum revolved around expanding English vocabulary through interactive games and nursery rhymes. English booklets delicately designed by our members were presented to the Bornean children to accompany them in learning. Furthermore, flash cards and teaching kits, adjunct to the English booklets, were also introduced to enhance the children's learning process.

Engineering and construction

Over the course of the 5-week expedition, we constructed a single-storey education centre of dimensions 6 m by 9 m. It is a steel-framed structure clad with cement fibre board on the exterior and gypsum board on the interior. Resting on a reinforced concrete pad, the education centre has a large central hall (approximately 6 m by 6 m) as a classroom. Furthermore, the education centre houses a pantry for teachers to prepare snacks, and a storage room. The latter facilities are roughly 3 m by 3 m in dimension. Steel trusses covered by metal sheets with wool insulation provide sufficient shade for the structure under torrid noonday sun.

Construction Challenges

Collaborative work between RED and three skilled Palipikan villagers allowed challenges that emerged to be overcome as the project progressed. This collaboration allowed transfer of knowledge between the locals and volunteers. Before our arrival, the site was cleared and excavated with help from the Palipikan villagers.

In the first two weeks of the expedition, monsoon season in Borneo posed significant challenges to our project as torrential rain disrupted our work. Recognising the evening rain pattern, we woke up before dawn to have an early start to our daily tasks. With more productive working hours, uninterrupted by the intermittent evening rain, we ploughed and moved soil to make the ground ready for concreting.

Once ground levelling was completed, boundaries of the site were marked with wooden planks:

Remarkable help from the villagers enabled wooden planks to be sourced locally from the forest that bordered our construction site. This eliminated the need to purchase wooden formwork and promoted a sustainable use of readily available resources. The wooden planks were also used to stabilise steel columns before they were concreted into the ground:

With the columns propped and set into soil, we proceeded with slab pour to raise the ground level of the education centre. Again, with the innovative use of available construction materials, we made spacers, which steel meshes rest on, from a mixture of cement, sand and water. The addition of gravel into the mixture burdened our work to obtain spacers with desired geometries. Fortunately, the final products were satisfactory and sufficient spacers were produced for the concrete slab:

Progressing into the second week, we decided to push for roof construction to reduce time working under scorching heat, with slab pour carried out simultaneously. The main supporting elements for the roof were steel tie beams that ran along the longer sides of the kindergarten.

Roof trusses were assembled on flat ground before being lifted onto the tie beams. The roof construction met with a major hindrance, which impeded our progress. For the tie beams to be attached to the vertical columns, welding was required. However, as the welding process demanded large electric current, the welding set strained the electrical outlets in the village beyond their capacity, which in the end fused several of the power points available.

Recognising the need for an alternative solution, electrical drills with bolts and nuts were purchased to screw the tie beams to the columns. With the tie beams in position, they formed vertical supports for the roof trusses to rest upon.

Subsequently, steel battens parallel to the tie beams were installed to hold the metal trusses together, forming a rigid roof system. The trusses were later covered with corrugated sheets equipped with wool insulation and heat reflectors. Slab pour was carried out at the same time. Layers of water-proof polyethylene sheets were placed underneath the spacers to ensure that the slab was water-tight.

In the third week, we proceeded to cast the outer slab surrounding the perimeter of the inner reinforced concrete slab:

However, due to a lack of cement, the outer slab at the side and back of the building was reduced from an initial design width of 1 m to 0.5 m.

Once the outer slab had hardened, wall studs, which acted as frames supporting the wall panels, were assembled and installed along the side of the building. The side door frame was erected first to act as a reference height for subsequent placement of window frames. The wall studs, made of thin aluminium channel section, were joined together using rivets to create a grid of interlocking studs:

At the same time, gutter and fascia were installed along the edges of the roof:

Moving on to the fourth week, wall panels on the interior and exterior were attached with screws onto the wall studs:

While working concurrently, the back, front and internal wall studs were assembled and installed:

Both cement fibre and gypsum boards posed some problems during installation. The soft nature of gypsum boards allowed them to be easily cut and sized. However, this also meant that the boards were easily cracked on installation. While the hard cement boards, which were less susceptible to cracking, provided little spatial tolerance, thereby making them difficult to fit in between adjacent boards. Silicone sealant was then used to fill up gaps in sections to prevent leakage.

Following our commitment to promote sustainability, a solar panel system was introduced into the project this year. In order to implement this system, two solar panels were attached onto the roof. Given that the brackets to hold the panels in place had to be custom-made, a 6 m steel channel section was cut and sized to create a housing for the two solar panels:

The solar panels were then lifted and screwed onto the battens beneath the roofing sheets:

In the final week, plaster was applied onto the surface of wall panels to cover any imperfections such as cracks, gaps and screw holes:

A layer of white primer was then applied onto the panels followed by a layer of paint. The same process was carried out on both the interior and exterior panels.

Once the rooms were painted, ceilings were then installed. Metal frames, which the ceiling panels sit on, were suspended from battens using tie wires:

Once the ceilings were in place, wiring and lighting were installed and connected to the solar panel system. At the same time, a rain water harvesting system, that collects rain water from the roof, was installed. The base, which the water tank sits on, was constructed using cement blocks filled with soil and covered with cement. A pipe was then connected from the gutter to the water tank:

Lastly, to finish off the building, doors and windows were installed and vinyl sheets were laid to cover the bare concrete floor.

The opening ceremony of the kindergarten marked the conclusion of our expedition. In the presence of the head of village and villagers, we were given a heart-warming farewell.

Geothermal Heat and Arctic Sea Ice Variability

Continuing his series of intriguing articles on the effects of volcanic eruptions on regional weather, Wyss Yim (Geology, 1971-74) has been examining the effect on the extent of Arctic sea ice.

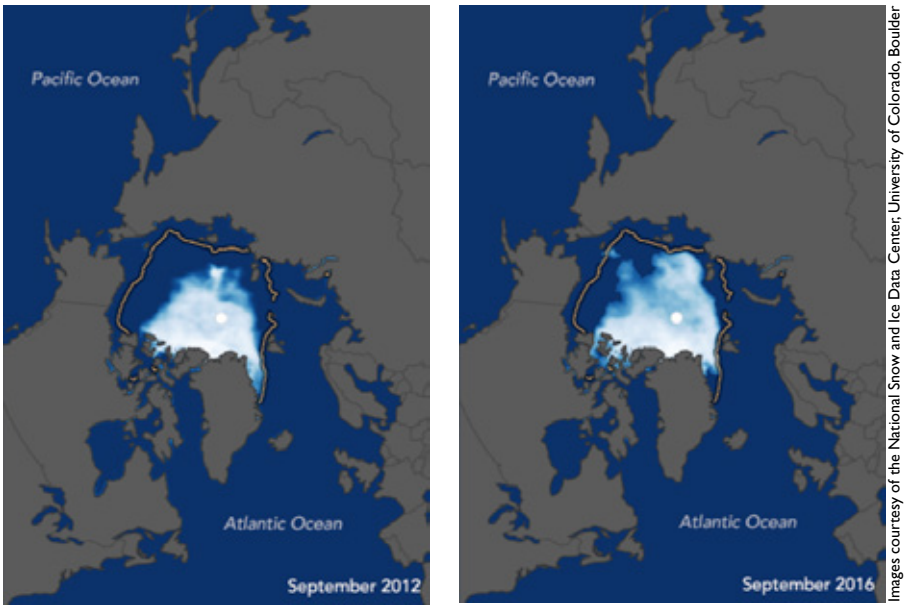
In previous issues of Imperial ENGINEER (Autumn 2013, Spring 2016, Autumn 2016, and Spring 2017), selected volcanic eruptions studied were found to have an important role in regional weather. Out of these, two eruptions releasing geothermal heat into oceans were particularly notable. The first eruption was entirely submarine, and the second eruption was initially submarine followed by both submarine and sub-aerial activities. Both these eruptions were also responsible for causing the Arctic sea ice to undergo major retreat. In this article, satellite observation records in support of the two retreats are presented, provided by the National Snow and Ice Data Centre, Boulder.

Satellite observation records of Arctic sea ice extent were first available in 1979. The Arctic Ocean is capped by layers of frozen seawater. Under normal conditions, Arctic sea ice grows dramatically each winter usually reaching its maximum in March. It melts just as dramatically each summer, reaching its minimum in September.

In the northern Atlantic Ocean from October 2011 to March 2012, an entirely submarine eruption occurred off El Hierro Island in the Canary archipelago. The eruption timing was between mid-autumn to early spring in the northern hemisphere generating warmer sea water than normal and causing the lowest Arctic sea ice on record in September 2012.

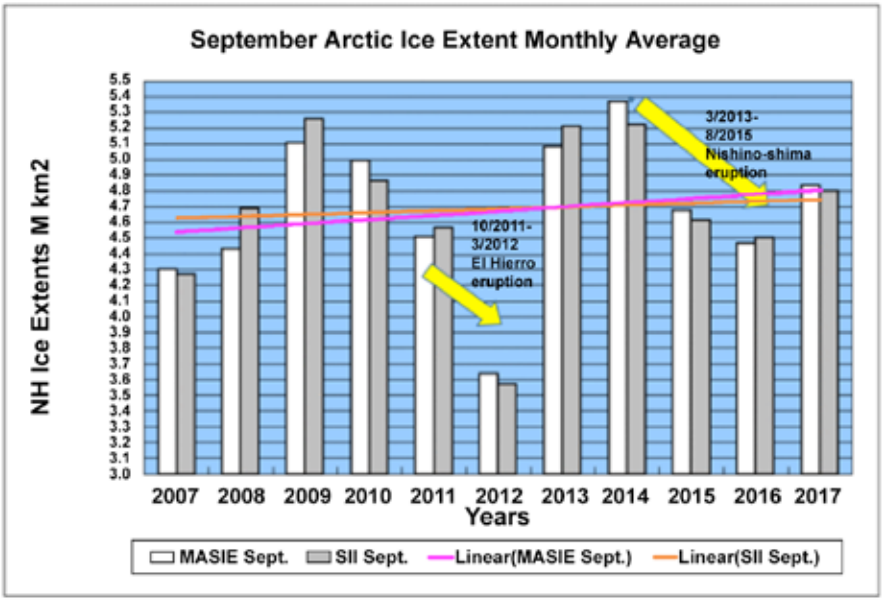
In the northern Pacific Ocean from March 2013, an initially submarine eruption occurred off Nishino-shima Island 940 km south of Tokyo. In November 2013, a new volcanic island was formed and both submarine and sub-aerial activities continued until August 2015. This 'long' lasting eruption provided an explanation for the northern Pacific Blob which puzzled many scientists who were unaware of the connection with submarine volcanism. The appearance of warmer seawater than normal on the surface of the north Pacific Ocean led to the development of strong El Niño conditions during 2014 to 2015 providing an explanation for the continuous and gradual Arctic sea ice retreat observed during September 2014, September 2015 and September 2016.

The natural release of geothermal heat into the northern hemisphere portions of the Atlantic Ocean and Pacific Ocean was therefore responsible for the two episodes of major Arctic sea ice retreat during the last decade. An improvement in the future monitoring of submarine volcanic activity is needed to provide a better understanding of polar sea ice variability.



Images courtesy of the National Snow and Ice Data Center, University of Colorado, Boulder

Opaque white areas indicate the greatest concentration, and dark blue areas are open water. The yellow outline on each image shows the median sea ice extent for September and March as observed by satellites from 1979 through 2000.



NH – Northern Hemisphere
MASIE – Multisensor Analyzed Sea Ice Extent
SII – Sea Ice Index

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.

CGCA / Mech Soc Careers Events in the C & G Building

Since the last issue of Imperial Engineer, the CGCA and Mech Soc (the students' society for the Department of Mechanical Engineering) have jointly held two careers events at the College's City & Guilds Building. In both events, several alumni of the department kindly gave up their evenings to engage with current students about their careers.

Rather than having the alumni stand up and lecture, the events adopted a 'speed-networking' approach: the students arranged themselves around five tables and an alumnus / alumna then visited each table in turn for ten minutes during which time the students were able to talk to each of them about their time in College and their career to date.

At each event, in November and March, nearly fifty students came to hear five alumni of the department chat about their careers. The questions asked included: What would you do differently? What were the best and worst things about your career? What's the best advice you can give to a current student?

The alumni in the first event had a spread of graduation dates: from **Richard Rumble**, who graduated in 1970 and has since had a long and varied career working and consulting in the oil, gas refining and chemical industries, to **Scott Fraser** of Exxon Mobil's Field Engineering Services, who is in the first phase of his career having graduated in 2014. **Waiman Cheuk**, who graduated in 1997 and now works for BP, also answered questions on his career, which started in management consulting. **David Law** (ME '73), mindful of the low take-up by Mechanical Engineering students of OC Trust awards, gave a short explanation of the Trust's work and how to apply to it for a grant, as well as providing the students with an insight into his long career with Lucas CAV Ltd.

The similar event held on 1st March was equally well attended, perhaps surprisingly given the arctic weather on the day. This time, in recognition of International Women's Week and of 2018 being the 'Year of Engineering' in the UK, all five alumnae were women; **Vassia Paloumbi** who graduated with a PhD in 2006, since when she has had a number of roles in sustainability and carbon reduction for several organisations culminating in her current role as Sustainability Manager for the Bank of England; **Tamar Roth** who graduated in 2016 and now leads product development (from concept to market) at an early-stage start-up called School of the Digital Age, which promotes 'lifestyle technology' to women; **Tanya Chong**, who graduated with an MSc in Innovation Design Engineering in 2013, and is now a project engineer in railway signalling with Siemens in the south-east of England; **Sara Dethier** who graduated last year with an MSc in Sustainable Energy Futures and is now an energy and climate change consultant with Arup; and **Caroline Hosier** who graduated with an MEng in 1992 and is now at Ford Motor Co., where she leads a team of experts in areas such as vehicle emissions and climate change.

Photo: Charles Parry

CGCA / Mech. Soc. event in March 2018

Photo: Omer Rathore

Waiman Cheuk at the November Careers Event with Mech. Soc.

Photo: Omer Rathore

David Law at the November Careers Event with Mech. Soc.

Careers events such as these can give to students a personalised view of life in industry that is a valuable alternative to that given by the staff of companies during their annual recruitment rounds. The events were much appreciated by the students – judged not just by their positive comments and their desire for other such events but also by the numbers who remained even after the food had been finished!

Pizza, sandwiches and drinks were provided by Mech Soc and funded by the CGCA, which was represented at both events by departmental alumnus **Charles Parry**, who, at the close of each, gave a short pitch on the merits of joining CGCA.

Thanks are due to Mech Soc's Alumni Relations Officer, **Omer Rathore**, who organised the students to attend, identified and booked the rooms, and arranged the catering, and to **Kellianne Bartley**, the College's Alumni Volunteer Officer for identifying the alumni, organising their attendance and arranging handouts and badges for the events, without either of whom the events would not have happened. Special thanks are due to all the alumni who gave of their time so generously and, in the second event, braved the weather and the transport system to attend.

The CGCA always welcomes the opportunity to support joint activities between alumni and current students. We will also provide experienced alumni to mentor students and those alumni in the early stages of their careers. If you would like to help in that regard please contact the CGCA at cgca@imperial.ac.uk

We would love to hear from you if you have arranged or attended a similar event in one of the Faculty of Engineering departments.

48th Triode meeting, 5th January 2018

This time 13 Triodes (i.e. Electrical Engineering graduates of 1973) appeared at the George for our 48th reunion (we always meet on the first Friday after 1st January). Many Triodes had arrived early, some even at 16:30, and had tried to take over the Fleet Street end of the pub but it was still difficult to circulate in the crowded bar. Set out below is what the Triodes have been up to over the last year.

Much discussion was had on the "5&10 Reunion Lunch" on 24th November 2018, which would be our 49th Reunion! Many Triodes (and Triode Spouses) say they are coming, so it should be a good event!

But what about the meeting in 2019? – it will be our 50th! Should we be doing something special?

After catching up we moved on to have dinner at the nearby Thai Square restaurant. As tradition dictates we stopped at the now dimly lit Triode Loo and got a passer-by to photograph us! The result is shown above. At the restaurant we opted for the set menu and continued on until late in the night. Another excellent reunion I was told; well attended, though not quite as many as our 47th, but will we break the record in November?

The next yearly Triode reunion (it will be our 50th as we had two meetings in year one, two in 2003, and two in 2013!) will be on Friday 4th January 2019 at The George, Fleet Street, from about 7 pm. The following year's reunion (51st) will be on Friday 3rd January 2020. So mark up your diaries now!

Those who came on the 5th January (there were 13 of us!):

Peter Cheung

It was good to see Peter after he was away last year visiting China and Hong Kong. He told us that he was spending January in retirement, but then rejoining Imperial College at 80% for at least the next five years. So his retirement is entirely fake – just a way of extracting the maximum from his pension company! As always if you are passing Electrical Engineering, please give him a call and he'll treat you to lunch.

Paul Cheung

It was indeed great to see Paul after all these years. He looked remarkably well and much younger than his twin Peter of course (just joking!). But just like Peter he offered that he would invite any of us (and family) to dinner if we can visit Hong Kong (provided that he is around at the time of course). He said he will definitely retire next June and he will travel a lot more!

Joan Clemow

Joan has volunteered for the National Trust at Montacute House for five years now and they have given her a badge to prove it! She sees her four grandchildren regularly, she collects her daughter's two from school one day a week and helps with some maths at their school one morning a week. As we know, Joan enjoys travelling and she has just come back from a cruise on a sailing clipper through the Panama Canal. Sounds exotic!

From left to right: Sid Seth, Tony Godber, Paul Cheung, Joan Clemow, Phil Harris, Peter Cheung, Martin Clemow, Rut Patel, David Mansfield, Pete Marlow, Peter Wright, Steve Glen and Martyn Hart.

Martin Clemow

The company that Martin works for supplies recorders for Air Traffic Control and has moved to the depths of South Wales. He should have joined the 'retired camp' by now but is working from home while his replacement is sought. Is this yet another example of the shortage of qualified 'practical' engineers (those who know which end of a soldering iron is hot?) Unfortunately the planned 'retirement activities', including the restoration of his MGC and the preparation of the 'real' Mini, in which he sprints and hill-climbs with his middle son, will have to stay on the back burner for a little longer.

Steve Glenn

Steve said there was no chance of retiring for him as he actually enjoys working in the MOD three to five days per week. He says it's really interesting work but he can't talk about it! His family/grandchildren keep him busy the rest of the time. His wife Anne hasn't quite retired yet but she is a full-time Granny (and Steve a full time Granddad!), which suits them well he says.

Tony Godber

Tony made it to London again this year from Perth. He told me that he had just got the news that he's had funding approved for a capacity upgrade study that he has been working on for some time, so he thinks retirement is off the agenda for a while. His family have built up an interesting set of international connections as a result of their children's partnerships. His eldest son's wife's parents are divorced with mother (originally from Mumbai) and father now living in Perth and Portugal respectively. His next son has a Scottish partner so there are possibilities of a wedding there in two or three years. His third son has married locally but his wife does have an aunt in the USA and finally his daughter's husband is from a large Sicilian family (although he was born in Australia). So lots of holiday options lined up!

With all those potential holiday destinations, as well as keeping in touch with family in the UK, it looks like Tony will have to keep working to fund the travel costs! However he is planning to move to part time working later in 2018.

Phil Harris

Phil and Lina continue their quiet retirement with country dancing twice a week; a workout for both mind and body he says. Another workout is looking after grandson Theo who is now three; "Enjoyable work though," Phil added!

Over the last year they have had a reunion in the Netherlands with Lina's sister and family, a tour of Southern Spain and Portugal, and a great weekend in June when Jonathan (Phil's eldest) married Charlotte in Southampton.

Martyn Hart

Martyn works three days a week (often four or five) in the public sector, mainly in the commercial area (large outsourcing/framework contracts). Now settled in the Triangle House in Ingatestone in Essex, he's involved with the local cycling, photography and other clubs and even the Parish Council he says!

Dave Mansfield

Dave is converting his father's old house into five self-contained flats but the project is now running months late as his builder kept disappearing off site. Penalty charges on the builder didn't work and it would be more expensive to employ another one!

During the year Dave and his wife flew to India to visit the golden triangle (Delhi, Jaipur and Agra) and came back via Dubai, Suez and Jordan on the QM2 to Southampton. Fabulous experience! Both of Dave's sons are working in London; the elder back from his overseas assignment at the FCO and the other working in investment banking.

Peter Marlow

Peter and wife Sally continued to enjoy the freedom of retirement in 2017 travelling to the Caribbean, Crete (walking holiday), Romania and Transylvania (choir tour), and finally Washington and Boston. In addition to his work mentoring project managers in developing countries (www.pmap.pm) Peter has joined the board of PM4NGOs (www.pm4ngos.org). This is an international organisation that promotes and sustains the professionalism of programme and project management in the international development sector.

Rut Patel

Rut has been very busy this year with his granddad duties which now encompass four- and two-year-old grandsons and one-year-old granddaughter. Taking the grandsons to school has been added to his list of duties and the four-year-old also wants to play cricket or football as soon as he gets home! The granddaughter is also with them one day a week. This pretty much fills up the whole of the week; so much for retirement!

However, he is allowed time off at the weekends. This he uses to visit Wembley Stadium to see his beloved Spurs. His elder grandson also tags along with him on occasions as he is also, surprise surprise, a Spurs supporter. For a change Rut has seen Spurs win a few matches at Wembley, with a highlight being watching them beat Real Madrid 3-1 in November.

Rut also managed to fit in a couple of holiday breaks to Portugal and Malta. He celebrated his 65th birthday in July in Malta.

Sid Seth

Sid is now working on a new 'secret' project. He still won't tell us what it is but it's something to do with cyber and IoT. He is keen to use the latest technology, particularly AI, to help improve lives. Maybe he'll be a multi-millionaire by the next reunion?

Peter Wright

Peter is still heavily involved in running his local Scout District as Secretary, Appointments Chair and various other roles including caretaker and handyman, some of which involves brushing up on wiring regulations!

A side benefit of all this Scout stuff is that he gets to go on lots of (adult) training walks in Snowdonia, etc. and has just returned from an exciting time attacking the Lake District with an ice axe and crampons.

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

Addy Adesara

Addy says he is extremely sad that he missed the get-together due to a customer issue but sends everyone his best. He is still working at Vodafone and promises to try to plan a bit better next year, assuming he is still working. He will also try to get to the 5&10 Reunion if he can.

Geoff Banks

Geoff is sorry that he couldn't make it because he has problems with his elderly parents at present; his Dad (89) is his Mum's (93) registered carer but he is himself recovering from breaking his hip! Things are getting back to normal (whatever that means when his Mum has dementia) and we sympathise with his problems. He plans to make the November 5&10 Reunion.

Graham Castellano

Graham was in Jamaica and says that having completed the second year of his second retirement (from IBM and then his electrical company) he's finding that he is busier than ever! He has had vacations (Rhode Island, Yellowstone, Sicily, skiing and Jamaica) but both his sons have moved house and then both have contrived to knock down walls and build extra bits. Graham says, "The phrase 'Dad, can you just...' is to be feared! I am told this is my duty as a good father, but I think I worked less when I was employed." However, he is still sailing his Solo dinghy most weekends and is looking to accompany a couple of friends on their yachts to locations around Northern Europe, Brexit allowing! He will try to make the November reunion.

Hugh Culverhouse

Hugh still lives in Munich and, although he is supposed to be retired, he's still teaching Business English. Unfortunately he fractured his left kneecap in September 2016 on the way home from the Munich Beer Festival (what a surprise!); this injury left him very uncomfortable for a few months thanks to pins protruding from the fracture into his flesh but once they were removed he started getting going again physically. That meant gradually more cycling (one-legged) and more running (on sticks). He did no cycle races in 2017 as part of a deliberate plan to reduce training intensity, and his running races have been very restricted. Yet he still reached 14,000 km on the bike for the year!

In April he spent ten days in Delhi for a wedding and adventures but he came back on his deathbed. It was an exciting experience but not to be repeated! In June he was in the south of France on his bike for two weeks, visiting old friends and knocking up nearly 2,000 km. Of course he visits England a few times each year to see family and friends, including a week in August this year as his sister and family were over from USA. And yes, he does plan to come to the November reunion but not by bike!

Tim Dye

Tim tells me that nothing much has changed in the last year, other than most of the television programmes he is involved with are now streamed or for YouTube. He continues cycling and walking much as before. The big event was that his second got married, but the grandchildren tally remains at two! He will try to make the November reunion too.

George Gabrielczyk

George says he accelerated past his 65th birthday fighting an attempted hostile takeover of his concrete paver business (quoted on the Warsaw Stock Exchange). The initial attack was successful and deposed George from his chairmanship but he continued fighting through the year and in November the enemy failed to finally persuade the shareholders in an EGM. The enemy were trounced and GG is back in the saddle!

In April he was elected President of the European Federation of Deer Breeders (FEDFA). In this role he faces conflicting forces currently let loose on farming e.g. Brexit; climate change (as perceived by Brussels); the enormous effect of the focus on the environment by the city-dwelling public; a new CAP to run from 2020; the hunting lobby; the environment (wolves); and the Polish Ministry of Agriculture, with whom he totally disagrees regarding regulatory (land ownership) farming policy and the economics of farming.

He bought some more fields last year before the law changed to limit landholdings. He's up to 1,100 acres or a little more including the lake. Finally, the architectural work on the Manor proceeds slowly; the 74 metre cowshed is nearly done and it's come out very nicely.

Chris and Daphne Giles

Chris said he and Daphne are fine but they are selling their last narrow boat this year to focus their energies on something else – but what? Meanwhile Chris has attempted to retire three times over the past ten years but still continues to work – currently for a small company which builds specialist tankers for fuelling aircraft.

John Harding

John sent his apologies for absence. He is working with CACI, mainly on service management issues. He says retirement is as far away as ever because he is really enjoying his work and still sees colleagues from CTIL and Vodafone. Meanwhile it looks as if a wedding or two might be in the air soon; in fact he couldn't join us on 5th January because he was at a friend's daughter's wedding (perhaps getting tips?). Anne is as busy as ever in retirement and says she is looking forward to seeing us all at the reunion in November.

Nick Hiscock

Nick had the winter bug but reported that he has been re-elected Hon. Secretary of Warsash Sailing Club for another year and is slowly progressing his weapons collection as time allows. His wife Sue has recently retired as a vet but with a zero-hours contract in place if the practice gets stuck or she gets bored. Jenny (elder daughter) is growing her supramolecular chemistry research team at the University of Kent and Pippa (younger daughter) is still with Roche Manor Research, employed as a consultant for HMG. Nick is hoping that he and Sue can make the November reunion.

Richard Lewis

Richard couldn't make it because he was in his hideout in the French Pyrenees. He reports that nothing much has changed since last year; he is still teaching single and further A-level maths at Haberdashers' Aske's Hatcham College, near New Cross. He works three days a week which corresponds to five relatively stress-free actual working days once lesson preparation and marking are included. But he adds that he is having his arm twisted (yes, already!) to stay on for the next academic year given the increased rigour required to teach the new A-level and the difficulty in recruiting decent A-level teachers. He's thinking about it.

Patrick Mason

Patrick was sadly unable to join us due to a nasty bug in the feverish and contagious stage! He is still very much involved with his company GlobalWebPay (www.globalwebpay.com), which allows consumers to send money abroad fast and cheaply. The company just celebrated its 7th anniversary and is still growing well. Whilst citing Brexit and changes to regulation as major challenges to overcome in 2018, they are still investing in a major re-write of their systems to take advantage of developments in consumer connectivity to the internet (e.g. devices and social media) and also of overseas opportunities. Also if anyone is a distributed ledger guru he'd like to hear from you! He re-iterated his offer to Triodes of great rates for anyone looking to move a sizeable amount overseas – please contact him direct.

He is hoping to cut his workload back a little so that he and his wife can travel more – looking forward to India, Japan and Mexico! Otherwise, their recent move to an East Sussex village and country life has been a great success – but London and all it offers is never far away!

Hari Singh

Hari took family holidays in Athens, Amsterdam and Goa and golfing holidays with his golfing buddies in France; not a bad year for holidays! However his golf over the year wasn't very good, although he did manage second place in Senior Player of the Year. His handicap has gone up to 11 so he needs more practice (or fewer non-golfing holidays)!

He now has another grandchild, making four grandsons in total, which keeps him and his wife busy and entertained; hard work but a lot of fun playing with them. He's soon off to Goa for four weeks for their first holiday this year.

Alice Spain

Alice said she was sorry she couldn't make the reunion as she was in Cornwall and didn't think she could make it there and back in time. She told me that her builders were now back after quite a long break because their main man had been ill. She said the plastering they've done over the past month has made a big difference to the look of the house, "It's beginning to look more like a house and less like a building site! There's still a long way to go but we're enjoying the journey."

And those who didn't make it and that we haven't heard from:

(Can anyone help?)

John Baird, Jacquie Buzzard, Al Farbridge, Chris Gaukroger, Ian Heap, John Macfarlane, Keith Marshall, Alistair Rogers

Have a great 2018.

Martyn
Arch Triode

If you have arranged a reunion of your classmates or contemporaries, please send us a photograph and a report. We would love to hear from you and there may be other alumni who would like to join you when you have your next reunion.

Let's remember, 2050 needs acceleration and young people

Our Canadian correspondent Nigel Fitzpatrick (Metallurgy 1962-65, 65-68), with help from Paul Fennell and Stephen Cheung, on a successful alumni talk in Vancouver.

Stephen Cheung (Computing 1978), inspired by alumni activity in Hong Kong and Vancouver in past years, shared pictures of local meetings, dropped into Imperial while on holiday and offered to re-convene an alumni group in BC. Half of British Columbia's 4.7 million live in Greater Vancouver with the same land area as Hong Kong. Alumni here could meet with equal ease. Meetings in the suburbs of Richmond, West Point Grey and North Vancouver followed and a core team evolved. Then in March 2017, Erin Hallet (Alumni Relations for the Business School) hosted an event while in BC for a family visit. Erin chose a less suburban spot, the restaurant/bar in the historic Fairmont Hotel Vancouver and doubled our previous best turnout.

Photo: Calvin Lam

Back (L to R): Joan Fitzpatrick, Linda Liu, Paul Fennel, Bob Evans, Stephen Cheung, Daniel Chan
Front (L to R): Talal Khan, Nigel Fitzpatrick

In mid July, Stephen received word that Professor of Clean Energy, Paul Fennell, could give a talk to alumni in October or November while visiting the University of BC. The BC team chose the "Boardroom" conference room in the hotel where Erin had found success. With Paul in the loop the date was set for 12th October[1]. The talk would be in the context of the IPCC recommendation for an 80% cut in CO_2 emissions by 2050 and would cover carbon capture and storage.

Linda Liu (Chemistry 2014) provided a link to register and book free tickets endowed with the college coat of arms. The format was similar to one used when Paul spoke in Menlo Park, California[2] and the alumni and guests were to enjoy a cheerful evening. Also helping with the planning was John Webster at SFU.

At the talk on October 12th, we were delighted to be joined by Pamela, Malcolm and Charlotte Fennell on their way with Paul around the world. Imperial alumni registered themselves and guests.[3] We were more eclectic yet and opened the door directly to the alumni of similar institutions. Robert Evans, UBC clean energy centre founder and Emeritus Professor, saluted both Imperial and Paul. Bob had travelled from Cambridge to Imperial for a course on Computational Fluid Dynamics (CFD) given by the late Brian Spalding in Chemical Engineering whose work also had brought fame to Imperial.[4 5]

Paul updated us on Imperial and took us deep into Climate Change. Most industrial emissions around the world come from a few thousand sites that could readily change direction given sufficient incentive and information sharing. Cement contributes 27% of industrial CO_2 emissions and 5% of total emissions. Of this, 60% comes primarily from the conversion of calcium to calcium oxide, lime. Other uses of lime make up another 5% of the global total.[6]

Paul works in the field of Carbon Capture and Storage (CCS), but stresses that it is very much one part of the mitigation solution and other solutions are needed. For example, the International Energy Agency believes that by 2050 end-use fuel and electricity efficiency improvements may be double the Greenhouse Gas reduction of CCS applied to industry and power generation combined. However, CCS is important for a large number of "hard to decarbonise" industries. To be stored, CO_2 must be separated from other exhaust products. For example in the production of lime, if the limestone were indirectly heated (i.e. with an external heat source but without direct contact with air) to 900°C the CO_2 released could be captured.

Imperial College is a partner in the European Union supported project LEILAC[7] which plans an indirectly heated pilot proven in four years when production equipment could be designed and tested and scaled up in one cycle.[8] CFD is used to model the mass and heat transfer processes of heated particles and flowing gases to accelerate scale up of the process selected. This method would need higher carbon prices than here, though less than double. A similar process, the Calcium looping cycle, could also act as a stepping stone: an economical process results if lime goes round a loop to capture and release CO_2, with a residue fed to the cement industry. The impact of contaminants is a focus of research.

Then Paul described steps two of his students have made with two companies, working in solar energy, and biofuels from waste, where the results are already being funded for pilot scale trials. Clementine Chambon, co-founder and CTO at Oorja is responsible for mini-grid design, installation and construction for electricity generation. With a mission to provide clean energy to 450 million people they are installing products in Uttar Pradesh, the most populous State in India. Florence Gschwend, COO & Co-Founder of Chrysalix Sustainable Technologies, obtained her PhD this summer funded by a Grantham Institute scholarship. The company is converting wood waste, and agricultural byproducts to biogas, liquids and materials, via novel technologies.

When Linda's site went up the news was out and BC government and industry were keen to hear more and there was a result. On September 29th, a group of energy professionals, the Pacific Energy Innovation Association, invited Paul to give a "Breakfast talk" on November 1st. Paul's encore presentation is embedded where we, industry and government can access it on the PEIA web site.[9]

Primary steel and aluminum production processes have half century replacement periods. There are only 1.5 quarter century cycles between now and 2050. The time and cost to pilot and propagate a cement technology may be longer than for the products that are coming from Clementine and Florence and others of a similar age!

In closing – Clementine and Florence's Scholarship was helped by alumni contributions. Let's remember we need to help the young keep this planet habitable!

Nigel Fitzpatrick

1 The Hotel Vancouver, then owned by the Canadian Pacific Railway, was opened by Britain's last Imperial couple George VI and Queen Elizabeth on a tour to discourage isolationism in 1939.
2 http://bit.ly/IE28-Fennell-Calif
3 Talal Khan (Electrical and Electronics Engineering 2009-2012) and Daniel Chan (MBA 2011) supported Linda and Joan Fitzpatrick registering.
4 http://bit.ly/IE28-Bob-Evans
5 http://bit.ly/IE28-Brian-Spalding
6 Cements and lime come from calcium and magnesium containing rocks, limestone, calcite and dolomite.
7 Low Emission Intensity Lime and Cement
8 http://bit.ly/IE28-Leilac
9 Slides presented at both talks are entitled "CCS, Cement and the Future" http://bit.ly/IE28-PEIA-Fennell

DIARY

Sun, 22 April, 16:30 – 19:00
Alumni Weekend
Global Celebrations – Kolkata
Alumna's home - Kolkata - India
bit.ly/IE28-Kolkata

Tue, 24 April, 18:30 – 20:00
Alumni Weekend
Global Celebrations – Boston
Massachusetts Institute of Technology (MIT, Room 5-234)
bit.ly/IE28-Boston

Wed, 25 April, 17:30 – 18:30
Year of Engineering
Volcano descent – Professor Christopher Jackson
Lecture theatre 200, City and Guilds Building
bit.ly/IE28-Volcano

Thu, 26 April, 19:00 – 21:00
Alumni Weekend
Global Celebrations – Geneva
Grand Duke Pub, Rue de Monthoux 8, 1201 Geneva, Switzerland
bit.ly/IE28-Geneva

Thu, 26 April, 19:00 – 21:00
Alumni Weekend
Global Celebrations – Prague
Vinograf Wine Bar, Senovážné Square 23, Praha 1, Praha, Czech Republic
bit.ly/IE28-Prague

Thu, 26 April, 21:30 – 23:30
Alumni Weekend
Global Celebrations – Madrid
Restaurante Makkila, C / Núñez de Balboa 75, 28001, Madrid
bit.ly/IE28-Madrid

Fri, 27 April, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 27 April, 19:00 – 21:00
Alumni Weekend
Global Celebrations – Tokyo
Victorian Pub The Rose & Crown
bit.ly/IE28-Tokyo

Sat, 28 12:00 – Sun, 29 April 16:00
Imperial Festival / Alumni Weekend
South Kensington Campus, Imperial College, London SW7 2AZ, UK
http://www.imperial.ac.uk/festival/

Sat, 28 April, 16:00 – 18:00
Alumni Weekend
Global Celebrations – Seattle
Elysian Brewing, 1221 East Pike Street, Seattle, Washington 98122
bit.ly/IE28-Seattle

Sun, 29 April, 10:30 – 12:30
Alumni Weekend
Global Celebrations – Taipei
Bitan Scenic Area, Xindian Road, Xindian District, New Taipei City, Taiwan, R.O.C 231
bit.ly/IE28-Taipei

Sun, 29 April, 12:00 – 19:00
Alumni Weekend
Global Celebrations – Shanghai
Polar research and climate change
Prof Martin Siegert, Co-Director of The Grantham Institute for Climate Change
This year the Imperial College Alumni Association of East China (ICAAEC) have organised an exclusive visit to the new Xue Long icebreaker vessel, currently berthed by the Polar Research Institute in Pudong.
bit.ly/IE28-Shanghai

Sun, 29 April, 20:30 – 22:30
Alumni Weekend
Global Celebrations – Riyadh
Serafina Restaurant, 831 Makkah Al Mukarramah Branch Road, Umm Al Hamam Al Sharqi, Riyadh 12721, Saudi Arabia
bit.ly/IE28-Riyadh

Thu, 3 May, 13:00 – 14:00
Imperial College Business School
Academic entrepreneurship: a personal journey with Professor Peter Cawley
Ground floor lecture theatre, Imperial College Business School
bit.ly/IE28-Cawley

Thu, 3 May, 18:30 – 20:30
Alumni Weekend
Global Celebrations – Zurich
Kennedy's Irish Pub, Freischützgasse 14, 8004 Zürich, Switzerland
bit.ly/IE28-Zurich

Thu, 3 May, 19:00 – 21:00
Alumni Weekend
Global Celebrations – Dublin
37 Dawson Street, Dublin 2, Ireland
bit.ly/IE28-Dublin

Thu, 3 May, 19:30 – 21:30
Alumni Weekend
Global Celebrations – Singapore
Praelum Wine Bistro, 4 Duxton Hill, Singapore
bit.ly/IE28-Singapore

Thu, 3 May, 17:30 – 18:30
Data Science Institute
DSI Privacy Debate – Do we still need privacy in the age of AI?
LT200, City & Guilds Building, Imperial College, London SW7 2AZ
bit.ly/IE28-DSI

Fri, 4 May, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Tue, 8 May, 18:30 – 20:30
Alumni Weekend
Global Celebrations – Vancouver
Fairmont Hotel, 900 W Georgia St, Vancuover, BC V6C 2W6, Canada
bit.ly/IE28-Vancouver

Wed, 9 May, 20:00 – 22:00
Alumni Weekend
Global Celebrations – Beirut
Babylonia Café Bar, Alam Street, Badaro, Beirut
bit.ly/IE28-Beirut

Thu, 17 May, 11:30 – 13:30
CGCA
Quarterly Johannesburg Lunch
Baron & Quail, Woodmead, Johannesburg, South Africa
Contact Richard Gundersen@yebo.co.za

Mon, 21 May, 14:00 – 15:00
IMSE Highlight Seminar:
Innovation by evolution: bringing new chemistry to life – Professor Frances Arnold (Caltech)
Imperial College Business School, LTUG
bit.ly/IE28-Arnold

Wed, 23 May, 18:00 – 20:00
Meet Prof. Tom Welton in Melbourne
Venue to be confirmed
bit.ly/IE28-Welton

Wed, 23 May, 18:00 – 20:30
Friends of Imperial College
Behind-the-Scenes @ Data Science Institute
Data Science Institute, Imperial College London
bit.ly/IE28-FoIC-DSI

Fri, 25 May, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 1 June, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Mon, 4 June, 17:30 – 18:30
Annual Peter Lindsay Memorial Lecture
Quantum Universe – Neil Turok
Lecture Theatre 200, City and Guilds Building
bit.ly/IE28-Turok

Thu, 7 June, 14:00 – 15:00
IMSE Highlight Seminar:
Completing the picture: correlative multimodal information across length and timescales – Professor Philip Withers (Univ of Manchester)
RODH 252, South Kensington Campus, Imperial College, London SW7 2AZ
bit.ly/IE28-Withers

Mon, 11 June, 17:30 – 20:00
CGCA
AGM and President's Evening
Queen's Tower Rooms, Imperial College, London SW7 2AZ
Refreshments available from 17:00
AGM at 17:30 followed by a talk entitled *Synthetic Biology / Engineering Biology – A rapidly growing area of the bioeconomy* by CGCA President Prof Richard Kitney OBE, FREng, FRSE, PhD, DIC, DSc(Eng), FCGI
Followed by President's Evening including hot buffet supper with wine.
See address carrier for details.

Mon, 18 June, 17:30 – 18:30
The Bioengineering Lecture 2018
Computational Cardiology – Professor Natalia Trayanova
SAF LT G16, Sir Alexander Fleming Building, Imperial College, South Kensington, London, SW7 2AZ
bit.ly/IE28-Trayanova

Wed, 20 June, 18:30 – 19:30
Friends of Imperial College
Summer Party
170 Queens Gate, Imperial College, London
bit.ly/IE28-FoIC-Summer

Fri, 22 June, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 29 Jun 19:00 – Sun, 1 Jul 14:00
Imperial College Club of Germany e.V.
AIRBUS, Blockchain and more in Hamburg
Hamburg, Germany, venue TBC
bit.ly/IE28-Hamburg

Fri, 6 July, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Fri, 27 July, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 3 Aug, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Thu, 16 Aug, 11:30 – 13:30
CGCA
Quarterly Johannesburg Lunch
Baron & Quail, Woodmead, Johannesburg, South Africa
Contact Richard Gundersen@yebo.co.za

Fri, 24 Aug, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 7 Sept, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Fri, 28 Sept, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 5 Oct, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Fri, 26 Oct, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

Fri, 2 Nov, 17:30 – 21:30
RSMA Perth, Australia
Monthly Sundowner
The Celtic Club, 48 Ord St, West Perth, Western Australia, 6005
Alan Dickson – alan@dickson.com.au
John Sykes – johnpsykes@gmail.com

Sun, 4 Nov, 7:00 – 16:30
CGCU
Boanerges in the London to Brighton Veteran Car Rally
Starts Hyde Park, London, UK

Thu, 15 Nov, 10:30 – 12:30
CGCA
Quarterly Johannesburg Lunch
Baron & Quail, Woodmead, Johannesburg, South Africa
Contact Richard Gundersen@yebo.co.za

Fri, 23 Nov, 12:00
RSMA Toronto, Canada.
Informal RSM meeting at noon on the Last Friday of every month.
Jason George Pub, 100 Front Street East, Toronto

An up-to-date calendar of events of interest to CGCA and RSMA members is always available on the CGCA and RSMA websites. Imperial College maintains a calendar of college events at bit.ly/IE-ImperialEvents and the Friends of Imperial regularly organise events of interest to alumni (see bit.ly/IE-FOI)

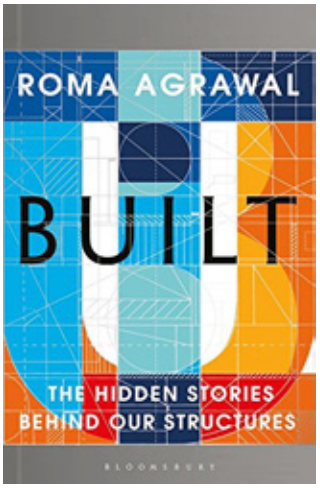
Please note that while many of these events are open to all and often free, they usually require registration in advance. Please follow the links in the entry to get more information including if and how to register and whether there is any cost.

For more information follow links, or see page 2 for contact details

Book Reviews

Readers will remember Roma Agrawal (Civils 2004-05) from the feature article she wrote in IE19 (The Engineering Brand) and various news items since. Here we review her first book, BUILT, published by Bloomsbury, available from all good bookshops.

From the moment you pick up Roma Agrawal's book BUILT you know that it will be an interesting experience. The hardback cover of the book is silver with a design on it that conjures up a CAD drawing with the letters of the title embedded. Overlaid is a jacket, unusually not full height but just covering the design and providing a colour version of it. The design is repeated across the endpapers of the book. So, it is clear from the outset that this book has been very carefully, even lovingly, designed. Which is, of course, fitting for a book that documents a love affair with buildings from ancient to modern.



Roma Agrawal is one of the best-known young structural engineers these days. Her technical ability has already seen her quickly build a career with an impressive track record; her enthusiasm, ability to communicate and personable nature has led to her being an effective, widely recognised and award-winning voice for engineering as a whole and promoter of STEM to women and minorities. So it is neither surprising that she has written this book, nor that it reflects her personality, principles and passions.

The book addresses the wonders of the engineering that has made the world we see today. As she says in her final chapter (don't worry, no spoilers): "Imagine, for a moment, a world without engineers.… What do you see? More or less nothing." and she goes on to say "Engineering is a big part of what makes us human." Despite being ostensibly about buildings, this is a very human-centred book, the book's subtitle is, after all, '*The hidden stories behind our structures*'. Roma has a very easy writing style, which also means that BUILT is an easy read. Her excitement at walking onto, and jumping up and down on, the Ishibune stress-ribbon bridge leaps out at you, as it does when she describes finally getting to stand on the Northumbria University Footbridge (her first professional project). She also sings the praises of lesser known engineers such as Emily Warren Roebling without whom the Brooklyn Bridge would never have been completed, and even a non-human bridge builder, the Darwin's bark spider. As you can tell, she likes bridges. But she addresses all sorts of structures, from high profile glamorous projects such as the Shard, to the hidden and decidedly unglamorous aspects of buildings like drainage and sewers.

This is a very personal book. We not only learn about fascinating engineering projects from ancient, classical, mediaeval, Victorian and modern times, but we also get an insight into Roma herself – her childhood spent partially in America then back in India, her love of making structures as a child and her 'geeky' interests at school, studying physics at university and then realising that it's the engineers who make a difference to the world, leading to her getting a Structural Engineering degree from Imperial. But for all that, it reads like a long conversation you would have with an enthusiastic fellow engineer about all the exciting things she has seen or investigated. While there is plenty of discussion of early engineering (the Romans feature a lot, of course) it never feels like a history lesson or a text book. She explains complex concepts with hand drawn diagrams, and suggests practical experiments using such readily available material as carrots and Maltesers! She is as enthusiastic writing about the great Cistern that the Romans built under Constantinople as she is about Bazalgette's Victorian sewers for London. She admits that she has no head for heights, which leads to a very engaging description of her first visit to the spire at the top of the Shard, which she designed, towards the end of construction – "My stomach churned. I suppressed a rising feeling of fear. Fresh, chilly air entered my lungs as I took calming breaths with my eyes closed. When I felt less dizzy, I opened my eye (that's right, just the one)."

The book is structured in a way that seems natural. It's not a chronology of feats of engineering, or a tutorial on how to build a skyscraper. It looks at various aspects of our world, from resisting the wind to protecting against fire; from getting clean water to drink, to disposing of poo. It looks at materials that have been used and are still used, as well as exciting new materials and technologies that are or soon will make innovation possible. A glimpse at the contents list will give you a hint of the journey on which this book takes the reader – all single word chapter titles (like the book itself): *Storey, Force, Fire, Clay, Metal, Rock, Sky, Earth, Hollow, Pure, Clean, Idol, Bridge, Dream*.

This is a book that is written for everyone to enjoy, to be enthused about engineering, to feel a degree of awe at the way humankind has developed technologies and techniques to enable us to cope with and control our world. 2018 is the government's Year of Engineering, and this book should be recommended reading in schools to encourage young people to see how exciting, fun, and impressive an engineering career can be. Roma is well placed as a role model for under-represented groups to see that engineering could be a fantastic career that can actually change the world.

Reading this as an engineer, albeit not a structural engineer, I was struck by how good a case Roma effortlessly makes for us as the designers and facilitators of humanity's progress. I learnt a lot too, although the book never feels didactic. There are plenty of awesome things that I now want to go to see for myself (such as the Falkirk Wheel); there are people of whom I had not previously been aware; there are some incredible projects that had passed me by, such as stabilising the Metropolitan Cathedral in Mexico City; there are forward-looking plans that will help secure the future for people around the world, such as Singapore's Four National Taps; equally, there are ancient structures that I now want to investigate, such as the Horologion in Athens and the Cistern under Istanbul.

I heartily recommend this book. To engineers (even structural engineers): it will no doubt tell you some things that you didn't know, as well as enthusing you (if you need it) about our profession and maybe make you consider being more proactive in promoting engineering to young people. To everyone else: it is a fascinating and highly readable overview of the built world around us and how it got there. To parents and educators: it is a great book to give your youngsters to encourage them to consider a career that can actually improve our world.

Peter Buck (Comp 1976-9)

*In the last issue of Imperial ENGINEER we asked for readers to let us know if they had self-published a book. The first to reply was Stephen Revess (Civils 48) with a copy of his book, **'never ending buzz....'***

This is a very personal book in that it is essentially a professional autobiography, but it is enlivened by personal anecdotes along the way. Selflessly, Stephen also includes anecdotes and praise for associates partners and friends. In the acknowledgements, he describes it as "practice notes on the activities of a structural engineering consultant's firm" while the dedication is "to my family and friends, illustrating a civil engineer's philosophy: running a small structural design practice with a large international building output". It fulfils both of those descriptions, providing a plethora of examples of projects, large and small, that made an impact on Stephen or in which he made a significant impact (sometimes not just on the individual project but on the wider engineering community). Over the years he has worked with many architects and other consultants, and for a wide variety of clients (governmental, institutional, corporate, and individual) and while never disrespectful he is generally candid in his observations about them. He explains that the title 'never ending buzz' relates to the job satisfaction that compensates for the often small financial reward!

The 'story' starts with Stephen working at British Rail where he is advised to apply for a Bursary Award for postgraduate study at Imperial to investigate and test to destruction pre-stressed concrete composite. As a result he enjoyed the "innermost happy experience" in his life at Imperial "floating amongst like-minded companions", enjoying his time in the department with the likes of A.W. Skempton (then a Reader) and Professors Sparkes, Makowski and Ford. He rowed for City & Guilds, and was invited to contest the 'Soot Race' on the Serpentine against RSM – Guilds won! In the summer of 1949, he took part in a Student Exchange, working at a waterworks in Graz in Austria, providing not only memorable experiences but also practical expertise that would prove valuable many years later.

Following graduation, he worked for consulting engineers, but by 1957 was ready to establish his own practice. Between then and his eventual retirement, he worked on some 1200 projects large and small, a few of which are described in the book (sometimes with a depth of detail that can perhaps best be

appreciated by other civil engineers). Having worked with Hugh Casson at one point, he was asked to be a tutor at the Royal College of Arts Post Graduate Department of Design for one day a week. He relished the opportunity to work with the post graduates and writes proudly about the subsequent achievements of some of his students.

As well as discussing the finer points of some of the specific projects, Stephen also addresses some of the issues that arise in building design and construction and how they can be dealt with. It is fascinating to imagine the effort that went into the drawings and necessary calculations, often in compressed timescales, in the days before the availability of affordable computers let alone CAD. There is a particularly impassioned section concerning his dismay at the removal of trees, as supposed causes of subsidence, frequently based on no evidence whatsoever. He adds, "Now, much later, we appreciate the value of trees in combating global warming, and may debate the environmental costs of removing a large tree, which existed long before a structure was built with insufficient footings". Finally, he addresses the financial aspects of running a small business, especially in the days when taxation was punitive and banks and the taxman didn't understand how construction or a consulting business works.

Overall, this is an interesting and often entertaining book. I came away feeling I had an appreciation for the operation of a small structural engineering business, as well as some insight into the personality of the author.

Put together and self-published by the author in a limited edition (which I guess was for the entertainment and enlightenment largely of friends and family) it is unfortunately slightly let down by the typesetters who apparently did not employ a proofreader. Nevertheless, it is fascinating and warrants a wider audience; Stephen tells me there are no printed copies left, but that an e-book version would be available.

Peter Buck (Comp 1976-9)

A worldwide career in petroleum

ROY BARLEGGS (Metallurgy, 48-52)

In late January, Roy Barleggs passed away after a short illness, aged 90.

Roy was born in Letchworth, Hertfordshire, on September 21, 1927, the only son of Ernest and May Barleggs. On completing his secondary schooling, he took up a traineeship with mobile crane builders, K and L Steel Founders in Letchworth.

In 1948, Roy started the Metallurgy course at the Royal School of Mines and in 1952 he was awarded the Bessemer medal for jointly topping (with his good friend, Alan Patrick) the First Class Honours list of Metallurgy Graduates. Initially after graduation, he returned to Letchworth, to work but more importantly, to marry.

In 1956, he accepted a position with the Caltex petroleum group where he was to remain for the rest of his working life. His role was to be part of the petroleum refinery arm of Caltex and he was initially posted with his wife, Miriam, to Bahrain in the Persian Gulf where Caltex had one of its largest refineries.

In 1958, Roy spent a year at Birmingham University completing a Masters in Corrosion technology, in the Chemical Engineering faculty, before returning to Bahrain.

Roy travelled worldwide, visiting refineries, owned and operated by Caltex and its associates, including in Kuwait, Oman, Singapore, the Philippines, Korea, Australia, South Africa and Japan.

In 1974, he was posted to Caltex headquarters, then in New York, returning to Bahrain in 1977, before heading back to headquarters, recently relocated to Dallas, in 1983.

After retiring in the late 90's, Roy was subsequently commissioned to undertake viability assessments of some of the company's ageing refineries. He and Miriam remained in the Dallas area, where many Caltex colleagues lived in retirement.

Roy was always very physically fit. In RSM days, his main interest was in athletics, particularly in sprinting. In Bahrain, in the '60s and '70s he played football and took up golf. The local golf course was played in the desert with oiled-sand greens, where the only grass was a square of synthetic turf which you placed under your ball before each shot!

He was also a keen shooter and, while in Bahrain, joined the Awali Rifle Club, competing against other clubs around the Gulf. In the '80s, back in Bahrain, he joined the running club, and right up until his passing was a regular at his local gym in Texas.

Happily retired to Dallas, Roy and Miriam travelled each year to visit their younger son in London, as well as family and friends in England.

Sadly, Miriam died in 2011, but Roy was still a regular visitor, and often arranged with an old college friend to spend a week walking around London and sampling the hostelries on the way.

With thanks to Roy's sons:
David and Philip

Always cheerful and willing to help: irreplaceable

ALBERT WILLIAM 'KITCH' KITCHENSIDE (Aero 1948-51)

Kitch was born on June 2, 1928, in Mayfield, East Sussex.

He gained a scholarship from Skinners School in Tunbridge Wells and started as an apprentice with Vickers-Armstrong in 1945, at the age of 16.

As all apprentices did, Kitch learnt all the basic skills of the various factory shops and departments, from the Fitters and the Tool Room to the Machine and Stress Shops.

Having decided that his career would be in aircraft design, Kitch went on to study Aeronautics at Imperial.

Graduating with first class honours, Kitch returned to the Stress Office in Weybridge and continued his career in the essential design elements of a whole range of Vickers and BAC aircraft and components, from Valient to VC10, TSR2, Concorde, parts of the Boeing 747 and even the Space Shuttle.

In 1961, Kitch joined the Royal

Aeronautical Society Structures Committee, assisiting in the preparation of Thermal Stressing data sheets.

After the closure of Weybridge, Kitch became a consultant to BAe at Filton, until 1992.

Kitch took his vast amount of experience and knowledge to Brooklands Museum in 1998.

Attending every Tuesday for 17 years, as a volunteer, Kitch worked in a less than inviting environment with a small desk surrounded by a labyrinth of shelving crammed with aircraft manuals, catalogues, files, folders, boxes, photographs and even component parts of the aircraft themselves.

But Kitch was always cheerful and willing to help as he worked to produce indexes of the mountain of material surrounding him.

The museum's curators were constantly trying to find information for researchers, or for displays, and Kitch took up each case with dedication until he found the answer, which he invariably did.

The enormous quantity of new material – constantly pouring in from the attics and studies of ex-aviation industry employees – rapidly filled every corner of the old archive store, but Kitch dealt with each in its turn, proving to be both invaluable and irreplaceable to the museum.

Kitch died on August 14, 2017, at the age of 89.

He will be sadly missed by his wife, Monica, his family and by the many contacts he made over the years.

A quintessential minesman

JOHN D. FAIRFIELD (Mining 1958-62)

Born in Sutton in 1938, John was educated at Epsom College. He was fortunate at that time to encounter a local resident, Professor David Williams (subsequently Dean of the RSM) who was influential in persuading John of the merits of the mining industry. As a result, John became one of the 'Bevin Boys' before joining the RSM, in 1958.

Big in stature as well as personality, John quickly established himself as a leader and became President of the RSMU in 1961 as well as the Chaps Club in 1960. This particular background provided him with the fund of songs and stories he carried with him throughout his career.

His personal qualities also led to prowess in the field of sports where he undertook boxing and became captain of the RSM rugby team. In 1962 he was awarded the AC Maccartney Memorial Cup for the outstanding RSM sportsperson of the year.

At the point of leaving college, John married Brenda who, for the next 55 years, became his team mate and companion during his several stints of living abroad or away from his home base in Melbourne.

For the 38 years of his career John was employed by the Rio Tinto company, initially with RTZ Consultants in London and subsequently with CRA technical services in Melbourne. The personal traits which John had demonstrated at the RSM were well recognised by CRA and, as a result, he was often called upon to establish good working relationships with local peoples, whether they be land owners, mineral rights owners, Aboriginals and so on, before any new ventures could begin. The application of these skills, combined with his technical background, took John from Melbourne to Bolivia, Western Australia and the Philippines for extensive periods.

John played a full part in maintaining the traditions of the RSM mining fraternity: he and Brenda were ever welcoming to those of us from the RSM who happened to pass through, or perhaps stay, in Melbourne.

Inevitably, such occasions always recalled earlier encounters in different parts of the world. I well remember singing Mines' songs with him late into the night while camping in the Barmah forest in Victoria!

Ginger O'Reilly recalls that when, as students, he and Mike von Kimmelmann went to Broken Hill in New South Wales, in 1966, they were met off the plane by John who promised the HR guy that he would safely deliver them to their respective digs. Several hours later, two anxious landladies received their respective charges with John remaining safely out of sight!

For the last seven years of his life, John endured a tough fight with cancer. It is a tribute to his physical strength, fortitude and character that he withstood the debilitating effects of treatments over such a period.

John died in October, 2017, and is survived by Brenda, two children, Sally and Peter (who is maintaining the mining connection in Australia), four grand and three great grandchildren.

He will be sadly missed by all who knew him.

Arthur Smith

"Happy and fun to be with"

MICHAEL FULWELL (Metallurgy, 49-52)

Mike Fulwell, who died on August 26, 2017, was born in Northwood, Middlesex on March 25, 1929, a second son to William and Dorothy Fulwell. William was the chief accountant at Southern Rail (which probably explains Mike's life-long love of steam locomotives.

After completing his secondary schooling at Merchant Taylors School in Northwood, Mike was called up for National Service and joined the Royal Air Force where he was employed on the testing and calibration of aircraft instruments.

On being demobbed in 1949, Mike went to the Royal School of Mines to take the BSc(Eng) Metallurgy course, graduating in 1952.

He started his professional career at the Imperial Smelting Corporation in Avonmouth, joining the team working on the development of the revolutionary zinc blast furnace process.

Two years later, in 1954, he moved across the Bristol Channel to a position as Assistant Works Manager at Western Metallurgical Industries, in Swansea, a company largely involved in the treatment of low grade smelter residues. Unfortunately, the company closed its operations less than a year later, and Mike, newly married to Vera, had to look for a new job.

In 1955, he accepted a position with Capper Pass & Son Ltd and spent the last 34 years of his working life at their operations at Melton, near Hull.

Capper Pass, which was acquired by Rio Tinto in the 1960s, was a non-ferrous smelting and refining company, specialising particularly in tin refining, and the treatment of low grade and difficult-to-treat multi-metal residues. Mike's long involvement meant that he was involved in all aspects of administration and management eventually becoming a group manager of the company.

In the later years, Mike was primarily involved with health and safety and pollution issues.

He retired in 1989.

Following his retirement, Rio Tinto engaged him and three colleagues as consultants in court cases which sought damages for cancer and chronic obstructive pulmonary diseases (chronic bronchitis and emphysema) attributed to pollution from the works.

This culminated in a study, published in 2005, led by Sir Richard Doll, showing an elevated risk of lung cancer amongst workers at the plant, which was found to be statistically associated with exposure to arsenic and other heavy metals.

A study in 2005, of lead and tin levels in soil around the former smelter, showed deposition up to 15 miles (24 km) with a distribution trend towards the north-east; the study estimated that about 2,500 tons of lead and 830 tons of zinc had been introduced into the soil surrounding the plant.

Retirement gave Mike the chance to spend time on a variety of interests, particularly sailing. He was an enthusiastic member of the Humber Yawl Club and sailed around the UK and across to the continent. Although Mike very wisely never owned his own boat, he was always in demand to crew for others.

He was also a keen motorist and helped set up the Advanced Motorists Group in Hull and the East Riding. In recognition of this, he was made an honorary friend.

Sadly, after successfully battling bowel cancer, twelve years ago, Mike's final years were blighted by Macular Degeneration which progressed to the extent that he was registered blind in 1999.

Mike had a lifelong love of music and played the piano, something he continued to do, despite his failing vision.

In spite of his devastating handicap, Mike remained happy and fun to be with.

He is survived by Vera, a son, three daughters and five granddaughters.

Prepared by Ron Butler, with considerable assistance from the Fulwell family.

Devoted Family Man

Michael with his sister-in-law, Lady Diane Knill, and daughter, Dr Kate Knill

Col (V) MICHAEL WILLIAM KNILL (Civ Eng 1949-52, 52-53) FICE, FCIWEM, FCGI, DIC, TD

His daughters, Dr Kate Knill, ACGI, DIC, and Elizabeth Bonnar write:

Our father, Michael William Knill, passed away peacefully on December 25, 2017 after a long, full and productive life.

Born in Wolverhampton on May 3, 1930, the son of a water engineer, Mr William C Knill (first President of CIWEM) and his wife Mary, Michael was destined to spend his life involved in water engineering.

Growing up in Croydon during WW2, Michael attended Whitgift School where he was a Victoria Scholar and was captain of the shooting team, also a member of the Junior Training Corps.

He read Civil Engineering, followed by a Diploma in Public Health, at City and Guilds College, and despite commuting from Croydon he was fully involved in college life, including fencing, and inter-college competitions such as building a copy of the Festival of Britain Skylon. He maintained close links with the College throughout his life, regularly attending careers advice receptions and reunions for his class.

Michael's younger brother, Professor Sir John Knill, was Dean of the Royal School of Mines in 1980-83, and both his sister-in-law – Lady Diane Knill – and his daughter Katherine were awarded PhDs at Imperial. Michael's close friend, Dr Tom Wyatt, Emeritus Reader in Structural Design, sadly passed away shortly after Michael.

National Service in 1953 saw Michael being selected as an officer in the Royal Engineers. After demobilisation, various water engineering posts around the country saw him designing dams and pipe works for a number of significant schemes, including that for the River Dee, and leading the River Medway scheme. He initially worked with clean water, but when he moved to Broadstairs as Southern Water's Divisional manager for East Kent, he became responsible for both water supply and sewage disposal.

He was passionate about improving sea water and beach quality. Restructuring of the water industry in the 1980s led to Michael taking up a new role as a Regional Training Officer for the Institution of Civil Engineers where he inspired and encouraged many young engineers until his retirement in the 1990s.

In parallel with his civilian career, Michael continued to serve the Royal Engineers through involvement in the Army Reserve, rising steadily through the ranks to Full Colonel and Commander of the Engineer Specialist Pool (V), and Deputy Commander of the Military Works Force.

On retirement from the Reserve, Michael remained involved as Honorary Colonel of the Kent Army Cadet Force Regiment and as a member of the National Council of the RE Association.

Outside of the Army, his life of service embraced membership of Round Table and Rotary, and acting as churchwarden at St Peter-in-Thanet, Broadstairs. He also served on the Deanery and Diocesan Synods, and as a Cathedral guide in Canterbury, where he enthusiastically shared his immense knowledge and enthusiasm for its history with visitors.

Michael will be remembered as a quiet achiever, who was kind, gentle, meticulous and a prolific keeper of records. He led a life of dedication to everything he did, and of service to and improving the quality of life of others.

Michael was a devoted family man, and was married to Pauline for 58 years.

He is survived by his children Andrew, Elizabeth, Richard and Katherine, together with six grandchildren.

President of South African branch of CGCA

ERIC ARNOT (Civ Eng 1941-43, 46/47)

Eric entered City and Guilds in wartime, in 1941, and graduated in 1947, after a period of interruption when he served in the Fleet Air Arm.

In his final year, he was president of the C&G Students Union.

In 1948, Eric married Helene White, and in the same year they emigrated to South Africa.

In 1969, he started his own engineering company which he ran for 37 years until he retired in 2006 at the age of 81.

Eric maintained his links with Imperial and was a strong supporter of the South African branch of the Old Centralians. He became its hon. sec. in 1983, chairman in 1987 and president in 1996, which position he still held at his death on December 31, 2017.

Eric is survived by his two children and four grandchildren.

IN BRIEF

Dr. TOM WYATT (Emeritus Reader in Structural Design) FREng

Tom contributed to the teaching of structural steel design and to the supervision of design projects at Imperial.

He had considerable experience in the design and assessment of structures, particularly tall buildings and bridges.

He specialised in dynamic effects on structures including wind, wave, earthquake, pedestrian and vehicular loadings.

Tom's projects included the second Severn Crossing, Stonecutters Bridge, Replacement Forth Bridges, Messina straights, Beijing and London Olympic stadia.

Tom passed away at the beginning of 2018.

PETER SPIRO (Mech Eng 1936)

Peter was one of the enduring characters of CGCA.

When he passed away, on February 9, 2018, Peter was 99, having been born on May 16, 1918.

Peter described himself as a Technical Translator & Interpreter, but he was also well known as a talented artist, as were many other members of his family.

Peter leaves a daughter, Elizabeth.

MICHAEL KENNETH RHODES (Mining and Mineral Technology 1967-70) BSc ARSM

Mike died on January 24, 2018, at the age of 72.

Dr. CHRIS HALLS (Mining Geology)

Chris passed away early on March 30, 2018, after a long and courageous fight against cancer.

He taught mineral deposit studies to several generations of undergraduate mining geology and MSc Mineral Exploration students from the 70s through to the mid-90s and undertook leading research in the field of ore genesis.

Chris was always in demand as an independent consultant by mineral exploration companies who in particular placed a high value on his field skills.

After his retirement from Imperial College, Chris remained active, professionally and academically, through his association with the Natural History Museum.

Dr. JAMES ANTHONY 'JIM' CHARLES (Metallurgy 1944-47) BSc, MA, ScD, FREng

Working as an academic at Cambridge from 1960, Jim was a Fellow of St John's College, Cambridge and Emeritus Reader in Process Metallurgy at the University of Cambridge.

Jim died on November 13, 2017, at the age of 91.

He will be greatly missed by family and friends.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