Welcome to another Newsletter from the Department of Materials at Imperial College. As usual we have news of activities in the College and Materials Department but also possible effects of some of the decisions made by the new government and the effects of the UK vote in the Referendum to leave the EU. The government’s decision to proceed with building the Hinkley Point C nuclear power station has been generally well received by College staff, but there is still much concern for future research funding following Brexit, and the future of the UK steel industry.

I hope you find some of the items in the Newsletter of interest.

1. The first Royal School of Mines mascot returns to the RSM

For the first time in over half a century, one of the first Imperial College Union mascots, a steam-powered tractor known as ‘Joanne’, returned to Imperial College as part of the 2016 Imperial Festival. ‘Joanne’, a five-ton Aveling and Porter class TE GND steam-powered engine, was built in 1919 by the Aveling & Porter company of Rochester in Kent. The engine was bought in 1940 by the RSM Union as the union mascot.

During the 1960s as Imperial College was rebuilt and enlarged it was not possible to house and maintain the engine on the South Kensington site. Mr Mike Elvy, an RSM graduate, kindly agreed to look after Joanne. In the 1980s the tractor was sold to Mr John Heselwood of Bury in Lancashire and is still owned by him and his family. Joanne joined the other Imperial College mascots, namely ‘Clementine’, ‘Boanerges’ and ‘Jezabel’ in the Transport Zone for the Alumni Weekend and the 2016 Imperial Festival, and gave rides to many of the younger visitors.

More about the Imperial College mascots can be found towards the end of the Newsletter.

2. Imperial Festival 2016

The 2016 Imperial Festival, our annual celebration of the science and engineering research work at Imperial College, was held over the first weekend in May. Magnificent weather brought out large crowds to the South Kensington campus to hear from over 500 staff and research workers about the innovative nature of the research work that is undertaken at Imperial College.
New zones for the 2016 Festival included Health and Wellbeing, Energy and the Environment, and a Transport Zone. These displays joined the ever popular zones featuring Superbugs and Robots. The Transport zone recreated London’s very first motor show held 120 years ago with a unique display of ‘horseless carriages’, and included some of the earliest examples of motor cars powered by steam, electricity and petrol. Also on display were cars and transport vehicles of the future. Visitors to the Festival were able to see new research areas in science that ranged from epidemics and climate change to artificial intelligence.

Visitors arriving for the Festival

Marquees were pitched across the campus for live music and dancing displays.

There were plenty of activities to catch the imagination and interest of the younger visitors

3. Professor Alice Gast gives her second annual address

In March, Professor Alice Gast, the President of Imperial College London, gave her second annual address to the Imperial College community choosing “excellence in higher education” as her theme.

Questioning what we “really mean” by excellence, Professor Gast said: “We each have our own personal measures of achievement. We push ourselves to do the very best we can and we know in our hearts when we measure up and we know when we don’t. We need to ensure that the peer-review processes will support the non-traditional, the avant-garde and the blue skies ideas that have not been tested. We must remember too that we are the peers and being an excellent reviewer should be something we all aspire to. If as
reviewers we promote innovative, multidisciplinary and blue skies research then perhaps our example will be followed by others”. Questioning whether metrics alone were an adequate means for assessing excellence, Professor Gast suggested that peer review and metric assessments should be turned towards a more balanced combination. She felt that it was important to voice our concerns when we think that a proposed framework might inhibit or discourage excellence rather than support and reward it.

Professor Gast went on to highlight the impact of some of the work from Imperial College, which has helped to tackle a number of key societal problems – from the eradication of polio to preventing forgeries, and from creating more efficient ways to power our homes to developing quieter aircraft.

At Imperial College measures aimed to improve student satisfaction would include improved feedback from students and increased mental health help, measures that would be supported with a new fund which would reward excellence and promote courageous and innovative ideas in both teaching and research. In her concluding remarks Professor Gast said “Together we will define and demonstrate excellence in ways that no other university can”.

Following her address, a reception was held to offer congratulations to more than 150 members of the College who had received external honours and prizes. These included Lord Darzi who had received the Order of Merit (OM) along with other members of the College who had received honours in the Queen's birthday awards and New Year honours.

4. Diplomats and scientists explored the future of new materials

In April, Imperial College played host to the London Diplomatic Science Club, an organisation that brings together the science attachés from embassies and high commissions in London, together with representatives from the UK government, the Royal Society and the UK research councils. Professor Alice Gast, Imperial College President, described how Imperial lay at the heart of a global scientific community with over 50% of our staff and students coming from outside the UK.

During the event, staff from the Materials Department which included Professors Mary Ryan, Neil Alford, Robin Grimes and Natalie Stingelin spoke about the research into future materials and their likely impact on society.

5. QS rankings for the top 200 universities in the world

The annual ranking of universities based on a series of league tables always needs to be treated with a certain degree of caution, particularly as the weighting given to the various categories of collected data can change from year to year. Previously, many of the rankings had undoubtedly favoured universities that were strong in research – that was good for Imperial College! Changes made this year to the tables aimed to give more recognition to universities that were outstanding in the arts and humanities. The effect was that the top UK universities slipped a little down the international tables, although four UK universities
remained in the world top 10. Imperial College was placed in eighth in the international rankings.
When individual subjects were assessed, Imperial College, Cambridge and Oxford remained in the world top 10 for materials science, with Imperial College in third place. Top of the table for materials science was MIT, with Imperial College 1st in the UK. The only other UK materials science department to make the top 50 was Manchester University, which was placed 27th.

6. The Hilary Bauerman Lecture
The Materials Department has established an annual distinguished lecture. Known as the “Hilary Bauerman Lecture”, the lecture has been named after one of the original seven students who in 1851 entered the newly formed Government School of Mines in Jermyn Street. The lectures are intended to be an annual highlight that aims to bring the whole of the Department together for both technical and social interactions.

The first Bauerman Lecture was given in April by Professor Stephen Mann FRS, Professor of Chemistry at the University of Bristol. Professor Mann is regarded as the founder of biomimetic materials chemistry and is Chairman of the Scientific Advisory Board for the Frontier Engineering Centre for Nature Inspired Engineering at University College, London. He is the author of “Biomineralisation: Principles and Concepts in Bioinorganic Materials Chemistry”. He used his lecture to describe how material principles and concepts have been successfully applied to biological systems and have reached the point that the engineering of biological systems has now been accepted as a discipline in its own right. Professor Mann illustrated his lecture with highlights of recent advances in the design and microscale engineering of synthetic protocells, a step towards autonomous material life-forms which are capable of rudimentary processes such as chemical cognition, signalling, modulated reactivity, self-reproduction and collective behaviour.

The lecture was attended by students, research staff, academic and technical staff from across the whole Department and was followed by a reception for all the attendees and then a Gala Dinner hosted by Professor Peter Haynes and held at the Polish Club for those who had been fortunate to receive an invitation from a ballot for the available places.

7. Promotions
We were delighted to hear that the College had approved the following promotions.

Dr Christopher Gourlay has been promoted to Reader in Metallurgy.

Dr Iain Dunlop promoted to Senior Lecturer.

Dr Theoni Georgiou promoted to Senior Lecturer.

Dr Peter Petrov has been made a Principal Research Scientist.

and Dr Vicky Bemmer has been made a Research Officer in Atomic Force Microscopy.

8. Fukushima revisited
In March 2011 an earthquake off the east coast of Japan triggered a tsunami which destroyed the Fukushima Daiichi Nuclear Plant. The disaster led to a series of explosions and a partial meltdown of three boiling water reactors and a mass evacuation of thousands of people who lived in the surrounding areas.
Professor Bill Lee, Director of the Centre for Nuclear Engineering at Imperial College and Dimitri Pletser, PhD student, recently visited the site to see how the clean-up operations were going. Since the accident water has been used to cool the damaged cores. The visit was part of the research programme that Professor Lee and Dimitri Pletser are part of, and is concerned with the ways of capturing and disposing of the radioactive waste collected from the cooling waters. Sight of the devastation wrought by the tsunami to the reactors and the 20 km exclusion zone around the plant was an experience which both said they would never forget.

The reactor buildings are now a mass of tangled metal and concrete, with most of the wreckage covered by temporary weatherproof structures. The site houses the facilities for the clean-up operations, including filter systems to strip the radioactive nuclides from the water which had been used to cool the reactor cores. A workforce of roughly 7000 people are on-site each day, many working in extremely difficult and hazardous conditions, which makes the progress achieved so far all the more impressive. A huge incinerator is used to burn all the contaminated clothing worn each day by the workers.

Much of the current clean-up is geared towards developing new techniques for examining the inside of the damaged reactors using robots. The teams are also examining how to stop water leaks from the damaged pressure vessels and developing techniques for remotely retrieving radioactive material that remains inside the reactor cores. Teams of engineers and scientists are putting together mid- and long-term road maps for decommissioning each reactor, a process which could last for the next 40 years because of the very high radiation levels.

The radioactive decay within the reactor cores of the damaged units generates much heat which requires constant water cooling. However, the site is beginning to run out of space to store the treated water. It is currently not possible to release this water into the ocean in a controlled and safe way due to political pressures exerted by the local fishermen who fear possible contamination of fish stock. Storing increasing quantities of tritiated water has meant that woodland that once covered the site has had to be cleared. However, this has led to run-off contamination, much of which runs into the sea. There is now concern that a plan to build a frozen earth barrier around the entire site to prevent the waste from entering the ocean may not be effective.

9. Dr Ben Britton receives a Young Engineer of the Year Award

Dr Ben Britton was one of five UK researcher workers to receive the prestigious Engineers Trust Young Engineer of the Year awards this year at the Awards Dinner held at the Tower of London in June. The award, a prize of £3,000, was made by the Royal Academy of Engineering with support from the Worshipful Company of Engineers.

Ben joined Imperial College from Oxford in 2010 as a Nuclear Metallurgy Fellow. In 2014 he was awarded the Institute of Materials, Minerals and Mining Silver Medal for ‘an outstanding contribution to the broad field of materials science’. In 2015 he was awarded a Royal Academy of Engineering Fellowship and was made a Lecturer in Materials. Ben’s research work is part of the Materials Engineering Alloys Group and is focused on the engineering and materials science of high-risk, high-value alloys used in aero-engines and in the
nuclear and energy industries. Ben specialises in using experimental micromechanical characterisation using a range of techniques that include electron microscopy and simulation.

On receiving the award Ben made the comment that "life as an academic is both fun and challenging, and is only made possible when working with talented, supportive and enthusiastic colleagues. I share this award with them."

In addition to his research work, Ben directs the MSc course in Advanced Nuclear Engineering. He teaches on two undergraduate courses, supervises and advises postgraduate students in materials. He also contributes to the College’s public engagement activities through events, science festivals and visits to schools.

10. **New horizons for Professor Natalie Stingelin**

In August Professor Stingelin, Professor of Organic Functional Materials, took up a Chair of Materials Science at the Georgia Institute of Technology. Natalie obtained her first degree in materials science followed by a PhD at the Eigennissische Technical Hochschule (ETH). This was followed by a number of research fellowships, first at the Cavendish Laboratory in Cambridge, and then at the Philips Research Laboratories in Eindhoven and at ETH Zurich. The fellowships were followed by an academic position at Queen Mary College London until in 2012 she joined Imperial College as a Senior Lecturer in materials science. She was awarded the Rosenhain Medal and Prize by the IOM3 in 2014 and an International Fellowship by the Chinese Academy of Sciences. Her current research activities cover a broad field of organic functional materials that includes organic electronics, multifunctional inorganic/organic hybrids and smart advanced optical systems based on organic matter and bioelectronics. Fortunately for us, Natalie will continue as a part-time member of the Materials Department academic staff.

We look forward to many future visits from her.

11. **Professor Molly Stevens receives prestigious award**

Professor Molly Stevens has been awarded the 2016 Clemson Award for Basic Research from the Society for Biomaterials. The award recognizes the outstanding contributions made by a researcher to understanding the interaction of manmade materials with human tissue, focusing on theoretical concepts, developing new materials or studying the interactions of bacteria in a biological environment.

Professor Stevens and her group are designing biomaterials for regenerative medicine and bio-sensing. The work includes developing innovative bone, cartilage, nerve and heart tissues. In the future, the materials could be used as replacements for damaged tissue in the body and helping patients to heal more rapidly.
On accepting the award Professor Stevens said: “It is a privilege to receive this award and it is very humbling knowing that so many pioneers in the field have received it in the past. These include the wonderful late Professor Larry Hench, a pioneer in the field of bio-glass materials. He previously had worked at Imperial and left a massive legacy here, receiving his award in 1977 whilst working in the States.”

On the bio-sensing side, Professor Stevens and her team are focussing on developing ultrasensitive disease detectors using nano materials. For example, she has designed a device capable of specifically detecting biomarkers in clinical samples that may point to the early onset of diseases such as acute pancreatitis, sepsis and rheumatoid arthritis.

12. Lots of Good News

**Dimitri Pletser**, PhD student, was awarded the Roy G. Post Foundation Scholarship worth $5000 in addition to an all-expenses paid travel to attend the 2016 Waste Management Conference in Phoenix, Arizona. Dimitri presented a paper which focused on the development of suitable waste forms for the nuclear waste arising from the clean-up processes following the Fukushima nuclear disaster. Dimitri is supervised by **Prof Bill Lee**.

**Madasir Yatoo**, PhD student, has been awarded one of the 2016 Mahatma Gandhi Pravasi Samman awards made by the UK Non-Resident Indian Welfare Society. The awards recognise those Indians who have made their mark overseas with outstanding services and achievements. Madasir, is supervised by **Professor Stephen Skinner** and **Dr Ainara Aguadero** and was one of several recipients who received the awards at a ceremony in Delhi.

**Dr Stephen Hanham**, an Experienced Researcher, collaborating with TK Instruments has made significant contributions to the success of the UK THz industry in the development and installation of systems for monitoring atmospheric pollution in China. A 340 GHZ monitoring system has been set up in Quindao, China and is said to be functioning well.

Following the publication of a paper entitled “Printing in Three Dimensions” by Research Associates **Drs Esther Garcia Tunon Blanca, Victoria Garcia Rocha** and **Professor Eduardo Saiz Gutierrez** in the journal of Advanced Materials, a synopsis of the paper, with a video of the process, was placed on the Imperial College website and attracted over 40k visits.

**Alan Charles**, a former student on the Nuclear Engineering MSc course and now a PhD student won the 2015 Nuclear Institute’s Masters Dissertation Prize.

**Professor Dame Sue Ion**, former student and currently a Visiting Professor and Lecturer in Advanced Nuclear Engineering, has been made a Fellow of the Royal Society. Earlier in the year Dame Sue had been a guest on the BBC Radio 4 programme, “Desert Island Discs”.

**Professor Mary Ryan** gave the opening presentation entitled “Engineering the lifespan of future materials” at Imperial Tech Foresight 2036, a meeting organised by the Imperial Business Partners. The meeting was held to explore the future of materials and design, asking the questions what it might mean if a material could last forever or machine intelligence could bring the same level creativity to product design as humans do today.

**Anna Constantinou**, a PhD student supervised by **Dr Theoni Georgiou**, has been awarded the 2016 James S Walker Award by the IOM3 for her MSc project entitled “Thermo-
responsive gels based on ABC triblock co-polymers: effects of composition and hydrophobicity”.

Paul Jones, PhD student supervised by Professor Julian Jones and Dr Iain Dunlop, was selected as part of the GB lightweight men’s four for the International Rowing Championships held in Pozan, Poland in August.

Sandy Knowles and Claire Burgess have been awarded EPSRC Doctoral Prize Fellowships. Sandy is supervised by Professor David Dye and Claire by Dr Martyn McLachlan.

Dr Paola Campagnolo, PDRA, has accepted a lectureship in biosciences at Surrey University. Paola worked with Professor Molly Stevens.

Dr Peter Petrov, Dr Andrei Mihai and Dr Bin Zou been successful in obtaining Impact Funding valued at £59,000 from the EPSRC for a project to develop an ultra-fast non-volatile storage device. Dr Petrov gave a plenary lecture entitled “Non-Linear Phenomena in Nano-Scale Oxide Layers” at the 11th International Conference on Physics of Advanced Materials in September.

Professors John Kilner and Stephen Skinner, Dr Sam Cooper and Matthew Niana together with colleagues from Kyushu University in Japan have been awarded the prestigious Daiwa Adrian Prize for 2016. The prize, awarded on a triennial basis by the Anglo-Japanese Foundation, is in recognition of the scientific collaboration between British and Japanese research teams.

13. Professor Neil Alford receives a prestigious award

The Royal Society has awarded Professor Neil Alford, former Head of the Materials Department, the prestigious Armourers and Brasiers’ Company award for outstanding contributions to materials science research which has benefited society.

Professor Neil Alford has led a distinguished research career that has covered a wide range of both structural and functional materials. The value of his work has resulted in many successful partnerships between academia and industry. The application of his many discoveries to current commercial applications and the international impact which his studies have made is evident from an outstanding record of publications, patents and industrial collaborations.

Neil graduated with a degree in geology and his first job was as a petroleum engineer with Exploration Logging, a division of Brown and Root, now the Baker Hughes company. He then returned to academia to undertake a PhD on the fracture mechanics of cement mortars. This was followed by an ICI Fellowship at Oxford University with research to develop high strength cements. The work led to a position at the ICI Corporate Laboratories to develop macro defect free cements with high strength. While at ICI, Neil’s interests switched from structural to functional materials with studies on perovskite ceramics and high temperature superconductors. A fundamental understanding of the properties of these materials found applications in microwave devices. The work on microwave dielectrics established him as an international authority on ultra-low-loss microwave dielectrics and ferroelectric thin films that are used in communication systems. In particular, the research resulted in the development of polycrystalline alumina-based ceramics, materials with the lowest dielectric loss that had ever been reported. Subsequent research on defects in titania led to the production of materials with a very high Q and high dielectric constants, materials now used for the microwave ablation of cancerous tumours.
14. The 2016 Postgraduate Degree Ceremonies

At the beginning of May some 3,000 postgraduates returned to Imperial College along with more than 15,000 family and friends for one of the largest ever Imperial College Postgraduate Degree Ceremonies. The ceremonies were held with morning, afternoon and early evening sessions in the Royal Albert Hall, and were followed by receptions for the new graduates and their guests held in departments spread across the South Kensington campus. Materials graduates and their guests were welcomed to the Department of Materials by Professor Peter Haynes, the Head of Department. The occasion was used for the presentation of the Materials Department prizes and awards.

The Constance Fligg Tipper prize for the postgraduate showing the most industry and independence in research was awarded to Zoltan Heizl. The Matthey Prize for postgraduate research was awarded to Edoardo Giorgi and the McLean Memorial Prize for the best paper to be accepted by a journal for publication went to Tamara Chapman. The Tony Evans Memorial Prize for the student with the best PhD thesis in the ceramics discipline went to Robert Harrison. The Larry Hench prize for excellence in a biomaterials research was awarded to Anthony Macon. The John Kilner Prize for the best PhD thesis related to energy materials was awarded to Samuel Cooper and the Thomas Young Centre prize for the student who had shown the most innovative contribution for research into the Theory and Simulation of Materials went to Niccolo Corsini. Theodorou Ionnis was awarded the prize for the best student on the Advanced Materials Characterisation MSc course. The William Penny Prizes for students submitting the best research projects on the MSc courses in Nuclear Engineering and Advanced Materials Science were awarded to Jure Aleksejev, Alan Charles, Anna Constantinou and Lucille Chambon.

15. The Government gives the go ahead for Hinkley Point C

In September the government announced approval for the construction of a 3,200 MW nuclear power station to be built at an estimated cost of £18 billion at Hinkley Point in Somerset. The decision follows over 10 years of planning and negotiations between the UK government and EDF the builders, with finance for the project from the French and Chinese governments. The decision by the new UK government to review the contract allowed the UK to place additional controls on the foreign investment in the UK and to impose new safeguards designed to protect national security. The deal paves the way for the Chinese to build a nuclear power station at Bradwell in Essex. The Hinkley Point project remains controversial, largely because the government had agreed to pay EDF £92.50 per MWh generated for 35 years, a price that is currently more than twice the price of electricity. Imperial College experts from the Centre of Nuclear Engineering, the Department of Mechanical Engineering, the Materials Department, the Energy Futures Lab and the Imperial College Business School have largely welcomed...
the decision to go ahead which will be the first new nuclear power station to be built in the UK for over a generation.

It has been estimated that the construction and operation of Hinkley Point C will create 25,000 jobs, with 60% of the construction costs going to UK companies. The power station is due to be operational by 2026. It will provide 7% of UK power requirements and make a significant contribution to the reduction in UK CO₂ emissions, reductions already agreed to at the international climate change conferences.

16. **College mascots joined vintage vehicles at the 2016 Imperial Festival**

The Imperial College Union mascots joined a collection of vintage vehicles brought together as part of the 2016 Festival Transport Zone. The oldest vehicle on display was a 1900 De Dion Bouton, owned by Mr Robert Goodwill, MP for Scarborough, who at one time was the Minister of State in the Department of Transport, but is currently Minister of State for Immigration at the Home Office. Mr Goodwill's interest in vintage vehicles began while his son was an undergraduate student in the Department of Mechanical Engineering and part of a team involved in the maintenance of 'Boanerges', a 1902 James and Browne car, which is the City and Guilds mascot. ‘Bo’ requires two drivers and this gave Mr Goodwill the opportunity to accompany his son, kindled his interest and the start of a collection of vintage vehicles. ‘Bo’ is seen in the centre of the photograph. The other College mascots in the photograph are ‘Jezabel’, a 1916 Dennis fire engine and mascot for RCSU, and ‘Clementine’, a 1926 Morris T-type truck (RSM mascot).

17. **Is there a future for a UK steel industry?**

The problems in the UK steel industry became apparent last October when the Thai owners of the Redcar steel works announced an immediate closure of the steel works with the loss of 1,700 jobs. This was followed almost immediately by an announcement from Tata Steel of the loss of 1,200 jobs at the Scunthorpe steel works and the Scottish mills. Then Caparo Steel placed their company in administration with the loss of a further 1,700 jobs.

The crisis had been triggered by the economic downturn that followed the worldwide financial crisis in 2008. While world demand for steel fell, China continued to invest in new steelmaking plant, producing an over capacity in 2015 estimated to be in the region of 250 million tonnes. The Chinese steel industry is effectively owned by the Chinese government who were reluctant to cut back on production since this would inevitably have involved the loss of thousands of jobs. Enormous quantities of surplus steel were therefore placed on the world markets and the price for steel fell to less than half of what it had been before the economic crisis.

Counties outside the EU took a protectionist view and applied huge tariffs on imported steel. The USA responded with tariffs of 522% on imported steel and China responded with a levy of 46% duty on high tech steels from producers worldwide. The EU seemed powerless to respond to protect the European steel makers. UK steel makers blamed the low price of steel on a combination of Chinese dumping, the high cost of energy in the UK energy, the strength of the British pound and high labour costs.
The crisis deepened further with an announcement from Tata Steel that it planned to withdraw completely from all its British operations and placed all its plants, including the Port Talbot steel works, up for sale. Tata claimed to have invested £3 billion in its European operations since buying them from Corus in 2007 for £6.7 billion. The South Wales steel complex employs over 4,500 workers, with a similar number of workers employed in the supply industries. The plant was said to be losing £1 million pounds a day. By the end of March it was said that seven groups had expressed an interest in buying Port Talbot. The UK government, anxious to see a sale go through, was said to have offered to buy a 25pc equity stake in the business and was also ready to offer “hundreds of millions” in financial support.

A major problem for the prospective purchasers was the Tata pension scheme, with 134,000 members and assets of £15 billion, but a current deficit of around £700 million. The pension scheme was a liability that none of the prospective purchasers were willing to take on board. Tata also refused to write off a £900 million loan to its UK business, adding yet further problems in finding a solution.

By July, talks between Tata and prospective purchasers had stalled, and the decision that the UK should leave the EU following the EU Referendum vote added yet a further complications. At this point Tata decided to halt the sale of Port Talbot, since with the financial inducements on offer from the UK government this made the retention of their UK assets a financially viable asset. It was also rumoured that following an efficiency drive the plant was no longer running at a loss!

With the sale of Port Talbot on hold, Tata began to review its European strategy and discussions were opened with the rival ThyssenKrupp group, one of the largest German steelmakers. The suggestion of a possible merger with Thyssenkrupp group to form a joint European venture to supply steel for the British and German car industries offered new possibilities. By early August it became clear that a possible tie-up between the two steel giants would take many months of legal wrangling to decide how much of the commercial information each group would be prepared to share. It seemed inevitable that a tie-up would lead to job losses at Port Talbot, since the more modern plant at Imjuiden in Holland and in Germany would have all the capacity the merged companies would require. Meanwhile, the 4,500 staff at Port Talbot now face many more months of uncertainty over their future.