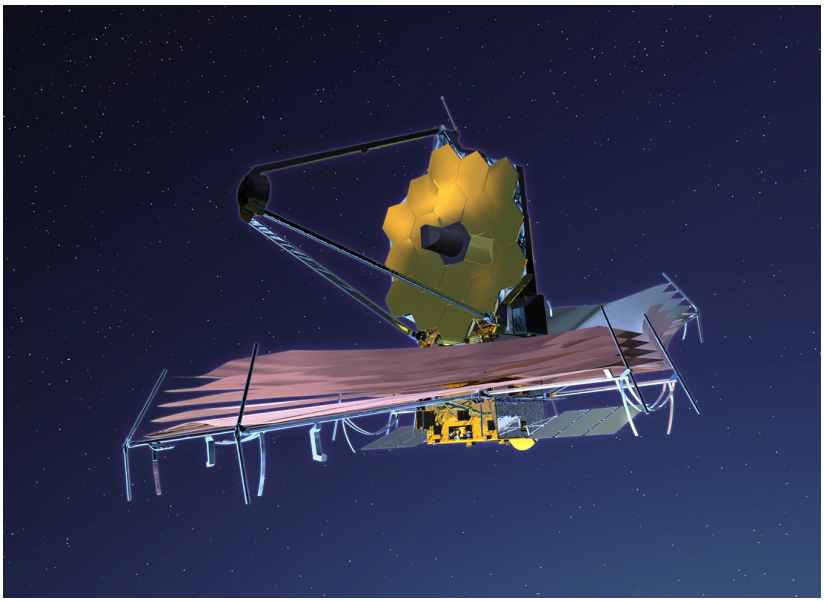
The Swordsman

Issue 49 - October 2022



The Worshipful Company of Engineers

(Incorporated by Royal Charter 2004)

Front Cover:
Artistic impression of the James Webb Space Telescope; NASA.

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The Worshipful Company of Engineers
&
The Engineers Trust
(charity number 289819)

Tech4All CIO
A UK based charity
(charity number 1054041)

innovation4all.award@engineerscompany.org.uk

The Worshipful Company of Engineers in partnership with UK-based charity Tech4All, are offering an award for the most creative engineering-based solutions to the alleviation of poverty.

The award is intended to encourage engineers to use their skills and expertise to create solutions to alleviate the causes or consequences of poverty. The judges may award runners up substantial discretionary prizes. Entries must be received by March 1 2023.

Submissions can address poverty across a broad range of areas including, but not limited to, health, social exclusion, education, banking or location. Applicants must clearly identify the evidence-based challenge to be overcome, how the innovation will benefit the under-privileged and how that benefit can be or has been measured.

Projects must be supported by a simple high-level business plan identifying essential immediate cash-requirements, and a self-sustaining future operating model.

Entrants can be independent, or part of a recognised body, but financial control processes must be present and openly reported. Entrants must be based in the UK.

For more information, please send an email to innovation4all.award@engineerscompany.org.uk

Chris Elston

Contributors

My thanks to the following who have contributed articles and photographs: *the Master, Past Masters Barry Brooks, David Johnson and Gordon Masterton, the Middle Warden, the Junior Warden, Roger Maber, Kate Barnard, Graham and Kate Parry, Sue Hewerdine, John Chandler, Margaret Ross, Justin Davies-Trigg, Norman Dawson, Suzanne Flynn, Peter Liddell, Stephen Davies, Colin Newsome, Jane Newsome, Lynda Masterton, Peter Gracey, Chris Earnshaw, Ros Garside, Brian Back, Linda Brooks, Matthew Waterhouse, Mike Inkson, John Canning, John Williams, Mark Witter Photography. Article photos are by the author unless otherwise stated.*

A Profile of the Master

Audrey Canning MA, CEng, FIET, FRSA, MSaRS, MIoD

Audrey was born on the South Bank of London to a Cockney mother and Londoner father. From the age of four the family relocated to Hertfordshire, where she was lucky enough to find an aptitude and love of maths and physics and - despite an inability to spell - 'scraped in' to a co-educational Grammar School. By the age of 14 she was determined to become an engineer against all resistance, including from her father, who advised her the profession was "overworked and undervalued".

On leaving school, and with admission to Churchill College secured for the following year, Audrey was accepted onto a 1-3-1 apprenticeship scheme with Marconi Space and Defence Systems. Not only did this ensure a 'top up' of a magnificent £20 per month to the government grant, but enabled her to gain experience in many different engineering departments, ranging from machine shop and wiring skills, to drawing office and planning, to QA on a production line, to electronic design, programming and systems analysis. The experience was an excellent complement to the theoretical training in a wide range of engineering disciplines at Cambridge including structures, mechanics, thermodynamics, fluid mechanics, electrical and electronic systems, and materials science.

On returning to Marconi Audrey was responsible for testing the first computer controlled homing head. Unlike today's computers embedded on a single chip, this system was built from individual TTL logic chips, and led to a deep understanding of the way data, storage and comms channels unite to form a computer architecture. Indeed, on joining an SME in 1980, the Intel 8080 processor chip came as quite a revelation!

Over the next three years Audrey focussed on electronic and firmware design, and build, test and commissioning of parts of a toll road system to be installed on the Mersey Tunnel. As well as gaining technical experience, she also learnt to deal with clients, salesmen and the unions (a result of testing the feasibility of automatic recognition of approaching vehicles, whilst hanging out of an overhead gantry!)

On moving to ERA Technology in 1983, she was initially responsible for developing the signal processing algorithm and software for a ground probing radar to detect land mines in the Falklands, and then use of artificial intelligence in digital comms and to analyse EMC signatures on board Naval Vessels. In 1985 ERA secured a contract with BP to assure their first computer based safety shutdown system on a North Sea platform. With her experience of control and signal processing, computer system testing and commissioning, and her theoretical underpinning, Audrey was asked to take on this project.

At this time the HSE was in the early stages of developing guidance for the use of computer based systems in safety applications, primarily focussing on chemical process hazard analysis and hardware and software development procedures. Audrey took the general principles, and developed techniques to implement the guidance, translating chemical process hazard analysis to functional hazard analysis (more appropriate for a software based system), ensuring traceability of hazardous failure modes to the Functional behaviour, and developing testing procedures to ensure all paths through the software could be traced to the desired functions and that no path could lead to undesirable behaviour. The work resulted in the opportunity to visit the BP North Sea platform – the first woman to do so after Her Majesty the Queen – and then to further contracts for BP, for the British Railways Board (assuring train protection warning systems) and eventually to establishing the first NAMAS accredited safety critical software test house.

In 1991 she was appointed Department Manager, organically growing the safety critical systems business to 22 people. During her work at ERA she led more than twenty independent safety assessments

in applications as diverse as oil and gas, military, medical devices, nuclear, air traffic control and railway protection systems. She also set up and led two multi-million pound collaborative research projects on safety critical systems, one for industrial data driven systems and the other in machine learning.

On establishing Virkonnen Ltd in 1997, she was approached by London Underground to help with the assurance of the Jubilee Line extension to Stratford, and also by the DTI for assessment activities for government funded research into computer based applications. Over the next 24 years she has taken responsibility as Engineering Safety Manager for the Piccadilly Line Extension to Heathrow Terminal 5, as Engineering Assurance and Compliance Manager for the Northern Line Signalling upgrade, and as Systems and Safety Engineering Manager for the feasibility and concept design stages of the Northern Line Extension to Battersea Power Station. Profoundly grateful for her multi-disciplinary training, she has led safety teams combining skills as diverse as civil, mechanical, electrical, fire, EMC, safety and human factors engineering, as well as signalling, track, communications and computer based technology. She continues to be involved in monitoring of InnovateUK funded collaborative R&D, mostly in Aerospace applications. Her professional activities have included past membership of the IET Council, chair of the (IEE) software engineering professional group, member of the Control and Automation Board and founder and past chair of the IET Safety Community and a current member of the IET Engineering Safety Panel. She has served on EPSRC advisory and NATO standardisation boards as well as being chair of the BSI GEL/65/1 Committee for over seven years. She is currently co-chairman of the international standard IEC61508 (Functional Safety of Electrical, Electronic and Programmable Electronic Systems) and she is the international lead on functional safety on the Advisory Committee on Safety (ACOS) to the IEC Standards Management Board. In 2020 she was appointed as the IEC

representative on the Joint ISO/IEC Working Group developing standards in Artificial Intelligence, where she has been responsible for leading the work to develop a Technical Report on Functional Safety and Artificial Intelligence. In 2016 she was awarded the IEC 1906 medal recognising exceptional achievements.

Audrey has been married to John for 43 years and has two children in their late 30s, one a professional computer systems engineer-turned-teacher and the other an astrophysicist researching galaxy formation. Her hobbies include dressmaking, walking and travel. She joined the Company in 1999, progressing to the Livery in January 2000.

Installation Court, AGM and Dinner 2022

Installation Court, Common Hall and Annual General Meeting 4 May 2022

During a Common Hall and AGM held at Merchant Taylors' Hall, following the Installation Court held on 4th May, **Mrs Audrey Canning** was duly installed as Master for the year 2022-2023. Immediate Past Master Prof Gordon Masterton officiated in the absence of Master Peter Blair-Fish who, with his wife Diana, was absent, recovering from Covid. Mrs Canning responded with the following:

I am deeply honoured by your trust in appointing me as Master Engineer for the coming year. I would like especially to thank you for the support I have received from so many as I look forward to continuing the traditions of the Company, its fellowship and social interaction, whilst positioning it for the challenges of the years ahead. On that note my theme for the year is 'Challenging Boundaries'. You may remember that this was the title of my Junior Wardens lecture, where the boundaries I envisaged as 'challenging'

The new officers of the Company and their partners: L-R Mr Roger Maber and Middle Warden Dr Dolores Byrne; Mr John Canning and Master Engineer Mrs Audrey Canning; Senior Warden Mr Raymond Joyce and Mrs Yvonne Joyce; Junior Warden Eur Ing Penny Taylor and Mr John Williams

at that time were around the increasing complexity, connectivity and automation of systems, shifting the boundary between man and machine. Little did I think that the challenges would extend to the disruptive effects of pandemic. Although aware that the green agenda would change our energy markets, I never foresaw the speed and scale of change brought about by the combined effect of aggressive climate change and war. Some of these themes will feed into the technical programme for the coming year. For example, the impact of Covid and environmental imperatives. The all-pervasive uptake of machine learning and AI driving automation of vehicles, factories and the home. The use of digital twins enabling simulation and control of highly complex systems and manufacturing processes. And big data allowing us to synthesis new materials, manage highly complex systems, predict traffic in our daily lives and understand how our universe is unfolding. We stand on the cusp of dramatic change which will challenge the boundaries within which we work as engineers. In this time of change, it is my great privilege to accept the role of Master for the coming year and to assure you that I will work to the best of my ability to promote the Company's standing in the eyes of the City, encourage greater engagement of us all, satisfy our shared passion for Engineering innovation and excellence, and to continue to build a diverse and thriving membership for our Company's future. Thank you.

Mr Raymond Joyce was then appointed as Senior Warden and **Dr Dolores Byrne OBE** and **Eur Ing Penny Taylor JP** made their declarations and were sworn in as Middle and Junior Wardens, respectively.

Air Cdre Mark Hunt was re-appointed as a court assistant for a second term. **Prof Nachiappan Chockalingam** and **Cdr Peter Gracey RN** made their declarations and were appointed as new court assistants.

The AGM and Common Hall were followed by the Installation Dinner, hosted by the new Master and her Consort John Canning and held at Merchant Taylor's Hall. Here we enjoyed excellent food and hospitality as well as the opportunity to hear the only remaining working organ in a Livery Hall. In her speech after the dinner, the Master reiterated that she felt honoured to be appointed as Master and to have the privilege of representing the engineering profession in the City of London.

She reflected on the role of the engineer and how the ability to create vastly distributed, adaptive, and interconnected systems are challenging societal norms, giving rise to her theme 'Challenging Boundaries'. She noted that the challenges had only increased in a world of fast changing markets, disrupted supply chains, changing international allegiances and threats to our energy supply and environment. How will engineers adapt to address these challenges in a way that is socially aware, inclusive, and secure?

Looking forward to her year she noted that the programme was designed to embrace inclusivity of the membership by reaching out to those living in the regions, but maintain the Company's City allegiance. To embrace connectivity in a virtual world, but retain the spontaneity, empathy and body language of the physical. To acknowledge the common goals of engineers, regardless of race, colour, creed, language or any other personal characteristics. She also introduced some of the themes, including how one of the UK's world leading industries was adapting to disruptive change, how our everyday on-line activities bring challenges in terms of space, power, cooling and networking and how novel algorithms and extraordinary instrumentation help us discover new science.

Finally she reflected on the fact that she was now the second woman Master, thanking Past Master Isobel Pollock-Hulf who was stepping down after her nine years of dedicated service to the Company. She also hailed the achievement of the Company in being the first in history to appoint talented female engineers to three quarters of the Master and Wardens team.

The Master then welcomed her guests, including her principal guest **Dr Scott Steedman, CBE FREng**, Director-General Standards at the British Standards Institute before raising the toast to 'The Guests'.

Dr Steedman responded on behalf of the guests and offered the toast to the health of the Company. Welcoming the Master's theme of 'Challenging Boundaries' by reference to the work of the great lighthouse engineer, Robert Stevenson in the early 1800s, he described how engineering advances in shipping had led UK engineers to take a leadership role in the creation of international standards for the electrotechnical sector, to which the Master herself has contributed her own expertise throughout her career.

He explained that despite the UK's early interest in setting international standards, the subject of standards is not well understood today in the profession, or in academia or government. Commitment has waned through a lack of education, and this has reduced capacity to deliver the true benefit of this vital tool for UK companies, government and society. Increasing the strategic use of standards is vital for the future.

The pandemic has accelerated innovation across the economy. The digital economy is now universal. Net Zero has become a business imperative for chief executives, a complete change from three years ago. Geopolitical tensions have transformed the world and raised the importance of standards to new levels.

Dr Scott Steedman Responding on behalf of the Installation Dinner guests

International standards have become a common language that all industries need to use, whether global or local. What matters is that British industries: medical devices, food, data, manufacturing, financial services companies use the same standards as other countries, he argued. For the UK, this means standards based on British practices and British values, not just quality and safety, but modern slavery, anti-bribery, ethics.

There has never been a more important time to get involved in this battle for global influence and soft power, he said.

Scott paid tribute to the Master for her work in international standardisation. He noted that she recently received an IEC 1906 Award and has been an exemplar of British engineering, representing her profession, her industry and her country in international standards. Thanking her on behalf the National Standards Body, he encouraged members of the Company and guests to use their networks to advocate the importance of standards as part of every engineer's career development.

In closing, Scott stressed that engineering is a way of thinking about the world, not just about making things work. We need to challenge our own boundaries if we are to succeed. We have a duty to serve, he concluded.

The Master

Engineering the Future

The Warden's lecture was delivered on board HMS Belfast on 8 June 2022 by Dr Dolores Byrne OBE, a graduate of Queen's University Belfast. This article is an edited version of her presentation.

Introduction

Innovation is key to national economic success and Britain has a strong track record of its achievements in a range of fields and across many industries. Innovation however is not just about the BIG idea. Realising the value of innovation to engineer the future requires an ecosystem which includes technical and management skills, manufacturers, financial investment, market opportunity, IP protection.

Britain is not the only country fighting for top place in the global research and innovation race. Many countries recognise that research and innovation capabilities will determine the leading economies of the future, and they have ambitious plans to boost their research spending to attract more global investment.

British investment in R&D as a percentage of GDP at 1.7% is now well below the OECD average of 2.4% and 40 per cent less than that of some of our European neighbours. The Government plans to invest 2.4% of GDP on R&D by 2027 which will get the UK to the current OECD average, way behind Japan, Germany and the USA. South Korea is already at twice that level.

Data from OECD show that private investment in 2022 as a share of GDP in Britain is the lowest of the 36 nations assessed. In the UK the ratio of public funding for 'Research' to that for 'Development' is approximately 85:15, with 85% funding supporting Research activities. In competitor nations, such as US & Germany, the ratio is closer to 50:50. There is a funding gap to support technology translation in the UK, frequently described as Crossing the Chasm. With UK industry reducing its investment and public funding so strongly geared to support for research, how does the UK develop and grow the skills and know how to Engineer the Future?

The Innovation Ecosystem

The UK is often cited as being poor at the commercial development and exploitation of its strong, and in many cases world-leading research, when compared with competitor nations. The 2021 UK Innovation Strategy reminds us that the UK has 4 of the top 10 universities in the world and 18 in the Top 100.
Because curiosity driven research is not immediately applicable to markets, significant funding is needed to de-risk, to develop from a concept demonstrator in the lab to a well-engineered product which meets customer needs, conforms to safety and other standards, is reliable, has a customer support service and so on.

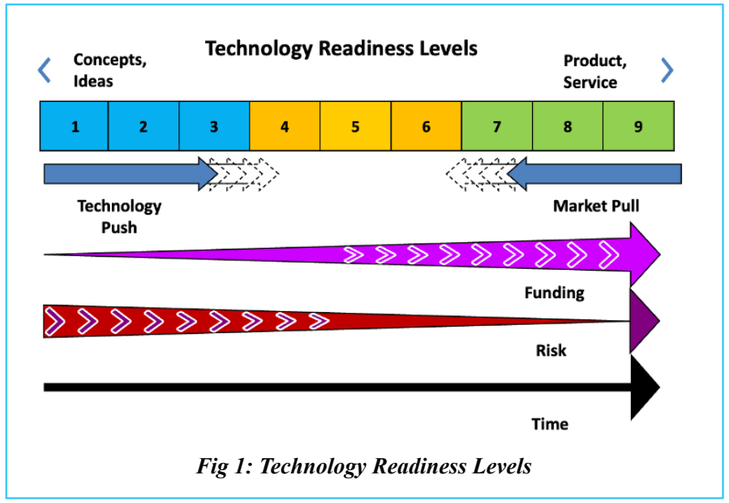


Fig 1: Technology Readiness Levels

New technologies are often at the core of innovation and their development pathway can be described in terms of technology readiness levels (TRLs). This scale, Fig 1, offers a common reference for stakeholders to assess, in very broad terms, the level of development a technology has achieved. TRLs are based on a scale from 1 to 9, from a conceptual beginning at TRL 1 through to mature technology and commercial product at TRL 9.

However, it is a tool and not a precise measurement system. In very broad terms research carried out in universities is considered to be TRLs 1-3, their output being concepts, ideas, discovery, new knowledge. At the other end of the scale, manufacturing industry operates at TRLs 7-9, producing products which are de-risked, have a user operating manual, kite marks, guarantees and so on.

In the middle range, TRLs 4-7, is the Innovation, Research and Technology sector. Independent of manufacturing, these organisations combine a strong technical base with an in-depth appreciation of the user's operational environment and so play an important role in accelerating the take-up of technology.

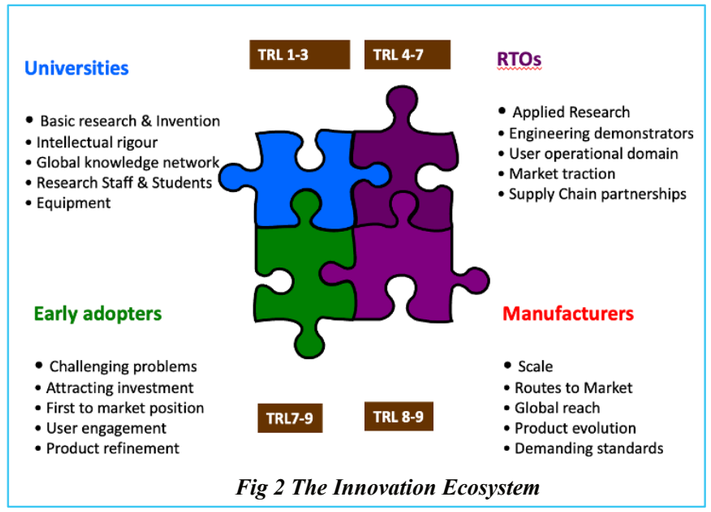


Fig 2 The Innovation Ecosystem

Partnerships are key to technology transfer and engineering of future products and services as partners bring knowledge, know-how and the full range of engineering skills.

The innovation ecosystem Fig 2 embraces the scientific discovery and invention in universities, the operational domain understanding of Research & Technology Organisations enabling the building and trialling of demonstrators, early adopters in industry and the public sector who share the risk of introducing new technology for the benefits of being first to market and manufacturing companies scaling up to mainstream manufacturing combined with expertise in intellectual property, marketing, legal, commercial.

Innovation

The innovation model Fig 1 is often viewed as a pipeline process starting with public funding of research, which then leads to development, demonstration and to manufacture. It is sometimes called the Technology Push model, seeking applications and markets while maturing technology from low level TRLs.

A complimentary approach is Mission Driven innovation to meet the needs of users or industry, rather than discovery driven Market Pull rather than Technology Push. Triggers for market driven innovation include regulation, improving safety, customer needs, new ways of doing current things.

One approach to innovation is not better than others but heavy reliance on a single model is suboptimal. The following sections offer some examples of mission oriented innovation, triggered and delivered to meet user needs, improve safety, reduce hazards, protect national health.

The World Altitude Record Challenge

In 2003 British pilots Andy Elson and Colin Prescot attempted to break the then 40-year-old world altitude record for a manned balloon, aiming to ascend to 40 km. The UK based company QinetiQ sponsored their mission. The user needs, and so the QinetiQ challenge, was to deliver a way of capturing their planned record-breaking achievement.

The QinetiQ proposal: a UAV (Unmanned Ariel Vehicle) which would also rise to the same altitude as the balloon and take pictures of the record-breaking event. The UAV needed its own fuel supply, be capable of withstanding extremes of temperature, have a guidance system and of course a camera system, and all on a very low budget.

Fig 3: The Zephyr UAV. The 150lb aircraft, with an 80ft wingspan, operates in the stratosphere at an altitude of 70,000ft. AIRBUS

The solution: Zephyr, an extremely lightweight aircraft, 30kg, wingspan of 18m, powered by day by solar cells, powered by night by stored energy. Zephyr was a novel aircraft engineered through partnership and open innovation, making use of state-of-the-art high TRL components to build this innovative aircraft.

The UAV was designed, built, and operated by QinetiQ, experts in aerodynamics, avionics and flight operations. Zephyr flew on solar power generated by silicon arrays covering the aircraft's wings, supplied by US based United Solar Ovonic. It was powered day and night by rechargeable batteries supplied by US based Sion Power, recharged during the day using solar power. The carbon fibre for the ultra-lightweight aircraft, came from Japan

Disappointingly on the day of the attempted trial, the new altitude record for a manned balloon was not realised as the balloon was seriously damaged in its take-off.

However, Zephyr developed over subsequent years and created in 2010 its own world record for longest duration unmanned flight of 14 days, surpassed in 2022 at 42 days. Zephyr, Fig 3, having been acquired by Airbus, is now part of the Airbus UAV programme.

The Longitude Challenge

Innovating to meet user needs is not an approach initiated in the 20th century. In the 18th century a mission driven approach was adopted to find a solution to the longitude challenge.

Determining longitude reliably was a problem which haunted sailors for centuries. Latitude is set by the equator and is simple to gauge by the length of the day or the position of the sun. Longitude is more dynamic; it moves as the earth rotates.

In 1714, merchants and sea captains petitioned the British Parliament to solve the longitude problem and thereby improve safety at sea. The Longitude Act established the Board of Longitude and offered a £20,000 prize (c £1.5m today) for a practical method to determine a ship's longitude.

Calculating longitude at sea means comparing the time on the ship to the time at a port, where longitude is known. That meant keeping accurate time for days. John Harrison, a carpenter from Yorkshire who had taken up clock making around the time the prize was announced, was driven by the longitude challenge for safer navigation, as well as the attraction of the prize money. In 1735 he brought his first clock to the Board, and three later versions over the next few decades.

Harrison's clocks were innovative, being virtually frictionless and requiring no lubrication. Without oil, a clock had a much better chance of staying accurate at sea because there were no lubricants to get thicker or thinner as the temperature changed.

Nuclear Decommissioning

Safety is also the key driver for innovation in the nuclear engineering industry. The mission of Sellafield, which ceased producing power in 2003, is creating a clean and safe environment for future generations.

In 1950s Britain, development of the atomic bomb was underway and the Sellafield site was selected to support the national defence programme. Sellafield's role expanded to also generate electricity from nuclear power. During the miners' strikes in the 70's nuclear plants across Britain increased power generation, resulting in spent fuel arriving at Sellafield at a faster rate than its plans for reprocessing. These two national nuclear programmes resulted in a complex nuclear clean-up challenge at Sellafield which is on-going.

One of Sellafield's clean-up programmes is the Magnox Swarf Storage Silo (MSSS) built in the 1960's and housing fuel cladding or swarf in underwater storage in the silo. Safely decommissioning this major hazard is a top priority for Sellafield.

MSSS comprises 22 concrete silos within the overall silo building, each of these is the size of six double decker buses. These concrete silos are water filled and the waste is the product of Magnox reprocessing which over time has degraded into a sludge.

The original approach for removal of the waste comprised a 22-step mechanical treatment and encapsulation process, requiring the construction of a new multi-million pound plant. With the aim of speeding up decommissioning an updated investigation was undertaken into the chemical behaviours of the waste and the corrosion of magnesium and uranium.

The findings confirmed that Sellafield could re-place the 22-step process with a simpler and ultimately safer 3-step solution which stores the waste directly with concrete grout inside a $3m^3$ shielded container for storage for decades to come. Switching to this new engineering approach is speeding up the decommissioning of MSSS by several years and providing savings of the order of £1Bn to the taxpayer.

The World Wide Web

Mission driven innovation underpinned the creation of the internet, a tool which has impacted the lives of everyone, spearheaded countless new businesses, revolutionised existing businesses and still offers seismic changes to come.

In 1989 when working at CERN Sir Tim Berners-Lee saw the needs of this dispersed community of engineers and scientists for electronic connectivity. Their demand was for automated information-sharing between scientists in universities and institutes around the world.

He says: 'Creating the web was really an act of desperation. The inefficiencies and difficulties posed by finding information stored on different computers was very frustrating. Most of the technology involved in the web, such as the hypertext and the Internet multi-font text objects, had been designed already. I just had to put them together.'

Tim Berners-Lee wrote the first proposal for the World Wide Web in March 1989. At the end of 1990, 18 months later, he had the first Web server and browser up and running at CERN, demonstrating his ideas. Customer need combined with innovative adoption of state-of-the-art technology and software building blocks such as hypertext had driven the short time to market.

The knock-on effect was that the Internet changed from being a system which allowed files to be sent from one place to another, to one which enabled anyone on the Internet to retrieve information from a web of sources. Tim Berners-Lee created the Internet that we know today.

The Oxford Covid Vaccine

Yet another trigger for innovation: the COVID-19 pandemic which presented a threat to the health of the population. The solution: develop a Covid vaccine. Before Covid the fastest development of a vaccine was four years, achieved in 1967.

Ten years' vaccine work was achieved in about 10 months for the Oxford Covid vaccine. Prof Dame Sarah Gilbert and her team at Oxford had a vaccine ready to start clinical trials in just 65 days. It took another seven months to test the vaccine.

This astonishing speed in vaccine terms depended on proceeding at risk. The team began before funding was secured and took each subsequent step while the results were being finalised on the last one. The risk was to time and money, not health. Innovation in process and manufacturing engineering resulted in the rapid development of the Oxford vaccine.

Dame Kate Bingham was appointed to head the UK's Vaccine Taskforce, the group charged with ensuring Britain obtained a sufficient supply of COVID-19 vaccines. This team provided the procurement route for the successful vaccine innovations to the reach the user community, the NHS.

She assembled a portfolio of seven vaccines that used four different underlying technologies. The UK government part-funded development of these seven and committed to buying hundreds of millions of doses, knowing that not all of them might be successful.

This approach of high-risk, high-reward is extremely untypical of UK government. But it worked: The UK emerged as a leader in vaccinating its population, a success which owes much to the role of Vaccine Taskforce. The Vaccine Taskforce ensured connectivity and partnerships with the vaccine manufacturers, the Government procurement arm and the NHS delivery arm. An innovation ecosystem!

Summary

For the UK to continue to attract investment and corner a higher proportion of global wealth relative to its size, it must continue to nurture a strong capability in Innovation. As with any good investment strategy, a portfolio approach to innovation is optimal.

The prevalent pipeline model of innovation and commercial exploitation, from research through demonstration to manufacturing, can seed many new industries but it takes considerable time to realise this potential, and can be viewed as a technology seeking a problem. Mission-driven innovation on the other hand is seeking a solution to a problem already defined. It delivers impact in a relatively shorter timeframe. Both these approaches require a spectrum of engineering skills and know-how to achieve impact.

The Government recognises that the mission driven, partnership approach to innovation which it adopted in 2020 enabled the rapid development, manufacture, and procurement of the Oxford COVID-19 vaccine, delivered in a timeframe similar to big pharma companies in the US. Impact was achieved in a very short timeframe.

Engineering the future, a future which presents us with significant societal challenges including food production, climate change, cybersecurity, health, transport, and for which engineering is a key factor in developing solutions. The pace of technology change continues to increase along with global competitiveness, driving the ambitions of other nations. The UK national funding structures need to reflect this increased complexity and adopt an updated approach to the funding of innovation which recognises the requirement for partnerships, mission driven and integrated approaches to Engineering the Future.

Dolores Byrne

The Brooch Lunch Returns...

5 May 2022

The consorts sit down to a splendid lunch at the Guildhall

In May the Engineers' Consorts were once again able to enjoy their customary lunch at which the newly installed Master's Consort is presented with the Company Brooch.

Held this year in the elegance of The Private Dining Room of the City's Guildhall, 15 Consorts were in attendance.

Unfortunately, Mistress Engineer Diana Blair-Fish, having avoided Covid during her year, finally succumbed to the virus and could not attend to personally pass on the Brooch to John Canning. Standing in for the Mistress Engineer, Linda Brooks, wife of Past Master Barry Brooks, welcomed everyone saying how sorry Diana was, having to miss such an important occasion.

Linda continued by saying how pleased she was to be passing on the Brooch as due to lockdown she had missed her own occasion in 2021. Even better, Diana had kindly provided the speech to be read out!

Diana's message summarised her year as being one of highs and lows, according to the dictates of Coronavirus, initially being confined to virtual Zoom soirées and dinners. By autumn much welcomed face to face activities returned with events such as the 'Out of Town' weekend and the Partners' and Companions' Lunch. Her personal highlights were an introduction to calligraphy followed by a guided tour of Vintners' Hall as well as a visit to the Royal Horse Artillery at Woolwich, courtesy of the Saddlers' Company. Above all her year had been an opportunity to meet, share events and make new friends.

Mrs Linda Brooks delivers Dr Diana Blair-Fish's address, having presented the modified brooch to the new Master's Consort, Mr John Canning.

Through Linda, Diana thanked the past and present Consorts for their support and Assistant Clerk Sandra for seeing Peter and herself through the thick and thin of the year.

Linda then on behalf of Diana presented John with the specially adapted Company Brooch saying how he and Audrey had done so much for the company and wishing him an unforgettable year.

Replying, John thanked Linda and of course Diana and said he how much he is looking forward to the year.

Roger Maber

The Future of Air Vehicles

Promoting Engineering in the City of London

In conjunction with

The Worshipful Company of Scientific Instrument Makers, The Worshipful Company of Insurers and the Honourable Company of Air Pilots

Over 45 members of the Livery and their guests were welcomed by new Master Engineer Audrey Canning to a fascinating discussion at Guildhall on 11 May 2022, focusing on the future of flight. She noted that the UK aerospace industry is one of the largest in the world, second only to the US, but that it also presented a challenging target to decarbonise.

We were treated to an excellent panel:

Jenny Body, Past President of the Royal Aeronautical Society, (Chair)

Gary Elliot, Chief Executive Officer, Aerospace Technology Institute (ATI)

Dr. Marko Bacic, Rolls Royce Engineering Fellow, Control Systems & Gas Turbine Functionality

Steve Raynes, Airbus UK, Head of Research & Technology Business Development

Dr Yoge Patel, Chief Executive Officer, Blue Bear Group

Miles Gray, Aerospace Policy Lead, UK Government, Dept for Business, Energy and Industrial Strategy (BEIS)

Each panel member gave an overview of how the industry was developing, with Jenny then opening up the discussion to questions from the audience.

The future of air vehicles is changing, and striving to meet Net Zero targets. Aircraft must also be designed to be recyclable, with a pressing need to move away from carbon-based fuels. The technology is moving very quickly, but must deal with the complexity of certification. Innovation isn't enough unless it's proven and demonstrated.

There are multiple interesting companies, including start-ups, that are getting into this space; people that many never even thought would have been involved in aerospace related projects all getting involved.

Both ATI and BEIS are supporting this growing sector, but the pandemic has caused many challenges - quite when we get back to 2019 flying numbers is probably anybody's guess, but it is getting busier again and net zero by 2050 is the number one target.

Gary described how the ATI focuses on commercial aerospace, creating a technology strategy, driving economic growth, and deploying convening power.

Master Engineer, Mrs Audrey Canning, addressing the conference.

The funding is significant, totalling £5.8 billion from inception in 2014 through 2031, half from government and the remainder from industry.

Miles observed that there is significant international competition, with investment returns very much long term, taking up to 15-20 years. Yet it is a growing sector and the UK is very strong.

The panel agreed that there is no silver bullet solution, it is complex and envisaged a transition rather than a direct path to the final solution.

Some sustainable aviation fuels (SAF) are bio-derived which risk competing with food supply, so other ways of deriving the fuel will be required, and to hit net zero by 2050 will require multiple approaches. SAF will be a major contributor, certainly in the short term, and both Steve and Marko noted that major companies have already demonstrated flights on 100% SAF.

Hydrogen is a longer term option to get a true zero emission. Realistically, cryogenic hydrogen is the only contender due to volume, but comes with its own challenges, needing storage at below -253°C. Marko did some impressive spur of the moment calculations comparing the energy of different fuels, demonstrating why we see range impacts and the need for differently-designed aircraft! He also noted the energy requirements in generating the hydrogen or SAF, suggesting that one approach would be to deploy additional nuclear power, such as Small Modular Reactors.

Hydrogen can be used either in direct combustion, or used to generate electricity such as through a fuel cell. Airbus are exploring hybrid options, meeting different power demands at different parts of flight.

Airbus also considered other fuels, such as ammonia, although concluded it is unlikely to be suitable. The recent ATI 'Fly Zero' project features both hydrogen and SAF, and the reports are available on the ATI website.

Yoge described the work of Blue Bear Research Systems, one of the companies in the UK designing autonomous and modular systems, highlighting that it is not just about the design, but also taking the community along on a journey of how you certify very novel platform configurations and highly integrated infrastructure.

Whatever the final journey, it is clear there is enormous capability and ambition in the UK. There's certainly a lot to do and not much time to do it!

The Company is grateful to Master Scientific Instrument Maker, Charles Holroyd, for closing the meeting with a very kind vote of thanks to the Panel and the Engineers for organising the event.

The full discussion can be seen on the Company's YouTube channel.

Kate Barnard

Regional Event - Isle of Wight

21 - 22 May 2022

Osborne House. Photo - John Williams

Osborne House

Saturday 21 May

"Our dear Osborne, which is like a little Paradise for us".

Queen Victoria, 13th December 1845

Queen Victoria bought the Osborne estate in East Cowes, Isle of Wight in 1845 for the sum of £28,000.

Prince Albert and Queen Victoria wanted to build a family home, not a palace, as they wanted a place to escape the court life in London and Windsor. The house was built in their private tastes, and both were heavily involved with the design of the buildings, gardens, wider estate and the decor. The house has ornate, Italianate decor and was copied by many of those who were invited to visit, such as ministers from the Government, foreign royalty, family and friends.

Family touches are visible throughout the house, such as Victoria and Albert's adjacent desks in The Queen's Sitting Room, the multiple cribs in the nursery (they had nine children), specially commissioned paintings and frescos, and the photographs of their children and relatives. There is a family tree showing their descendants at the time of Victoria's death in 1901 showing how intertwined the European royalty was. Both HM The Queen and HRH Prince Philip are great great grandchildren of Victoria and Albert.

As well as the house, there are extensive grounds which include a Swiss Cottage and a 1.2km walk down a tree lined route (Valley Walk) to the beach, the original landing pier and where Victoria's bathing machine has been relocated (after refurbishment) close to its original position.

Although Victoria and Albert loved Osborne, after their deaths it was not used by the family. From 1903 until 1921 a Royal Naval College used the estate, and it became a Convalescent Home from 1904 to 2000.

In 1986 English Heritage took over Osborne and have worked since to restore it to a pre-1901 condition. It is most definitely worth a visit.

Graham & Kate Parry

Dinner at Hewitt's in Newport

Saturday 21st May

Hewitt's is a very stylish 'restaurant with rooms' just off the High Street in Newport. We had booked the back room for our party and originally it was meant to be just for us, but Hewitt's had some additional bookings who were offered a table knowing they would be next to a large party. I did feel a little sorry for them as the noise level gradually crept up with all the chatter and laughter amongst our group, but their compensation was the excellent food and service.

We had one long table for our party and had pre-ordered our meals, but as is often the case, some people had forgotten what they had ordered and accepted whatever looked interesting. John and Audrey kept us all in line making sure that the dishes got to the people who had ordered them. For fine dining the portions were quite substantial but very little went back to the kitchens, it was mostly clean plates all round.

On the Sunday evening, there were still about a dozen of us left and we all arranged to meet at The Bargeman's Rest, which seemed to be the only place large enough to accommodate our party and still serving food on a Sunday evening. This is a very interesting pub in the location where a brewery used to load beer barrels on to waiting barges for transport around the island. The food and real ale were excellent, and this was a great way to round off an excellent weekend.

Many thanks to Audrey and John and Jane Forrest for all the organising to make it happen.

Penny Taylor

The Engineers' Isle of Wight party. Photo - John Williams

Engineering Heritage Walk

Sunday 22nd May

Isle of Wight – it sits like a neat jigsaw piece in the Solent with just 57 miles of coastline, 380 square kilometres in area, but within that space it not only packs 15 National Trails but over the half the island is of Outstanding Natural Beauty. Our walk was to go from Alum Bay back to Yarmouth via Tennyson Down, Freshwater and the estuary of the River Yar. Perfect day for a walk with blue skies and the Solent postcard perfect with a complement of bobbing yachts

At Needles Park, Alum Bay, is a monument marking the site where Gugliemo Marconi carried out his pioneering experiments in wireless communication in the final years of the 19th century. From that spot using a 168 ft mast, Marconi exchanged radio messages with Bournemouth and Poole and then ships at a distance of 40 miles from Alum Bay.

Linking to another of the visits, in the summer of 1898, at Osborne House, summer home of Queen Victoria, Marconi set up communications between the Royal Yacht and Osborne House, so that Prince of Wales could keep Queen Victoria updated on his injured knee.

After a short walk along the cliff top of Alum Bay, with its different coloured sands and seals playing in the bay, we arrived at the Old Battery, one of the Solent's ancient defences, although the guns were only fired once in anger. Worryingly the gun mounts all had a 360 degree swivel. A short narrow tunnel gave a perfect view of the Needles, that iconic landmark, which is the last visible sign of a chalk downland ridge before it dives under the Solent to continue over on the mainland. After lunch it was along Tennyson Down to Tennyson Monument accompanied by a chorus of sky larks. Sadly no-one would give a musical rendition of "Come into the Garden Maud", possibly not one of Tennyson's finest poems and certainly devalued after it became a

The Needles. Photo - John Williams

The Master thanks Jane Forrest for her organisation. Photo - John Williams

popular song of the day. BUT there was a far greater treat as a kestrel hovered just a few feet away on the cliff edge where we watched it for some time before it peeled away to try better hunting elsewhere.

The path then dropped down into Freshwater and refreshments. It is a truth universally acknowledged that when an engineer comes to halt, it must be in want of food. And so it was at the Dimbola Gallery, home of noted Victorian pioneering photographer Julia Margaret Cameron, where a "nice cup of tea" and excellent home-made cake was served. The Dimbola Gallery is now a museum and gallery dedicated to her work. Then off on the final part of the walk through a wetland marsh and out onto the Yar Estuary, a tangle of creeks and inlets to arrive at Yarmouth.

A walk of contrast with headlands, cliffs, flower strewn chalk down, dropping down to a flat estuarine wetland teeming with bird life, well deserving of the title of "England in Miniature". But the highlight, which made the walk even more wonderful, was the sight for such a short time of that perfect bonding in a bird of heart, sinew and feather that enabled it to remain suspended. Gerard Manley Hopkins described it perfectly –

"My heart in hiding, stirred for a bird
– the achieve of, the mastery of the thing!"

Sonnet *"The Windhover"*

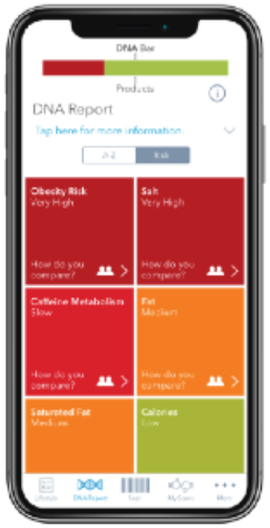
(With thanks to Jane Forrest who organised a perfect weekend. Thank you Jane for showcasing the Isle of Wight so perfectly. Thanks to the Master who gave excellent insights into Marconi's life and experiments and the geology of the Isle of Wight. Thanks are also due to the Junior Warden for the observations on the feeding habits of Engineers and apologies to Jane Austen, who sadly to my knowledge never visited the Isle of Wight)

Sue Hewerdine

The Bargeman's Rest. Photo - Penny Taylor

An Evening with DnaNudge - MacRobert Award Winner 2021

DNA Wristband



Associated smartphone app

In our 25th Soiree on Zoom, held on 25 May 2022, we gained an insight into the development of the COVIDNudge rapid test technology from the parent company DnaNudge, our 2021 MacRobert Award Winners. Their presentation was given by Dr David West, their CEO and Mohammdreza Sohbat, a founding member and their Commercial Director.

DnaNudge focusses on biological sampling technology that can take the laboratory to the customer. They initially developed a device that analysed the customer's own DNA from a mouth swab and, using a wearable device that analysed the customer's lifestyle, nudged the customer towards better nutrition by offering healthier options via a phone app. Trials showed that users could achieve around a 25% healthier lifestyle with no increase in their food budget. As examples, the DNA analysis could detect such factors as hypertension and increased cholesterol, and the increased risk of diabetes, obesity or heart problems. An app-based system then recommended healthier personalised nutrition choices with, for example lower salt or sugar content. The device consists of a disposable cartridge containing the customer's sample and the required reagents, and a shoebox-sized laboratory that undertook the analysis.

As we all remember, the arrival of Covid presented enormous challenges to the NHS, and not the least of them was the need to screen staff daily for the virus and to get rapid results. Existing PCR tests required samples to be returned to a laboratory for processing, resulting in an unacceptably lengthy time between test and result. DnaNudge very quickly adapted their technology to carry out PCR testing using saliva samples, with the result that the "shoebox" could be placed on-site and results obtained within the hour. If required, the cartridge could contain up to 10 samples for batch testing. Government contracts were placed in August 2020 and the system is now in wide use with the NHS. Other customers such as the London Symphony Orchestra also solved their challenge of rapidly PCR testing the entire orchestra before each performance by adopting the COVIDNudge system.

Of course, scaling up production presented its own significant challenges. Production of small batches on site had the significant benefit of allowing production and design optimisation to proceed in parallel and enabling modifications to be rapidly inserted into the production process. However, once the design was perfected, volume production was achieved by outsourcing with the aim of scaling up output from 1,000 to 30,000 units a day Understandably, there were major challenges and setbacks. Obtaining tooling and specialist equipment while monitoring cash flow. Obtaining the required reagents and plastics, all in high demand elsewhere due to the Covid crisis. One of the biggest challenges in scaling up was to maintain quality while moving from a skilled to a semi-skilled production line staff. Recently, the production process has been further developed and is now mainly robotic, with new markets are opening in the EU, the US and Australia.

The presentation ended with a lively round of questioning, a sincere vote of thanks and the traditional toast to the Engineers' Company.

John Chandler

Court Visit to Superbloom' Project

31 May 2022

Earlier this year the (then) Master and Senior Warden, working through the Engineers' Trust, sought the help of the Trust to provide a donation to the Historic Royal Palaces to mark the occasion of Her Majesty's Platinum Jubilee. This was duly achieved and just over £1,400 was gifted to the 'Superbloom' project installed in the moat of the Tower of London.

On 31st May, as a 'Thank You' to the Company, members of Court were invited to attend a 'VIP preview' of the 'Superbloom' project. Six members, including the Master, Immediate Past Master, Clerk and Assistant Clerk were delighted to accept the invitation.

We were met by the Director of Public Engagement at Historic Royal Palaces Tom O'Leary who explained the concept of the plantings, the constraints of the site (archaeology preventing disturbance of the soil), the significant construction work undertaken to introduce ramps, entrances, and landscaping, and the strange 'Venturi' effect from the Tower walls shaping, causing some areas of the planting to be severely retarded by the cold North wind funnelling up from the Thames, whilst immediately adjacent areas could be seen in full bloom. We can confirm his explanation for the delay to the 'Superblooms' with our own experience of the highly localised 'chill factor' in the late May air!

We were escorted on a personalised tour where it was explained how Scottish folk music cadences had been used to mask the traffic noise on the North side of the Moat (yes – it works), how landscaping enabled 'zones' to be created with different characteristics and vistas, how attracting 'insect life' is not a problem (not only were there an abundance of bees during our visit, but a rare beetle has already taken up residence), but that their food source is a concern, and why the WCE contribution is so valued by the Historic Royal Palaces (Covid having closed the Tower to visitors and – since the Tower is by far the largest 'revenue generating premises' - seriously derailing long held celebratory plans).

Most important of all (from my perspective) it was confirmed that the 'Superbloom' project was anticipated to be a permanent installation, with – at least some – of the plants re-seeding every year providing a sustainable 'English meadow' installation.

Accompanying the planting is a glorious hand-crafted willow sculpture by artist Spencer Jenkins and some bespoke insect sculptures made of brass copper and titanium.

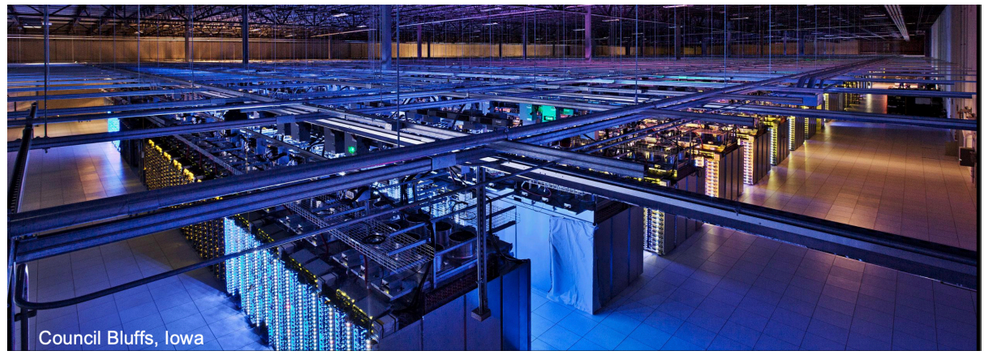
We hope to return in the autumn to view the next wave of 'Superblooms'.

After our visit some in our party repaired to a local hostelry where, as luck would have it, we enjoyed an impromptu birthday 'brunch', eased down with champagne.

Audrey Canning

Building Warehouse Scale Computers

Engineering Soirée No. 26, 22 June 2022



This soirée came direct from California and was delivered by Dr John Wilkes, who is a Principal Software Engineer at Google.

Following his PhD at Cambridge, John moved to California where he had a distinguished career at HP Labs for over 25 years, before moving to Google in 2008. He is now in one of the teams that automate the fulfilment and provisioning of computing, storage, and networking resources to all of Google.

The success of Google has been and is dependent on the accuracy of its business decisions and its forecasting. This fascinating presentation describes the selection of very critical timeframes by John Wilkes for "Building Warehouse Scale Computers or What's it Like to Supply Exponential Growth".
A warehouse-scale computer could vary from 5 to 40+MW.

To achieve the 25% to 40% of the global traffic, Google must consider the location, efficiency and development of these globally located data centres, taking account of the varying restrictions on power, privacy, laws and stability of the various locations.

The preparation to be able to produce computer facilities and in particular services has a very complex lead time up to approximately 10 years, such as for the purchase of land or for laying undersea cables, for the end products can be dependent on the whim of the general public, customers, new technical development or other external forces affecting any point of the supply chain. The complexity of the production of the various components and the lead times that may vary

from under 6-months through to several years; and the need for the ordered components to be produced and delivered to the various locations for further manufacturing, become major business risk considerations.

The access to sufficient power, ideally totally renewable, with plans for carbon free by 2030, to address the fluctuating daily demand usage, and the actions to try to balance these demands and the variability of renewable power sources is very important.

The problem of reuse of heat, often warm rather than hot, and the distance of these data centres from large populations makes the reuse of heat often a challenging issue.

The decision to delay commitment for the delivery, to ensure a better prediction of demand so less chance of over or under production, has to be balanced with the decisions of non-availability and variation of costs of these decisions to ensure capacity were shown against the exponential growth in demand. Actions to increase efficiency were discussed, one being the need, not only for more efficiency, production of hardware but also in particular for changes in software, notwithstanding that approximately 44% of this is now in the Cloud.

Illustrations: top: installation at Council Bluffs, Iowa; right: connections in a >100 petaflops computer; left: cooling system. Pictures, Google.

Margaret Ross

Regional Event - Cardiff

1 - 3 July 2022

Industrial Visit to Nantgarw China Works Museum, Friday 1 July 2022

Monday morning and everything was in place. Lunch, dinner venues contacted and checked, menus in place, visits arranged and checked, and the walk walked for the umpteenth time. Now for some well-earned R&R for the next few days in Blackpool under the glitter ball of the Tower Ballroom (really!)

Then the email pinged. A message from the hosts of our Friday afternoon visit. Apologies but they were unable to accommodate the Engineers on Friday afternoon. PANIC time to run round screaming, tearing out hair whilst cursing OR calmly think of an alternative (whilst still cursing etc...). Both scenarios took place simultaneously from two different people. So where do you take 15 or so Engineers on a Friday afternoon in July at short notice? Answer Nantgarw China Works Museum of course! A desperate email and reply and an hour later and we had our Friday afternoon visit rearranged, booked, with tea and Welsh cakes included.

Having negotiated the M4's Friday afternoon racetrack we arrived at Nantgarw Works in brilliant sunshine (something was going well!). The site is below the A470 dual carriageway, the main South/ North arterial route for Wales, following the ancient trading routes of packhorses, roads, canals and then railways up the Rhondda Valley.

The Nantgarw China Works is the only surviving porcelain works in the United Kingdom. During the period of 1813 to 1814 and again in 1817 to 1820 the finest porcelain ever made was produced in Wales by William Billingsley with his partners Samuel Walker and William Young. Although hard paste porcelain had been produced by the Chinese for more than a thousand years, Europeans tried to refine this to produce a whiter, more translucent paste by the addition of bone ash. William Billingsley perfected a secret porcelain recipe which was known only to him and produced the finest porcelain ever made. The resulting porcelain had an unmatched translucency and whiteness making it perfect for enamelling. Unfortunately Nantgarw Pottery was never successful with 90% of production being wasted by shrinkage and breakages in the firing process. Most of the remaining pieces produced at Nantgarw were sent as "blanks", undecorated porcelain, to London for enamelling and further firing.

Billingsley and Walker absconded from Nantgarw 1820 leaving a quantity undecorated porcelain (and debts!). Young in an attempt to recover some of his losses invited the enameler and decorator Thomas

Sally Stubbings, Principal Ceramicist, Nantgarw Pottery,was instrumental in rediscovering and recreating the original recipe for Nantgarw softpaste porcelain.

Pardoe, a noted flower and bird painter, to decorate the remaining "white" porcelain. His son, William Pardoe, in 1833 eventually re-established the China Works but now producing salt glazed stoneware and brown glazed earthenware. The China Works continued until 1920 producing clay pipes, when the introduction of cigarettes killed the market for clay pipes.

Today the Trustees of the Nantgarw China Works have undertaken extensive research and painstaking trials to recreate as nearly a possible the amazing translucency and whiteness achieved in the best of Billingsley's porcelain and will undertake special commissions in porcelain. However those of us without large (very large!) sums of money necessary for a commission, can own a small piece of Billingsley exquisite porcelain. As the site is excavated, shards of discarded decorated pottery are unearthed and these are transformed into lovely necklaces and cufflinks.

The theme of the weekend was the Glamorgan Canal and its benefits to the South Wales coalfields and other industries. The Nantgarw China Works stood on

the eastern side of the Glamorganshire Canal. Raw materials arrived by the Canal and the finished "white" porcelain blanks were sent to London for finishing by the same means of transport – the Glamorganshire Canal.

As we left the Nantgarw China Museum and looked over a wall, there far below us, in a narrow culvert, hidden from the sun, were the sad remains of the Glamorganshire Canal, once a mighty artery for South Wales industries

Sue Hewerdine

Heritage Walk on the Taff Trail, Saturday 2 July 2022

Livery Member Windsor Coles briefs the walkers

Despite the weather that was threatened in the forecast making a short appearance, catching only those local and travelling to the muster point, or those looking to sample the local breakfast offerings, the rain retreated enough for the visit to Melingriffith Tinplate Works to go ahead as planned.

Travelling a short distance out of central Cardiff to join the Taff Trail the walk started at Radyr Weir, originally built in 1774 on the River Taff. The weir is the most upstream of the three that can be found along the river down to Cardiff Bay and at this point water was diverted down a leat that supplied the mill at Melingriffith. Keith Williams provided a brief history of how this originally supplied an earlier mill in the 1300s with the addition of the weirs to control the height of the Taff to ensure that the flow of water was maintained to the tinplate works. Today the weir has been updated to include two Archimedes screw turbines that provide up to 400 kW power, as well as features that allow salmon and eel to travel along the river. This has supported the restoration of the species following the improved water quality since the coal industry in South Wales ceased.

The leat leads to what remains of the Glamorganshire Canal through Hailey Park, which started from a plot of industrial land donated to the City of Cardiff that was reclaimed, with more being added over the years. The park was completed with the addition of land where a rubbish dump stood, purchased in the 1980s and decontaminated.

At the site where the Melingriffith Tinplate Works stood, with four generations of his family having worked at the mill, Keith explained the tin plate process, its evolution, and link between the mill's activities and the history of the canal. The process used local pig iron transported by the canal to the mill, until the advent of steel which led to the demise of iron production in the area. However, this was replaced by the growth of the coal industry, in part to supply the production of steel, and led to the growth of the canal. With its growth the canal required additional water, which was drawn from downstream of the mill so as not to impact the mill's operations. Having operated for 130 years the pump that supplied the canal is all that remains of the industrial heritage in the area, operations having ceased when the canal closed in the 1940s.

Heading towards Cardiff centre the Taff Trail passes the City of Llandaff, which is surrounded by the City of Cardiff. Just a short diversion off the path on to the Pilgrim Trail takes you to Llandaff Cathedral, the seat of Bishop of Llandaff, Head of the Church in Wales.

Justin Davies-Trigg

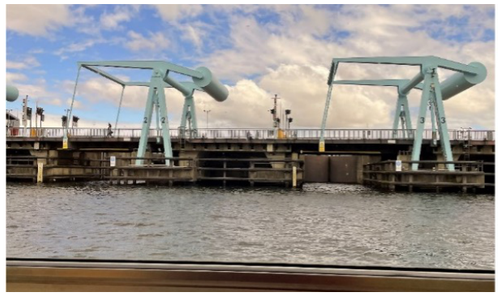
MOOT *micro-voyage* - Rivers Taff and Ely and Cardiff Bay - Saturday 2 July 2022

After a lovely snack lunch at the Secret Garden Café https://bute-park.com/attraction/secret-garden-cafe/ in Bute Park, near the end of our morning walk along the Taff, we boarded *Seren-y-Brae* at Taff's Mead Aquabus Stop, downstream of the Millenium Stadium, for the afternoon's tour of the 2km² Cardiff Bay. Note this is NOT the 70km² aspirational Cardiff Tidal Lagoon intended to generate 3+GWh electricity http://www.tidallagoonpower.com/

In case anyone had not seen the Millennium Stadium, our captain took us back up river to see this impressive structure, demonstrated his boatmanship by turning the boat in its own length and past, not a whirlpool, but one of the aeration points to keep the lower river and Bay waters fresh.

I should mention that, as it was a warm day, we were kept well lubricated with bottles of fizz!

We circled inside Cardiff Bay, historically Tiger Bay, once a tidal estuary for the Rivers Taff and Ely.



Completed in 1999, the Barrage provides flood defence and a permanent non-tidal high water lake with limited access to the sea.

There are 3 locks in the Barrage, allowing passage to and from the sea in 5 to 20 minutes. The cranes can lift lock gates for maintenance.

All around the Bay, development has included Welsh Assembly, Millennium Centre (Opera House), Mermaid Quay (restaurants and bars), yacht clubs, homes, Norwegian Church, and leisure facilities, such as a *floating* Aqua Park. https://aquaparkgroup.co.uk/cardiff/

Before returning to shore, we stopped by the marina in the River Ely (for our captain to collect his credit card machine as drinks were not free after all). Coincidentally the Marina Manager is a former CO of HMS Astute, the Welsh Livery Company's affiliated submarine.

A great day out with sea breezes and lots to see!

Text and Photos: Barry Brooks

Awards and Livery Dinner

Guildhall, 14 July 2022

Sheriff-Elect Andrew Marsden, the Master and the 2022 Award Winners

The 14th July was one of the hottest days of the year, so it was pleasing to gather in the relatively cool of the Guildhall.

The Award winners and their supports along with our Livery members convened in the grand setting of the Guildhall Livery Hall for the presentation of the Awards, given through the Engineers' Trust. This is one of the most important events in the Company Year and is a clear celebration of its charitable aims. It was pleasing to note that the Company has continued to give in the order of £100,000, ranging from certificates, to small grants, through to the significant donation of £20k to the McRobert Award. This year the Awards were presented by Sheriff-Elect Andrew Marsden, who stepped in at two day's notice

The Master and Consort John Canning

when Covid prevented Rolls Royce CEO, Warren East, from attending.

This was a truly inspiring event and congratulations go especially to our award winners whose achievements were universally agreed to be outstanding. Judging by the attendance, we were lucky that so many had been able to come to the event, despite Covid still being active. Speaking to awardees and their supporters after the event, I had the strong impression that they felt honoured to be recognised and several were keen to continue their relationship with the Company in the future. Details of the Award winners can be found towards the end of this issue. Thanks must also go to the Honour Guard who lined the staircase down to the Livery Hall. This year it was superbly provided by 6F

The Master presents IPM Dr Peter Blair-Fish with his Past Master's goblet

(Romford) Squadron, Royal Air Force Cadets, London Wing.

Following the Award ceremony, we moved to the Old Library bathed in glorious summer sunlight, another truly impressive space. At the start of the dinner, the Master proposed a vote of thanks to Immediate Past Master Dr Peter Blair-Fish and presented him with his Past Master's Goblet, which ceremony was postponed from the Installation due to Covid. On sitting down to dinner the heat was such that is became necessary to prompt the Master to invite the gentlemen to remove their jackets. Throughout the meal we were gently serenaded by a reduced size brass band performing an interesting interpretation of New Orleans Jazz, and causing the Master to enquire whether the guests were placing requests!

The Master addresses the dinner guests

Our four-course dinner, based on the Jubilee Banquet menu, was delicious. Cook and Butler did themselves proud. To be a little different, we had chosen a cheese course, served before dessert, with a sweet sparkling Touraine Brut Rose wine to accompany the dessert.

Our official Livery guests were The Master Glazier Eur Ing Phil Forty, The Master Tin Plate Worker alias Wire Worker Erica Stary, the Master Scientific Instrument Maker Mr Charles Holroyd. We were also joined by our Service affiliates:
- Rear Admiral Higham, OBE, the Chief Naval Officer of Defence Equipment and Support and an Honorary Liveryman of our Company;
- Major General Nick Cavanagh, CB, President of the Institute of the Royal Engineers, who was representing the Chief Royal Engineer, also an Honorary Liveryman of our Company;
- Captain Rayner Shelmerdine-Hare, representing The Master General, REME; and
- Mr Alistair Fischbacher, President of Institute of marine Engineering, Science and Technology, which organisation was jointly sponsoring our HMS Prince of Wales awards.

We were especially pleased that the Services award coordinator, Miss Kathlin Baty was able to join us, as anyone who has been involved in the Awards process knows how much work is involved. We are also very grateful for all those in the Company who gave their time voluntarily to selecting the many award and bursary winners.

The Master's Speech reflected on the awardees and 'where better to celebrate learning and excellence than in this beautiful Old Library'. She also used the opportunity to celebrate the benevolence of those who give freely to allow others the opportunity education brings, quoting form Victor Hugo 'he who opens a school, closes a prison' and remising on the visit two weeks previously to the Cardiff Clink restaurant. The Master closed her speech with thanks to the guests, official and personal, and to the caterers and staff who made the evening possible.

The evening was rounded off by the Company Toast given by Sheriff-Elect Andrew Marsden. A shortened form of his speech is given below. This focussed on the importance of education in enabling change and the importance of the engineering profession in general. His words were very warmly received.

The evening concluded with a stirrup cup at the back of the Old Library before venturing out into the heat of London. Our thanks also goes to Clerk David, Assistant Clerk Sandra and Beadle Lee for helping to make it a truly unforgettable evening.

John Canning, Masters Consort

Address given by Sheriff-Elect Andrew Marsden at the Awards Dinner

Master, Wardens, visiting Masters, Distinguished guest, Ladies and Gentlemen.

This is a very special evening for us all to attend, a wonderful venue, excellent food, and convivial company. An evening where the Company recognises engineering excellence in all its forms. What inspirational winners…congratulations! Recognition given in the very best traditions of the livery- which prizes education highly both as a driver of excellence, and as an aid to social mobility and inclusion. Indeed, the livery have been operating apprenticeships from the early 12th century, formed the City and Guilds organisation in 1878, and today has a whole smorgasbord of educational initiatives like the livery schools link and the livery companies' skills council, let alone the £40m+ and over 230k hours of pro bono support given to education you mentioned earlier Master

But let's not be complacent. The plain facts are that we still have an education system, which although we spend higher than the OCD figure of around 5% of GDP, after 14 years of education costing some £100k, still turns out about 18% of pupils without substantive qualifications at level 2 (= receptionists & care workers)

Master, your theme "Challenging Boundaries", could not be more apposite to the new threats we now face into.

Post Brexit and largely post-Covid, the West is now having to reflect deeply on the impact of the unconscionable war in the Ukraine …on energy security, on food security, the impact on technology of Ukraine being the principal source of neon gas so necessary for the production of lasers and micro-chips, of the return of that old value killer… inflation; …the need for a complete review and increased funding of defence forces;… and of course the collective impact on any prospect of moving towards a more sustainable future.

As the ancient Chinese curse goes "May you live in interesting times!"

These are complex problems requiring practical solutions. I for one am convinced we need many more engineers of the calibre recognised tonight to be part of that solution. And here we face a national skills shortage.

Engineering and manufacturing are a cornerstone of the UK economy, generating 21.4% (£1.2 trillion) of the UK's £5.7 trillion GDP in 2018, and employing some 18% (some 5.5m) of the workforce.

Yet, despite having 165,000 engineering graduates a year, this critical industry faces a shortfall of some 60,000 in meeting the annual demand for core engineering roles:

- Half (49%) of companies claim a lack of skills available in the external labour market
- and 45% skills gaps within their internal workforce. 71% of this is in engineering.

The engineering industry has also been plagued by an outdated image of spanners and dirty overalls for decades. I for one am astonished that in Parliament we only have 26/650, graduates in the STEM subjects… only 6/650 in engineering! Whilst it is encouraging that two of these were in the current contest for the leadership of the conservative party – surely, we need to improve that overall number in our elected representatives.

Another sticking point has been the lack of diversity within the engineering industry. Only 1/3 of companies have taken action to improve the diversity of their workforce

Finally, this skills shortage is exacerbated by the impending retirement of an ageing workforce.19.5% of engineers currently working in the UK are due to retire by 2026, leaving a skills, knowledge and experience gap.

Master, it is against this background, we your guests applaud tonight's celebration of both the excellence within the profession, but also the excellence of the profession as a meaningful, enjoyable, and worthwhile career for people upon which the future of our country materially depends.

Thank you!

Regional Event - Midlands

22 - 23 July 2022

Photos: John Williams

On Friday 21 July 2022 there was a welcome return, post-Covid, of the annual Midlands dinner, organised by Junior Warden Penny Taylor. In a change of venue, this year's dinner was held at the Nuthurst Grange Hotel, Hockley Heath, where 45 members and guests enjoyed an excellent dinner.

This was followed on the Saturday morning by a five-mile walk, organised by the Master, which included lunch at the Navigation Inn (the Senior Warden's local) and a visit to the National Trust Property, Packwood House.

The walk was partly along the Grand Union and Stratford-upon-Avon canals and included the Kingswood Junction between the two. Senior Warden Raymond Joyce gave a brief talk to the walkers, explaining the history of the development of the two canals and how a short linking section of canal at Kingswood allowed Stratford to benefit from the prosperity being brought by the new navigations. Raymond pointed out several interesting features, including the cantilever bridges with gaps to allow tow ropes to pass and the unique barrel-roofed lock-keepers cottages. The walk took us past an impressive flight of 21 locks on the Grand Union.

Chris Elston

The walkers, led by Junior Warden Penny, stride out boldly

Senior Warden Raymond relating the history of the canals

Massive Telescopes and Other Celestial Matters

Engineering Soirée No. 27, 2 August 2022

After prayers from the Hon Chaplain, the lecture was given by Dr Rebecca Canning, daughter of the Master and John Canning, a senior lecturer at the Institute of Cosmology and Gravitation at the University of Portsmouth. Having gained her PhD at the Institute of Astronomy in Cambridge she spent eight years at the Stanford Kavli Institute for Particle Astrophysics and Cosmology in California before taking up her present post.

Dr Canning began by explaining how progress in astronomy was driven by a cyclic process of interactions: new technology drove discovery which in turn led to innovation which itself resulted in new technology.

She described the progress which had been made, beginning with unaided eyes which had allowed the discovery of five planets and 6,000 stars. The next technical innovation was the invention of the refractive telescope. Larger and larger lenses were made but the increasing focal length of these resulted in massive support structures up to 30 metres in length. However, these had enabled the discovery of the planets Uranus and Neptune.

The next development was the use of the reflective telescopes, replacing the lens with a mirror - and Pluto was discovered. Dr Canning explained that the two "enemies" of these were gravity and the atmosphere. Even with the most rigid support structures, large mirrors deflect when they are moved to point at the subject area of sky. This can be overcome by supporting the mirror on movable actuator jacks which can be adjusted to correct the deflections in the mirror surface measured by lasers

The atmosphere is what makes stares twinkle but it also distorts the images that are detected at the earth's surface. The solution, of course, is to send telescopes higher into the atmosphere, and balloons and specially modified aircraft have been used. Dr Canning explained that a modified Boeing 747 had been used to fly at very high altitudes. At these heights the rare atmosphere made the aircraft liable to stall and it had to be flown within very tight airspeed limits.

The solution is to send telescopes beyond the earth's atmosphere, into space. In 1990 the Hubble Space Telescope was launched and more recently the James Webb Space Telescope for which all the components had to fold up to be transported into space, even the mirror, which is made up of hexagonal pieces.

Dr Canning explained that there was an optimum place to position telescopes in space shielded from the sun known as "L2". She also described the risk of instruments being damaged by space debris.

She admitted that her favourite areas of work were optical and x-ray astronomy and described how several radio telescopes could be linked together as interferometers which had effective diameters of hundreds of miles. She gave examples of the amazing resolution that could be achieved.

She closed by explaining that the future challenge for astronomy was the management and analysis of the vast quantities of data that are generated.

The lecture was followed by a series of questions including: "What caused the Big Bang" (Anne

Bawtree), "Are there spin offs for climate change?" (Jane Newsome), "Does space debris interfere with observations?" (Margaret Ross), "Is the UK a leader in Astronomy?" (John Lowe). "Does anyone look out for asteroids that may hit Earth?" (Paul Mayo)…. NASA does!

Finally, Rebecca received a round of applause from the forty-four participants for an excellent lecture.

The evening ended with a toast to the Company and thanks to Peter Elliott for managing the technology.

Norman Dawson

Photos: Above: Sofia telescope on modified 747, credit NASA/Jim Ross; right: deep field image from the James WebbSpace Telescope, credit NASA, ESA, CSA, and STScI.

The Master's Out of Town Weekend 2022 - Cambridge and the Fens

Thursday 15 - Sunday18 September 2022

A Note from the Master

The 2022 Out of Town to Cambridge and the Fens was scheduled to take place only seven days after the very sad news of the passing of Her Majesty Queen Elizabeth II.

With almost all events in the City of London cancelled, there was concern to ensure that appropriate respect was shown to Her Majesty, the New King and the other members of the Royal family.

The Master called a meeting of the Nominations Committee and also consulted extensively with both Colleges, the University Engineering Department and the Imperial War Museum (IWM). All four venues confirmed that external events would proceed as Business as Usual, except on the day of the funeral.

In light of the above, the unanimous decision of the Nominations Committee was that the Out of Town should proceed, but with appropriate acknowledgement of National Mourning. The Master adjusted the Programme to include one minute silence immediately after Grace, to modify the menus to show black surround or tassel, to update Loyal Toast and to express condolences to the King, and changed the IWM dress code to more sombre attire. All events proceeded as planned, with the exception that the trip to Ely Cathedral and the Glass museum were replaced by a guided walk on the monasteries and architecture of Ely.

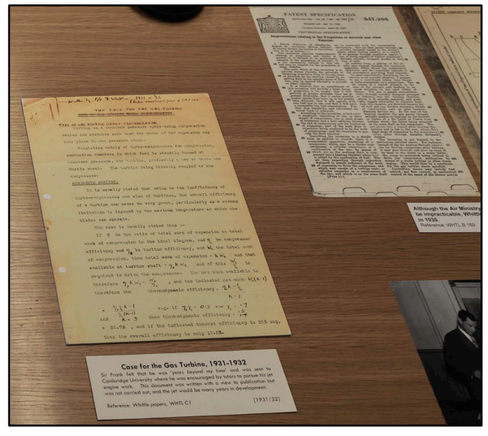
The Master is grateful for the support she has received in these difficult circumstances.

Thursday Afternoon: the Churchill Archives

We visited the Churchill Archives in the dedicated Jock Colville building. Jock Colville was a former private Secretary to Sir Winston Churchill and was instrumental in securing many of the papers stored in the archive. Our first presentation was from Alan Packwood, Archives Director, who gave us a history of the archives and introduction to the various papers and items stored in them. The building was built in 1973 and Jock Colville approached former American Ambassadors requesting their help in securing the funds for the building. Many of them contributed, notably Joseph Kennedy and David Rockefeller.

The archives not only contain Churchill's papers but also those of many other prominent politicians and public figures such as Margaret Thatcher, Ernest Bevin, John Major, Neil Kinnock, Admiral Ramsay, Field Marshal Slim, Frank Whittle, and Rosalind Franklin. There are also papers from Sir Ove Arup the Danish-English civil engineer and architect, well known for his design of the Sydney Opera House. Not all the archives are papers, Margaret Thatcher gifted her everyday handbag and its contents, such as a powder compact. Frank Whittle donated his slide rule in its original case. Inside the box is a typescript note signed by Whittle stating that the slide rule was the one he used while at Cambridge University and throughout the work on the jet engine development. He continued to use it until 1974 when it was bent by the heat whilst out in the tropics.

Our second presentation was by Sarah Lewery, Senior Conservator, on "Conserving Fragile Archives." She covered the preservation of paper and digital materials. We saw before and after examples



Papers relating to Sir Frank Whittle's gas turbine work. Photo John Canning

of paper damaged by insects, mould, and water. The paper is carefully cleaned with cotton wool, soft brush, or crumbled plastic eraser material. It is "relaxed "to take out the creases and then restored by mounting on special Japanese archive paper. If there is part of the sheet missing it is simply replaced with blank paper, the missing text is not added. Removal of Sellotape is particularly difficult as the clear film lifts off easily but leaves a difficult to remove residue. Similarly, those sticky self-adhesive photo albums are a difficult restoration job. They were so popular in the seventies but as I know from personal experience, the polka dot sticky bits lose their stickiness and turn brownish yellow. The conservators keep the cover of the album and mount the photos on clean new pages inside. Sarah described digital conservation: a problem here is that cleaning off or playing the item removes a layer of material each time. These items are copied onto new media.

Last but not least we were invited to view some specially selected items for us from the collection, amongst them: Thatcher's handbag, Whittles slide rule and Ove Arup papers. We were then taken to the storage area which is environmentally controlled and has a sophisticated fire detection and suppression system. Nearly all items are stored in special cardboard boxes suitable for archiving and preserving.

Suzanne Flynn

The Thursday evening dinner party. Photo John Williams

Formal Dinner, Thursday Evening, Churchill College

Our first social function was the aptly named "Sparkling Reception"; it was not only the wine that sparkled but the company was also bright and the repartee scintillating. An hour passed in a flash and then it was into dinner in Churchill College Hall with a brief stop on the stairs to the Hall for a team photograph. After a minute's silence in memory of Her Majesty The Queen, followed by a minute's silence for our Padre, Rev Peter Hartley, and other members of the Company who have passed this year, we sat down, each in our own thoughts, to enjoy a delicious meal. A raffle was held for 8 lucky winners of the Concorde Cockpit Experience to be taken during our dinner at the Imperial War Museum, Duxford on Friday night. With commendable efficiency the raffle was arranged so that Professor Dame Athene Donald, Master of Churchill College, could draw a single ticket to identify the 8 winners. Then Dame Athene gave us a brief history of the College, highlighting that the college Charter requires that 70% of students be drawn from STEM subjects. And in 1972 Churchill was the first of all Oxbridge colleges to vote to admit women to an all male college. Dame Athene was delighted to be able to report on the college's diverse community, drawing 75% of its students from state schools and, moreover, has now achieved a 50% gender balance. She concluded that Churchill was an exciting place to lead. Then, following the loyal toast to the King, the Master advised us that the Churchill tradition was to repair to the bar after a formal dinner. It was a tradition that met with warm approval amongst the assembled diners. All in all, an excellent conclusion to our first day.

Peter Liddell

Friday Morning Technical Visit - The Institute of Manufacturing and Materials Science

Touring the Robotics Laboratory

Starting the day early with an impressive breakfast spread, the Technical Group gathered shortly thereafter outside the Porters' Lodge for the short coach trip to the Institute of Manufacturing (IfM) and arrived correctly on time to the Master's meticulously detailed schedule. It was the start of a morning packed with a combination of wide ranging and intriguing presentations and mini tours.

On arrival we were directed into a lecture room to hear an introduction to the IfM from Prof Richard Prager, Head of Engineering, explaining the wider multidisciplinary hub nature of the Department of Engineering (DoE) of which the IfM is a part. The introduction gave a flavour of the history of key innovations emanating from the IfM/DoE, the three core activities (Research, Education & Application/ Consultancy) and examples of current projects with various commercial clients/partners/spinouts.

After that Dr Florian Urmetzer, with input from Prof Ronan Daly, led us through an overview of the structure of the Undergraduate and Master's qualifications with their strong focus on industrial projects of practical relevance carried out at the sites of industrial partners. This was followed by Prof Daly explaining the IfM's scientific methodology applied to technology scale-up, particularly for smaller spinout enterprises, with several recent examples of the approach in practice.

We then stretched our legs with a quick mini tour of the impressively equipped Robotics Lab before seeing one of the undergraduate project rooms with various poster displays of recent projects.

After a brief refreshment break, we then headed for a short walk down the road to the Material Science & Metallurgy department where we heard firstly from Profs Howard Stone and Nick Jones regarding the development/transformation of novel super alloys, controlling crystal structures in single crystal turbine blades and additive layer manufacturing. This was then followed by Prof Chris Pickard and Dr Bartomeu Monserrat taking us through their research utilising quantum mechanics and AI to streamline the development of new materials with specific targeted properties.

These presentations were followed by splitting into various groups for a mini tour of the Process Laboratories and Workshops where the distinctive whiff of hot metal could be smelt in the corridor air. The labs and workshops were all very impressive with an extensive range of furnaces, casting and metallurgical handling equipment and a complete suite of X-ray and electron microscopes including the brand new Spectra 300 Scanning Transmission Electron Microscope which was just reaching the end of its commissioning period and whose configuration/ abilities make it the only one of its kind in the UK.

With the mini tours completed and after gathering and appropriate confirmation that we had not lost any souls in the labs/workshops we returned to the IfM for a superb buffet lunch and much discussion on what we had seen and heard during a busy and fascinating morning.

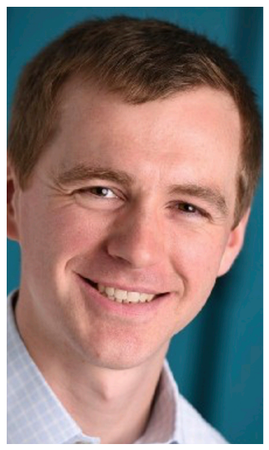
Stephen Davies

Dr James Macdonald

- **PhD 2017-2021**
  - Laser processing and inkjet deposition techniques to functionalise sheet glass and steel material.
- **Research Fellow in Manufacturing Processes**: University of Leeds, 2021-present
- *"I am a postdoctoral researcher in the Future Manufacturing Processes group and working to fabricate magnetically actuated soft robotics for medical applications. I am developing a novel multimaterial aerosol jet 3D printer which will allow us to manufacture these robots at the sub-millimetre length scale needed."*

Dr Jon Parkins

- **PhD 2012-2016**
  - Distributed Energy Delivery Strategies to Improve Consolidation Rates of Laser Powder Bed Fusion of Metal
- **Graduate Trainee:** Halma plc 2016-2019
- **Evacuation Lighting Manager**: Apollo Fire Detectors 2019-2022
- **Head of Customer Marketing**: Apollo Fire Detectors 2022-Present
- *"I am currently running the customer marketing team at Apollo Fire Detectors, focusing on developing and implementing business strategy as well as customer engagement. At Apollo we make devices that keep people safe from fire every second of every day and that gives me huge pride in my work."*



Dr Jonathan Waite

- **PhD 2014-2018**
  - Extrusion and inkjet based additive manufacture
- **Senior Technologist:** Alchemie Technology Ltd, 2018-2019.
- **Platform Technology Leader:** Alchemie Technology Ltd, 2020
- **Development Engineer:** CMR Surgical, Nov 2020-Present
- *"I'm currently full time on new product development. I'm part of a team prototyping an instrument to bring new functionality to the Versius system. This should allow surgeons to work more quickly and with less manual assistance from the bedside nurses. The project is very much in a stage of iterative design-test-analyse loops, so making good use of my research and experimental skills"*

What Our Leete Award Students did Next

After a superb and somewhat over-catered lunch under the eagle eyes of the waiting hungry students, we reconvened in the Institute for Manufacturing to hear about the research and subsequent careers of the four postgraduate researchers whose PhD research in manufacturing technology was sponsored by the Engineers Company – specifically the three-year Leete Premium Award for manufacturing excellence.

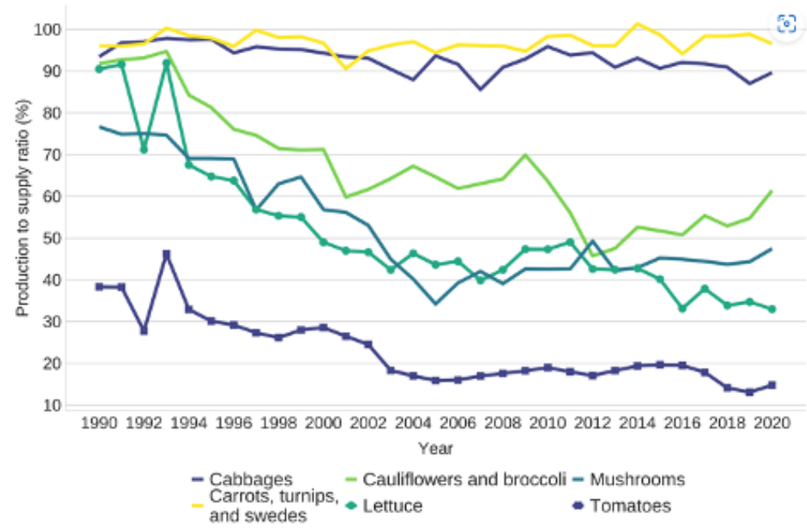
Professor Ronan Daly presented brief details of three of the four award winners who remained in contact with the Institute, noting that all had gone on to interesting careers.

Bio-Inspired Robotics

Our first technical presentation of the afternoon was by Professor Fumiya Iida, Professor of Robotics who moved to Cambridge in 2014 to set up a robotics lab after gaining a degree in mechanical engineering in Tokyo University of Science and post doc work at ETH Zurich. Prior to that time, Cambridge was lagging behind other UK Universities in this area, such as Edinburgh, Bristol and Birmingham.

Professor Iida introduced us to the complexities of vegetable harvesting, a significant problem in the East of England where the total income from farming in 2019 was £885M. Given the shortage of labour for harvesting, it is becoming increasingly difficult to balance the economics of vegetable production.

He illustrated his talk with the example of 'lettuce harvesting' showing how human harvesters can detect individual lettuces, determine which are worth harvesting, hold them gently to avoid damage, then trim away the outside leaves in one swift 'hack' through the main stem. The end product is a perfectly prepared, clean, 'supermarket ready' specimen in around 15 seconds.



From United Kingdom Food Security Report 2021: Theme 2: UK Food Supply Sources - GOV.UK (www.gov.uk)

A robot replacement has many problems to overcome. Prof Iida noted that the problems are not new; he quoted Muravec (Harvard, 1988) 'that whilst it is easy to make a robot which mimics an adult it is impossible to give them the self learning skills of a one year old child when it comes to perception and mobility'. In the case of lettuce harvesting, first the robot must identify a specific 'target vegetable' amongst a chaotic pattern of intermingled leaves. Then it must determine which lettuces are ready for harvest, leaving others to grow further and rejecting those that have failed to form adequate 'hearts'. Then it must 'secure' the lettuce with a grip that is sufficiently firm to allow a knife to be applied to the stem – but not so firm as to crush the lettuce itself, and finally it must determine where to make the 'trimming hack' to remove the tatty leaves, but leave the maximum amount of heart before transferring the lettuce to the trailer.

Acknowledgement lettuce-381047_960_720.jpg (960×720) (pixabay.com)

Prof Iida's work focusses on the application of soft sensing technologies and adaptive stiffening for wearable devices, haptic interfaces and robotic systems. The mechanical properties of a sensor strongly affect its tactile sensing capabilities. By exploiting tactile filters, mechanical structures between the sensing unit and the environment, it is possible to tune the interaction dynamics with the surrounding environment. By using these technologies on a robotic 'hand' he has shown it possible to apply the appropriate 'strain' to secure and trim the lettuce without damage.

Audrey Canning

Friday Afternoon Technical Visit to the Maxwell Centre for Interdisciplinary Engineering

The late afternoon slot required a short walk to the Maxwell Centre which allowed decompression following the Agri-Food Robotic Revolution. Our host "Aga" (Dr Agnieszka Iwasiewicz-Wabnig FRSA, Director Partnership Development) enthusiastically explained the history, purpose and future proposals for the centre under the title, "Strategy and Serendipity". This title reflects that people with knowledge or capability probably don't talk enough to those that have a "need". The centre was created to enable research and industry to meet and discuss needs and opportunities. It was highlighted that the centre is not a "gatekeeper" but a signpost to opportunities for co-development with the university. The volumes of potential research ideas and development possibilities were quickly identified as exceeding capacity so two key themes have been selected

- the Carbon Zero challenge
- science in medicine

A "continuous community" is envisaged which will permit a constant refreshment of ideas and thinking. Whilst participants will be subject to confidentiality agreements, the opportunity to maximise the co-creation and use of knowledge and scarce assets is seen to be key to success. The shared resources are designed to enable small companies and enterprises to use equipment that they would not otherwise have access to or be able to justify the investment. Additionally, participants would have access to experienced operators who could maximise the benefits to be gained.

The new building was two-thirds funded by the UK Government Research Partnership Investment Fund; the £25m raised by the University has enabled a significant building for research and innovation across the Physical Sciences and Technology. Laboratories on the ground floor could not be visited because of time constraints but the meeting areas were used and the office space on the third floor described.

One of the five participating companies is the Henry Royce Institute exploring savings in energy transmission; additionally, there are ten hot desks for associated companies and fifty industry researchers. Local industry knowledge is brought in from the Cambridge Clean Tech network and local start-up companies. This network targets the creation and exchange of ideas and helps address the emerging challenges facing these small companies.

Successful demonstrations of the size and scope of ideas which have been launched include:-

- Solar powered splitting of water to generate hydrogen
- Solar off-grid water pumping

Foyer at Maxwell Centre; laboratories below

- Sustainable ammonia production
- Photo reforming of plastics
- Science input into the policy for "forever" products eg Teflon

Physical evidence of the successful implementation of this initiative can be seen in companies including

- MediSMITH – sustainable manufacturing for the medical technologies
- WaterScope – a 3D printed microscope for studying water purity in the field
- Xampla – a replacement product for single use plastic
- BT – increased use of copper twin core cables for data storage
- Centre for Digital Built Britain and their Innovation Hub

The briefing closed with Aga describing the vision for the Innovation District of the University Western Science campus comprising the Cavendish III laboratories, future-industry R&D facilities and the Health Tech Enterprise zone. The comparison of the initiative to a pinball machine was very appropriate demonstrating that whilst, as a developer you may get bounced about, the good ideas will be kept in play for a long time. A chastening thought is that you have to have the money to play in the first place.

In a time-constrained Q&A, it was proposed that the initiative should seek to influence the City more. Support for the Chief Scientific Officer, who is in a minority of influencing voices in government, was also recommended. It was noted with a hint of irony that two of the four great offices of state are held by Cambridge alumni as is the Metropolitan Police Commissioner, so they are probably communicating already.

Colin Newsome

Friday Morning Cultural Visit - A Stroll Around Ely

Our planned guided tour of Ely Cathedral and visit to the only stained glass museum in the UK was, owing to the nation being in mourning, replaced with a one mile circular tour of Ely starting from Cromwell's house. This is now a museum and the Tourist Information Centre.

Prior to Cromwell's rise to fame, he was Ely's tax collector. Working on behalf of the cathedral, which owned all the land, he collected a percentage of all produce (including eels) and/or money from all of Ely's citizens. The tithe office was housed there, with a huge tithe barn to the rear. I was told that Cromwell kept for himself anything that was left over.

Eels were a dietary staple during Cromwell's time and a valuable source of income. Our walk took us past a circular bench on which is inscribed Mrs Cromwell's recipe for roast eel. Heading towards the cathedral we passed the, 'Cannon on the Palace Green', which was captured from the Russians during the siege of Sebastopol and given to Queen Victoria in 1860 to mark the formation of the Ely Rifle Volunteers.

The fifteenth century Bishop's Palace is now let to a private international school, opposite which is the privately owned Chantry House, named after the thirteenth century chantry which stood on this site.

The drainage of the fens had only recently begun by Cromwell's time. We were asked to imagine a time when Ely was an island and when Ely was an important port and trading centre. The trade followed the route of the river from the Hanseastic port of King's Lynn all the way to Cambridge and passing through Ely. Ely was also on a busy pilgrim route through to Walsingham. Surrounded as it was, by water, Ely Cathedral was known as, 'the ship of the fens'. Ely's founder was Ethelreda, a seventh century East Anglian princess and Abbess of Ely. She died of the plague and was later canonised.

A stop was made at Prior Crauden's chapel, built in the early fourteenth century for John Crauden, prior of the monastery. Tradition has it that he adapted a nearby building to create a hall to enable Queen Philippa, the wife of Edward III, to stay. Traces can still be seen of a bridge linking the hall with the chapel.

Stained glass windows in Prior Crauden's chapel

Inside the chapel is a splendid stained glass window, the remains of wall paintings are still visible and a superb medieval tiled floor. The chapel escaped the ravages of the dissolution by being passed off as a private dwelling.

Firmary Lane is the site of the monks' infirmary and associated buildings such as Powcher's Hall which was the bloodletting house. Leeches were routinely used, several times a year, to bleed the monks.

Although, as a group, we could view the cathedral only from the outside, we had an excellent view of the octagonal tower which is unique in medieval architecture. It owes its existence to a dreadful accident. While the lady chapel was being built, excavations broke into bed rock causing water to flood in and weaken the tower footings. In time, the original tower came crashing down and was replaced which the present one which is constructed of oak with the eight towers being lined with lead.

Upon the advice of our excellent tour guide, a few of us entered the cathedral in ones and twos for a moment of quiet reflection and to view the magnificent and enormous black oak table* which was created from a 5,000-year-old fossilised black oak tree discovered in the fens.

Jane Newsome

**Editor's note: my younger daughter, Rachel Elston, was one of the team of craftspeople who made this table.*

Friday Afternoon Cultural Visit
Denny Abbey and the Farmland Museum

After a delicious lunch, we took a short coach journey to Denny Abbey and the Farmland Museum, a fascinating pairing of an 850-year-old cell of Ely Cathedral Priory, with a 20th century collection of farm machinery and artefacts. Denny Abbey was established in 1159 and was home to Benedictine monks, Knights Templar and the Poor Clares (Franciscan nuns) at the invitation of the Countess of Pembroke, who had been given the buildings by Edward III. The buildings were converted to a farmhouse and barns after the Dissolution. The Farmland Museum is built on the Delanoy family's collection of horse-drawn farm machinery and craft tools, originally based in Haddenham, but relocated to the Denny Abbey buildings in 1997. It's a happy combination for visitors.

We were greeted by Museum Manager, Sarah Michael; Trustee, Jane Williamson; and Christine, one of the many volunteers. Jane led our group to the Abbey and described its many changes of use over the years, revealed in details concealed for centuries. Teas and home baking at the Delanoy Education Centre provided an opportunity to view the shop next door, laid out as a 1930s village shop with nostalgic glimpses of long-gone trademarks and displays (no plastics in sight!)

The displays in the museum shed focussed on rural crafts, with basketmaking (featuring the amazing "Mouse House"), a dairy, a farrier's workshop, a fenman's hut. Fen people who lived off the eels and ducks they caught were apparently known locally as "slodgers" (shades of Rambling Syd Rumpo there). It was nice to see the Worshipful Company of Farriers mentioned in the display boards as the qualifying body for farriery since 1356 to the present day.

Walnut Tree Cottage gave a lovely insight into living accommodation for farmworkers in a two-up two-down tied cottage, fitted out with furniture from the 1940s and 50s. Quite spacious – but no indoor toilet. China chamber pots had to suffice! The very large washroom implies that it may have also been used as a source of extra income.

The nun's refectory (used as a barn for 400 years) still had some 14th Century tiles on the floor.

The Stone Barn was built in the 17th Century using some of the Abbey's stonework, and a magnificent timbered oak roof. Originally used for threshing in the winter, it now houses the large collection of farm tools and equipment collected by the Delanoys, the oldest being the "Bassingbourn wooden ox-drawn plough". Other highlights are the seed-dresser used to clean seeds for the following season's planting- and the maize kibbler, the chaff cutter and the cake breaker all used for preparing animal feed.

The time flew by, and by the end we had absorbed many insights into the varied history of the area, through the lens of the changing uses of a cluster of buildings. English Heritage deserve great credit. There are no farm animals to see but it's still a wonderful place to take children, with Play Areas inside and out, including of course a sit-on tractor.

Lynda Masterton

Above: the Mouse House; below: goods on display in the 1930s shop

Friday Evening Dinner at the Imperial War Museum, Duxford

On Friday evening we headed of to the Imperial War Museum, Duxford. This is somewhere that I have driven past frequently and has been on my 'must visit' list for quite sometime. Now what better way to experience this historic aircraft collection than with a glass of fizz and such eminent company?

We enjoyed a lovely drink reception whilst walking amongst the fascinating historic exhibits. Everyone had chance to walk through the cabin of Concorde 101 and the lucky few from Thursday's raffle also got to visit the cockpit.

Now this Concorde wasn't exactly what I was expecting. Where was the luxury seating? There was in fact very little seating at all. There were however, 200 miles of test wiring, two ominous looking escape hatches and large flight test observers' work station. This aircraft was in fact a pre-production model built specifically to test and refine the Concorde design and achieved the highest speed of any Concorde.

We were then called for dinner under the sweeping port wing of Concorde 101, with TSR-2 ahead, the remaining fuselage of a Handley Page Hermes to our right and a Avro Vulcan to our left.

Our dinner concluded with the usual toasts and a speech by Professor Richard Prager, Head of Cambridge University Engineering Department. Professor Richard talked about challenging boundaries. Those between disciplines being broken down by developments and collaboration of engineering with healthcare, architecture and synthetic biology, to name a few. He also spoke of the boundaries of access to higher education. The need for effective outreach so that Cambridge continues to admit the brightest students with the greatest potential. He concluded by thanking the Master and the Company for choosing to visit the Engineering Department.

Peter Gracey

Above: tables set for dining under the wing of Concorde. Below: aircraft on display at IWM Duxford. Photos, John Canning and John Williams

Saturday Morning Industrial Presentations

Saturday morning dawned, crisp, bright and early, and I found myself sitting outside the Jock Colville Centre waiting for the arrival of my industry speakers. By half past eight we had the presentations up and running, waiting for our audience to arrive. Surprisingly, given the excitement of the previous night, almost all of the technical group were ready and waiting by quarter to nine and we started exactly on time.

First up was Adam Durant, CEO of SME Satavia who gave a fascinating talk on how knowledge of the water content of the atmosphere can be used to predict the likelihood of formation of contrails. This in turn enables aircraft operators to forecast, prevent, quantify and offset surface warming caused by contrails, potentially cutting up to 60% of aviation's climate impact, equivalent to 2% of all human generated climate impact.

Adam explained that Satavia's numerical weather prediction model quantifies all meteorological parameters across those regions
of the globe most used by flight paths and then uses simulation to create reliable forecasts of climate impact of individual flights. He also explained how a small enterprise had grown to a 20 person venture-backed business, with expectations of significant further growth in the next two years.

We then heard from Jade Auston, Head of Energy, Utilities & Sustainability at AstroZeneca PLC. Jade explained how AstaZenica is addressing the 17 United Nations sustainability goals and how sustainability is embedded in everything they do. In particular she explained that the new Discovery Centre located just outside Cambridge is a feat of environmental engineering, equipped with 174 boreholes to provide natural geothermal energy, four 'hybrid cooling towers' and a ground source heat pump that will save enough energy to power 2,500 homes. Low-energy ventilation and high levels of insulation also help ensure the efficiency of the building, along with the 'saw-tooth' roof design which minimises energy use by flooding the interior with natural daylight. The company has the ambition of reaching zero carbon emissions from its operations across the world by 2025, and for its entire value chain to be carbon negative by 2030.

Then, it was off for refreshments and away to find our bus.

Audrey Canning

Photo: John Canning

Saturday Morning Technical Visit to Agden Green Farm

To complement the presentations from leading academics at the University we also made a field visit….literally! to a farm some miles outside Cambridge close to Grafham Water.

Here we heard from Will Mumford, a 5th generation farmer and owner of Agden Green Farm, who certainly knew his onions …well actually his soil mechanics. Will told us how the challenging economics of farming had led him to develop a business in technology to support the farming industry, initially focusing on farm communications technology and, when that was overtaken by the general availability of public cellular mobile systems, more recently automated agricultural machinery underpinned with GPS and machine learning technologies.

Will explained how traditional thinking to improve efficiencies had resulted in larger and larger farm machinery, which had resulted in unintended consequences for the structure and health of topsoil as a result of compaction from the heavy machinery. As Will said, quoting Paul Harvey, "Despite his artistic pretensions, his sophistication, and his many accomplishments - man owes his existence to a six-inch layer of topsoil and the fact it rains". We ignore it at our peril.

A modern tractor can easily weigh 17.5 tonnes, a four-fold increase since the 1960s. A 5 tonne wheel load applied at the surface can permanently reduce crop yield by 2.5% due to subsoil compaction. A modern autonomous tractor might weigh less than one fifth of the giant machines typically in use today.

Will explained that by using autonomous machines, capable of precision actions and potentially 24/7 operation, a massive increase in productivity could be achieved. This enabled machines to be smaller and lighter with subsequent reduced damage to soil structure which not only resulted in higher crop yields but also environmental benefits. This included massively lower use of chemicals and hence pollution from ground water run-off, something Will was very aware of, given a large part of his farm drained into Graham Water , which supplies 5 million people with drinking water.

Autonomous farm machinery was still relatively new to the UK, but Will was committed to introducing such machines through his growing business and investigating how machines available today might be augmented by other technologies such as LIDAR, soil density monitors (allowing variable rate application of chemicals) and enhanced GPS allowing sub-centimetre accuracy.

Needless to say, as a 'field' visit we had opportunity to see some of the different types of equipment used by farmers today. There was no shortage of volunteers to climb aboard to get a farmers view of how to operate the machines from the cab. It took some while to prise everyone out of the vehicles at the end of a very inspiring visit. It was good to know that farmers such as Will had a real interest in using new technologies to transform farming with resultant benefits to both food production and the environment.

Chris Earnshaw

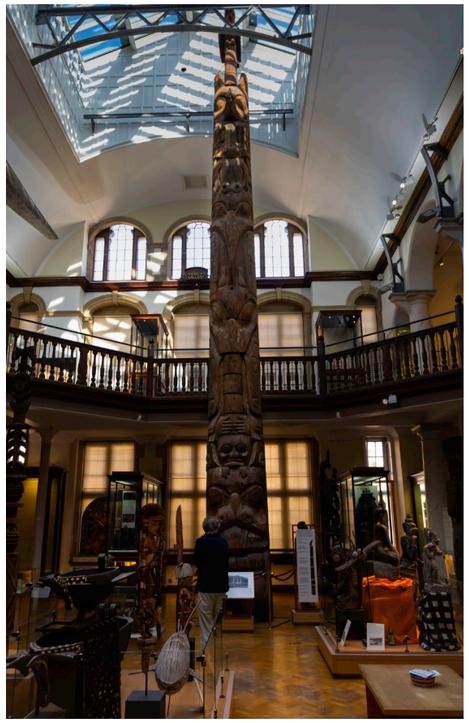
Top: farm machinery on display; middle the Engineers' tour

Saturday Cultural Visit to the Museum of Archaeology and Anthropology and the Museum of Zoology

We boarded the coach on a bright sunny day for a short journey towards central Cambridge, alighted near the Queen's Ditch and were ably split into groups for the 2 visits by John Canning. A short walk took us to view the Queen's Bridge, where we paused to see early punters on the Cam. We continued past cafes, bikes, many interesting buildings, new developments clothed in scaffolding, "Fitzbillies" (no time to indulge in the sweet treats inside!) and barbers' shops. Finally, our group reached and entered the Museum of Archaeology and Anthropology. Following an introductory talk, we were able to explore the three floors independently, encountering 2 million years of human history through countless artifacts and stories from Cambridge's Roman roots to contemporary Pacific sculptures. So many items - but here are a few:

A huge stone coffin containing a female skeleton, excavated during the building works for a housing estate, intrigued our group. (Sylvia Plath referred to it in one of her poems).

A new "Colour Exhibition" included a montage of small crochet shapes which made a beautiful artwork. An exotic 19thC Amazonian headdress made from



The totem pole in the Archaeology and Anthropology museum

Viewing exhibits in the Zoology Museum

brightly coloured parrot feathers, was used for rituals and dances.

The massively tall carved Totem Pole dominated the whole building! One hour was not enough to take in all the ivories, necklaces, masks, charms, pubic sporrans for the dead (!), colourful batik textiles, ornaments for ears/legs/neck, Mayan figurines, pottery, Roman glass ……an endless list. A wonderful museum and a great resource for students.

Next, we took a short walk across to the "New Museums' site, to the more modern Museum of Zoology. Our first sight was a massive fin whale (21m) hanging from the high ceiling! We had an excellent guide, a very knowledgeable historian. Again, such a lot to see and take in, in one hour. However, we learnt that mammals are the most "modern" animal group, appearing (only!) 200 million years ago. Specimens included apes, kangaroos, sloths, anteaters, ungulates (giraffes), deer, cows, cats, bats, and birds. Many were displayed "stuffed" alongside their "skeletons" which aided our understanding of their movement. The largest skeletons of elephants, deer, cows, plus a giraffe, surrounded the Atrium, lit by plentiful natural light from above. Our guide described different kinds of animal's feet structures, with regard to their weight-bearing properties. A real learning experience! Several of us enjoyed the bird display, with great pictures behind them, giving context. We also saw some of Darwin's specimen jars brought back from his Beagle Voyage (fish) and also his Pheasant Feathers.

There was just time for a quick coffee before we emerged from this bright airy museum into the sunshine once again. All in all, two excellent visits – well worth return visits in the future.

Ros Garside

Photos: John Canning

Saturday Barbecue

After a morning sharpening our appetites on visits to an automated farm (technical) and Cambridge museums (cultural) we made our way to the Graduate Hotel for a barbecue lunch.

Some in the party remembered the hotel in its former existence as The Garden House Hotel which gained notoriety in 1970 when a student protest against the Greek military junta became violent, and later in 1972 when the hotel burnt down in suspicious circumstances. On a happier note, it was discovered that Ted and Sally Willmott had their wedding reception there and Norman Dawson went there for a dinner to celebrate his 21st birthday.

The Company assembled on the lawns by the river watching punts glide gracefully up to Grantchester or, more or less expertly, negotiate Silver Street Bridge en route to "The Backs". This area was a bustling commercial centre when Cambridge was an important port, connected to the sea at Kings Lynn via the Cam and Ouse. It was the site of several warehouses and flour mills but now it is given over to tourists and a few cows on Laundress Green.

It was decided that the wind was chill enough to persuade the party to move inside where a barbecue spread of lamb kebabs, grilled chicken with vegetarian options and fruit was set before us. We were joined by our hosts from the morning's activities, in particular, by Adam Durant and his young family, and Jade Auston. The Master made presentations to our hosts before we prepared ourselves, well-fortified, for our afternoon walking tours of Cambridge.

Norman Dawson

Spies, Mice and Rivalry

An intriguing tour, that commenced at Pembroke College.

By all accounts Cambridge is a University that seems to have trumped its rival Oxford in its affinity for those attracted to what is claimed to be the second oldest profession, one that is even mentioned in the Bible, that of spying.

So, what makes a spy? We were told that the answer lies in the acronym MICE which according to our guide stands for Motivation, Ideology, Coercion, and Ego.

On the subject of our guide, he/she/they did not wish to give their name, expressing a desire to remain incognito on the bases that one of our party could have been a spy. Hence, to preserve their anonymity I feel it only fitting to hide their identity in the group photograph.Back to Pembroke, which includes alumni such as James Bond actress Naomie Harris who played Moneypenny in Spectre, and the former head of MI6 Gordon Cummings on whom it is believed Ian Fleming based his character Q. This has led to Pembroke being dubbed as the home of James Bond 007. Then there is also Tom Hiddleston, another spy series, from the Avengers.

But for real spies, that is those that were caught or uncovered, we need to move down the road to Corpus Christi, infamous for the Cambridge Five; Maclean, Blunt, Burgess, Philby & Cairncross.

Then to Kings College, alumni Francis Walsingham, who uncovered the plot by Mary Queen of Scots to assassinate Queen Elizabeth I, and then later on "Dilly" Knox who exposed a German plot for Mexico to enter WWI on their side.

However, who will ever know how many spies there are/were and if Cambridge really trumped Oxford as it may be the Oxford spies were better and didn't get caught?

Brian Back

Saturday Afternoon Walking Tour - "Death and Disease"

The earliest cause of death was the River Cam into which all sewage flowed making the water unfit to drink. This was still apparent in Queen Victoria's time. She was visiting and noticed pieced of white paper in the river – the quick-thinking Master of Trinity College told her that they were notices telling people not to swim in the river.

During the second World War local pilots liked to drink at The Eagle and they covered the ceiling of the Bar with graffiti around a picture of a naked lady outlined in lipstick, but never their names as this was considered unlucky. Many of them would not have returned from their missions. At the same pub upstairs is an open window to one of the rooms – this is where a woman burnt to death in a fire as she could not get the window open. The window is welded open.

At Gonville and Caius, we were regaled with the tales of the men who jumped the gap between two buildings. Initially they were roped to a hook, but the hook was then removed and deaths followed.

Linda Brooks

The RAF Bar at "The Eagle"

Quirks and Curiosities – a walk through Cambridge town centre

"I do quirks not facts!" said our guide. But here are some of the things we learnt.

1. Before the Romans came to town, Cambridge was a port as the river could accommodate small boats. The Cam, being a chalk stream, needed "managing" and was canalised. A stone road was laid over most of the length in the middle of the river in order that the horses (pulling boats) could walk in the river without sinking or churning up the chalk. This stone road is the reason punting is so successful – it provides the solid base on which punting poles push! Punts originated to allowing fishing and eeling but also could carry "punt guns".
2. Students arrived about 1209 – all male – and women, only in 1869 (Girton College opens). Education stems from religion. Walking past Queens' College – here only because of its proximity to Kings College – the post box is noteworthy. Before the postal service the colleges had their own post service – between themselves. They only agreed to use the new system if they each had a post box accessible internally and externally!
3. The phrase Hobson's Choice originates from the hosteler who would only hire out the next horse in line rather than letting a rider choose a ride from all available – hence Hobson's choice or no choice.
4. There is a "grasshopper escapement" clock in the doorway to the old bank. This cost £1M and was gifted by Dr Taylor. An interesting clock with a very angry grasshopper that actually controls the speed of time. The clock is only right every 5 minutes with the grasshopper allowed to speed it up, slow it down or even to "stop the clock", as long as it is correct every 5 minutes. The blue lights tell the time. Tempus Fugit.
5. Gonville and Caius College is next door to the Senate House. A mini was put onto the roof of the Senate House by students climbing out of G & C, as a prank. Having been parked outside all day, it was moved to the roof, overnight, using some block and tackle equipment to get it up, by the "night climbers", a legendary group in Cambridge. In the morning there was no evidence of the methods used to, or who achieved this feat. It was there for several days. Nobody got caught. At the end of the year the Master of G & C sent a case of champagne to the likely candidates.
6. Trinity College, the largest and wealthiest college, and home of 35 Nobel prize winners and Isaac Newton has large amounts of land gifted by Henry VIII. Henry's statue is over the front gate holding not a sceptre but a wooden chair leg. Another student prank! On the grass outside Trinity (where Newton tested his alchemy theories in a small shed) is an apple tree said to have grown from a seed of the original "Newton apple tree".

Matthew Waterhouse

Out and About in Ely and Cambridge

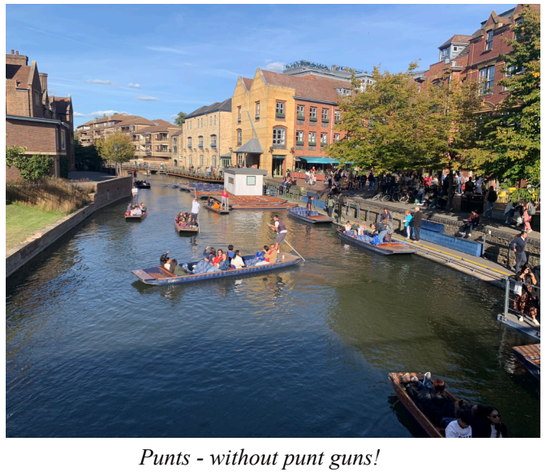
The Ely strollers

Spy catching in Cambridge

Guided around the quirks

The grasshopper escapement clock

Trinity college, with King Henry holding a chair leg



Punts - without punt guns!

Photos: Jane Newsome, Brian Back, Matthew Waterhouse

Saturday Evening Banquet at Corpus Christi College

The banquet at Corpus Christi College. Photo: John Canning

After a day filled with interesting and thought-provoking presentations, it was time for a swift change of clothing at Churchill College whence to Corpus Christi College.

Having debouched from the buses, we made our way along the beautifully manicured quad to the Old Combination Room for pre-banquet drinks.

History pressed upon us as we recalled that Corpus Christi had been founded in 1352 by two town guilds in the aftermath of the Black Death when many skills had been severely depleted. Founded by these Catholic guilds, the College had occasional bumpy rides during and even well after the Reformation, but nevertheless flourished, as is evidenced today.

Having gathered and enjoyed refreshing drink ,we were then ushered into the Parker Library where Dr Philippa Hoskin, Director of the Parker, was on hand to supply us with a brief and fascinating background to the history of the library and the great contribution of the 16th century Master of Corpus, Matthew Parker. He devoted his whole time and energies as Master from 1544 to 1553 to the intellectual and financial well-being of his College, ensuring that his garnered collection of books, manuscripts and silver would never "escape" from the College. Parker very reluctantly eschewed his Mastership at the behest of Queen Elizabeth 1 and was installed as Archbishop of Canterbury.

What a rare treat it was to step into that library redolent of age and to inhale the particular deeply satisfying aromas of aged books and vellum. Before us were laid out many books and manuscripts from various centuries, so close, unguarded by glass, that one could almost feel the ghosts from scriptoria, quills and pigments at the ready, waft by us. The freshness and clarity of the scripts is astounding. Grateful thanks to Dr Hoskin for sharing her time with us answering questions.

It was all too soon that we had to leave this library of antique delights and take our seats in the magnificent Corpus Hall where generations have dined, debated and very likely made merry. From the walls, portraits of past Masters gazed benignly upon us.

Liveryman Norman Dawson said Grace in the stead of Peter Hartley, sorely missed by us all.

The WCE, partners and guests enjoyed an unhurried veritable feast accompanied by fine wines. Even Lucullus would have trimmed his gourmandising to enjoy this excellent dinner. Thanks to all those in the background who fed and "watered" us so well!

Gatherings, formal and informal, give an opportunity to indulge in camaraderie, debate and as has been mentioned, merriment.

There was a merry moment when the Master stood to address all assembled. She began: " Master….Oh, I AM the Master!" Trip-wires assail us all, Master Engineers and lesser beings alike. A great rumble of empathetic laughter arose and then affectionate applause before she could continue the address. An indelible, delightful memory for all.

The entire evening was splendid and we proffer our gratitude to the Master of Corpus Christi College, Professor Christopher Kelly, and other members of the College who made this excellent, exciting and memorable evening possible.

Gratias vobis agimus!

Mike Inkson

Sunday - Survivors walk to Grantchester

The post-OOT walk was an optional extra which enabled a few to walk off some of the calories gained in the previous three days. One-way trips were enabled by our locally based shuttle service, Scahill Taxis so that earlier car departures from The Orchard Café, Grantchester became viable.

Eleven intrepid explorers braved the hordes along Trinity Street and gained access to the River Cam at the Mill Pond where punts, kayaks or canoes were available for the unwary traveller. Losing no-one, we walked across Coe Fen and learnt that this was the site of the Master's early foray into geospatial surveying. Fourteen days spent in extreme heat one summer recess, we were informed, saw the Fen dry out to settle, in places, by up to six feet (old money folks) most of which occurred during the survey period. There was some jocular scepticism about survey error and "best reason" for measurement inaccuracy, but the overall result was apparently a significant success. It was good to learn that health, safety and welfare were considered for the students with water and salted water being brought to them during their travails. It is Cambridge after all.

Within months the Fen was flooded, and the group was invited to envisage Audrey cycling along this route with the water above the axles. Walking conditions on that occasion were apparently less appealing.
The Fen is grazed by cattle and in an interesting reflection on the comparative threat presented to walkers by cows and cyclists, bovines are at liberty to pass under Fen Causeway but on the joint-use footpath gates have been installed for the protection of pedestrians.

The walk proceeded past two open water swimming areas on the Cam. The first is available to all but, in the past, the Masters pool was also a naturists swimming area. Nothing further was revealed. The walk through Paradise (Local Nature reserve) was uneventful but we were shown some of the bridges which can be climbed from a punt whilst it passes underneath. Our own former climber (John is a dark horse) explained how it was done but declined to demonstrate.

We emerged into the open reaches of Skaters Meadow and Grantchester Meadows under gathering clouds and increasing breeze which emphasised the sound and movement which is generated in the fens close to willow trees. Having not sighted house martins or swallows for some days, it was a pleasant surprise to hear their airborne chatter overhead as they headed in the direction of our destination.

The Orchard Café and Tearooms is delightful. Set in an apple orchard with extensive seating under the trees or in sunny clearings, it retains characteristics of a by-gone age which are highlighted by information boards about bohemian poets, writers and philosophers from the early 20th Century. Home cooked fresh food tempted many and the "best scone and jam" award will probably land here. The arrival of the Royston Brass Band for the afternoon concert added to the atmosphere and the walkers enjoyed a guest appearance from David and Gillian Scahill.

Goodbyes, or rather "au revoirs", had to be made at this point, so thirteen became six. Rupert Brookes' poem is displayed in full at the café and a detour to the village church was catalysed. Sadly, it was standing at quarter to three but there would have been honey for tea, if we'd had room.

Colin Newsome

Above: Coe Fen; Below: the survivors. Photos: John Canning

CITY AND LIVERY EVENTS

Sheep Drive across London Bridge 25 September 2022

As all our members who are Freemen of the City of London may remember from their Freedom Ceremonies, there is an ancient right to drive sheep over London Bridge. This opportunity comes round once a year in the form of a charity event organised by the Woolmen and I understand that 50% of the money raised goes to the Lord Mayor's Appeal.

This year at least 7 members of the Company, accompanied by their partners or other family members gathered on a gloriously sunny and not too cold Sunday afternoon in an uncoordinated move at the registration desk at Mansion House. Here we were rapidly badged and allocated to our different groups, amazingly all at a very similar time. Whilst we waited for the main event, we had the opportunity to view the 'show' sheep, and visit the many stalls setup by other Livery Companies mingling amongst the many spectators and gowned Masters, Wardens, and Assistants.

When our allotted time came, we were taken and corralled in pens on London Bridge in groups of up to 10 fellow drivers. The sheep, standing docilely were also in a similar pen. The sheep drive consists of a relay of 4 groups who "drive their sheep" a quarter of the way across the bridge to another holding pen, where the next group takes over. It is all over very quickly, but in a very organised and happy and jovial atmosphere. We all posed for the many tourists on the opposite side of the carriageway looking bemused at our activities. I got the impression that the many gowned and badged sheep drivers were more of an attraction than the sheep.

I must report that the sheep behaved impeccably, none tried to escape, there was no moaning (or baaing) and the dry weather meant that the pavement underfoot was not treacherous.

Having completed our allotted drive, we were then marshalled back to Mansion House to collect our certificates. A very enjoyable experience, even if you did not get up and personal with a sheep. But now we know how they must feel. Congratulations to the Guild of Young Freemen who expertly marshalled the many groups without any escaping to my knowledge.

Following the hectic activity, most of the group adjourned to a local Thames side hostelry for some much needed time to chew the cud and drink a few beers. An excellent afternoon and many thanks to our members for organising informally the meet up.

John Canning

Left: shepherdess and Member of the Freedom Cathy Hinton proudly showing her sheep; below, shepherds gathering; bottom: shepherds taking a well-earned refreshment.

Election of Sheriffs 24 June 2022

On mid-summers day Members of our Livery exercised our duty at the Election of Sheriffs in the Guildhall, where Alderman and Sheriff Alastair King and Sheriff Andrew Marsden were appointed to serve for the year 2022-23. Immediately after the Election we repaired to Painters' Hall where we were joined by our partners and members of several other Livery Companies. I am pleased to report that, despite our numbers being affected by both Covid and the rail strike, we gave a very credible cheer for the Engineers in the traditional end of lunch inter-Company rivalry.

After lunch, the Master represented the Company in the 'Raising the Flag' ceremony in the Guildhall Yard to mark the national celebration of the UK's servicemen and women ahead of Armed Forces Day the following weekend.

Audrey Canning, Master

'Raising the Flag' ceremony in the Guildhall Yard

Election of the Lord Mayor 29 September 2022

On Michaelmas Day nine members of the Livery reconvened once more to elect the Lord Mayor, this time mercifully without either high Covid rates or train strikes. The procedure progressed as planned, enlivened with a 'stream of consciousness' from the Assistant Town Clerk on the vagaries of City traditions whilst the result of the Livery vote was considered by the Court of Alderman. Again a unique ceremony and well worth attending.

After the election, twelve members and their guests repaired to Saddlers' Hall for a splendid lunch hosted by the Prime Warden of the Saddlers' Company (our Landlord) and in the Company of our fellow Saddlers' House tenants, the Weavers Company.

Audrey Canning, Master

The Lord Mayor Elect, Alderman Nicholas Lyons (4th from right)

The Worshipful Company of Engineers Charitable Trust Awards 2022

The Engineers Trust

ARKWRIGHT SCHOLARSHIPS 2020-23

Jack Barton – The Marlborough CofE Comprehensive School, Woodstock, Oxfordshire.
Jessica Mead – The Thomas Hardye School, Dorchester, Dorset.
Bhavy Metakar - Westcliff High School for Boys Academy, Westcliff-on-Sea, Essex
Grace Turner - Kesteven and Grantham Girls' School, Grantham, Lincolnshire.

IET ENGINEERING HORIZONS BURSARIES

Rachel Akinyemi	Studying for a BEng in Aerospace Engineering at the University of Leicester.
Harry Burgess	Studying for an MEng (with Nuclear) degree apprenticeship with the Ministry of Defence (DE&S) Abbey Wood, the University of the West of England and Weston College.
Shakil Hussein	Studying for a BEng in Biomedical Engineering at Kings College, London
Alexander Jeffery	Studying for an MEng in Electronic and Computer Engineering at the University of Nottingham.
Ted Mellow	Studying for an MEng in Engineering Mathematics at the University of Bristol.
Jared Newnham	Undertaking an Engineering Degree Apprenticeship at the Ministry of Defence (DE&S) Abbey Wood and the University of the West of England.
Emily Wilson	Undertaking an Engineering Degree Apprenticeship in Aerospace Engineering at the Ministry of Defence (DE&S) Abbey Wood and the University of the West of England.

THE ROYAL ACADEMY OF ENGINEERING & ENGINEERS' TRUST YOUNG ENGINEERS OF THE YEAR *(£3000 prize)*

George Imafidon	A Performance Engineer with the Team X44 electric racing team
Dr Robert Hammond	Lecturer in Infection and Global Health at the University of St Andrews
Dr Fragkoulis Kanavaris	Arup's leading concrete materials speialist
Dr Matthew Marson	Global Market Sector Director at Arcadis
Dr Beatriz Mingo	Materials Engineer and Presidential Fellow at the University of Manchester

THE ROYAL ACADEMY OF ENGINEERING MACROBERT AWARD

Quanta Dialysis Technologies - ***(£50,000 Prize)***

John Milad	CEO
Professor Clive Buckberry, FREng	Chief Engineer and Technology Officer
Keith Heyes	Systems Engineering Director and Original Inventor
Mark Wallace	Lead Innovations Engineer
David Spurling	Lead Architect (Mechanical Engineering)
Maddy Warren	Strategic Dialysis Advisor and Community Engagement Consultant

THE STEPHENSON AWARD

Wg Cdr Gemma Lonsdale – (Medal & £1000 Prize)

THE HAWLEY AWARD

Dr Alalea Kia (medal and£5000 prize)

THE WATER ENGINEERING AWARD

Madeleine Crisp – (Medal)

THE MERCIA AWARD

Maria Roldan – (Medal and £1000 Bursary)

THE BARONESS PLATT OF WRITTLE AWARD

Alex Keeler – (Medal & £1000 Prize)

THE CADZOW SMITH AWARD

Beth Gwyer – (Medal & £2500 Prize)

ENGINEERING OUTREACH GRANT

2021 Grant (£5,000) - ***Just a Drop***

THE SERVICES' ENGINEERING UNDERGRADUATE AWARD

Abigail Hallett (Medal)

THE SERVICES' ENGINEERING POSTGRADUATE AWARD

Captain Adam Stephenson (Medal)

THE ROYAL NAVY ENGINEER OFFICER OF THE YEAR 2022

Lieutenant Commander Michael Harris RN (Medal)

THE ROYAL NAVY ENGINEER RATING OF THE YEAR 2022

Chief Petty Officer Jamie Dougal RN (Medal)

THE ARMY ENGINEER OFFICER OF THE YEAR 2022

Captain John Hastings RE (Medal)

THE ARMY ENGINEER SOLDIER OF THE YEAR 2022

Warrant Officer 1 (Artificer Sergeant Major) Ashley Crampton REME (Medal)

THE ROYAL AIR FORCE ENGINEER OFFICER OF THE YEAR 2022

Squadron Leader Laura Frowen RAF (Medal)

THE ROYAL AIR FORCE ENGINEERING TECHNICIAN OF THE YEAR 2022

Warrant Officer Ian Danks RAF (Medal)

THE DEFENCE EQUIPMENT & SUPPORT ENGINEER OF THE YEAR 2022

Dr Jody Wing Coote (Medal)

HMS PRINCE OF WALES AWARDS

THE VICE ADMIRAL WILDISH AWARD FOR ENGINEERING INNOVATION

Chief Petty Officer Engineering Technician (Marine Engineering) Ben Mills (Certificate and £200 prize)

THE COMMANDER MARINE ENGINEERING AWARD FOR OPERATIONAL ENGINEERING

Petty Officer Engineering Technician Hayley Garnett (Certificate and £100 prize)

HMS ANSON AWARD

Leading Engineering Technician (Marine Engineer Submariner) Cameron Dale (Certificate and £150 prize)

The Company YouTube Channel

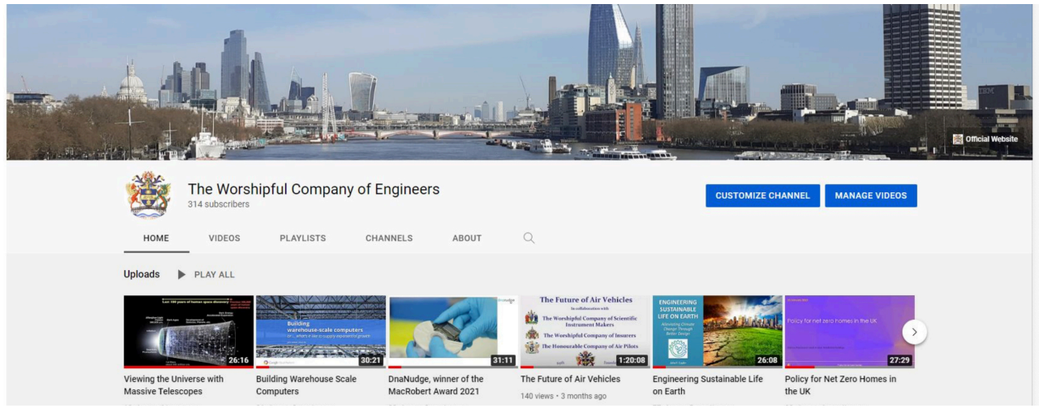
Early in lockdown, once we had a few Engineering Soirées under our belt, we began to use the Zoom facility to record them. I was also at the time rapidly acquiring new skills to be able to convert lectures into videos that could be used to provide back-up online teaching material for students. That was a huge boon in that first year of COVID-19 and, after a VERY busy summer converting lecture notes, formed part of the alternative package offered to our distance-learning students.

That new skill was put to use in converting the Zoom recordings to create a video that might be of interest to the wider engineering community, as well as publicising the Company through a new channel – the YouTube Channel.

The first video to be uploaded to the Channel was the Virtual Tour of Bombardier's Crossrail Depot. This was prepared by Bombardier, and once permissions were granted, it was uploaded in July 2020. The Channel now has 37 videos and 6 playlists of related material (typically videos already in YouTube that feature our members).

The first Soirée to be recorded, edited and uploaded was Professor David Bogle's talk on Engineering Ethics. Since August 2020 this has been viewed 293 times.

In 2020-21, all Soirées were delivered by members of the Company, the concept being to allow us to have personal enthusiasms and knowledge shared within the Company, encouraging member participation in these difficult times, and stimulating conversations with the presenters when next we dined together. It turned out to have some additional benefits.



YouTube also provides certain analytical statistics, including number of views, average duration of viewing (some viewers may not watch the entire video – that's the nature of publicly available material), and cumulative information on hours watched, subscribers, "impressions" (the number of times that the video links were visible to visitors to YouTube – automatically generated by topic relevance), returning viewers, gender and age distribution, and much else besides.

The ten most viewed channel videos, recognising some have been available longer than others, are shown below.

Collectively, the videos have had 39,060 views, 3,972 hours of watch time, 877,003 impressions and we have 314 subscribers. These statistics have not been generated by members alone!

Simon Watts' talk Radar Against the U-boats leads the field at the moment. This was a slow burn. It was uploaded in February 2021 and had a respectable, but not remarkable, 164 views in the first 300 days. But by Day 400, it had 24,067 views. The trigger appears to have been YouTube's protocols recognising the content as significant and relevant to browsers viewing videos on the history of radar, U-boats or the Battle of the Atlantic and the thumbnail then appearing on the browsers' screens. What's more, these were not short-duration views. The video was viewed solidly in this period, and generated many comments, to which Simon replied, and 169 new subscribers to the Channel. Viewers were mostly from the USA, Australia, New Zealand as well as the UK. It clearly tapped into a large community of enthusiasts worldwide.

Graham Owens' talk on the Thames Barrier and Gardner Crawley's on the Rother Valley Railway are both still generating a steady stream of views, appealing to communities interested in these topics.

As the Channel matures, we will have more videos, and more statistical data to analyse, and perhaps other videos may go, in our terms, as viral as Radar Against the U-Boats.

Meantime, please subscribe to the Channel (it's free!) and you will hear when new videos are added. We do not record the discussions after the Soirée presentations so while the experience is not as good as attending live, if you happen to miss an event, the initial talk will, subject to the permission of presenters, later appear online.

Personally, I am delighted that a significant secondary benefit has been created from what was initially intended to be just one of the ways of binding the Company together through lockdown.

Visit the Channel here: https://www.youtube.com/channel/UCqTjHzIT0UHndPUK5YAy34Q

Past Master Gordon Masterton

Title	Presenter	Number of Views
Radar Against the U-boats	Simon Watts	27,085
The Thames Barrier	Graham Owens	6,332
Rother Valley Railway	Gardner Crawley	1,269
Master's Christmas Message	Gordon Masterton	401
London Bridge	Richard Groome	376
City of London Engineering Hall of Fame	Gordon Masterton	347
The Ship That Never Was	David Bawtree	340
Engineering Ethics	David Bogle	293
Achieving Net-Zero	Tony Roulstone & panel	229
London's Lost Underground Stations	David Johnson	223

Company News

THE MASTER'S REPORT

It has been a very busy and unexpected few months so far. This was the first full year in which we had surfaced after Covid, and it was unclear how the plans would turn out.

Before I give the Company news, it is sad to report that this period has also been one of great sorrow for many in our Company. As I write this we have heard of the death of Her Majesty, Queen Elizabeth II. I have to also report on the passing of our Honorary Chaplain Peter Hartley, a former Master and founding member of our Company Sir Frank McWilliams, Assistant Emeritus Denis Filer and senior Livery Member Sir Robert Walmsley. I am also aware that many of you have seen personal loss or illness in recent months and my heartfelt sympathy is with you all.

Life as a new Master started well with my Installation Dinner and the excellent speech given by the Director General of Standards at the BSI, Scott Steedman. His talk is on our blog, but in essence he stressed the importance of the work in standardisation to facilitating Global Trade, a key priority for our country.

We held our Promoting Engineering in the City of London (PECL) evening in May on the Future of Air Vehicles, intended to bring to the attention of the City the challenges facing one of our country's leading industries responsible for much of our wealth creation and employment. I was particularly pleased that Alderman and Sheriff Alison Gowman managed to make time to join us, and indeed, our event has featured on her city website, as well as in a number of conference presentations. I must thank the other Companies, particularly Charles Holroyd, Master Scientific Instrument Maker, but also the Insurers and the Air Pilots, for their support of our event. It has also resulted in an invitation to be part of the City Green Aviation Initiative which I am attending on your behalf. If any other member of the Company would like to step forward for this initiative, I would warmly welcome your help.

Amongst the early highlights of my year was the visit to Superbloom which several of our members kindly supported through donations to the Engineer's Trust. This initiative will leave a lasting green space in the moat of the Tower of London, not only to bring pleasure to visitors, but also to aid insect pollinators, another of the City Livery green initiatives. The Engineers name is recorded on the Superbloom website and the exit board from the Tower as a contributor to the installation, side by side with several of the 'Great Twelve'.

The very unwelcome news at the start of June that, for personal reasons, our Gallant Clerk wished to submit his resignation has of course not only been a 'bombshell' to our operations, but also resulted in considerable effort in recruitment of a suitable successor. We have been very lucky that both Clerk David himself and our Assistant Clerk Sandra have helped us enormously in this endeavour, and I am very pleased that our chosen candidate is a member of our own Livery, Court Assistant Pete Gracey. But please don't think this was a simple choice – we had a number of very high quality candidates and the assessment process was rigorously and uniformly applied across the board.

As some of you will know I have also initiated a review of the Company's strategy, supported by the Office, the Wardens and representatives from the Past Masters and Court Assistants. Unfortunately, due to a number of additional demands that have yet to come to fruition, the review is proceeding more slowly than I would have wished, but I hope to report on a couple of highly positive outcomes at the Court in October (sadly after the copy date for this article).

My goal of taking the Company to the regions to engage with those who, for one reason or another, find it difficult to travel to the City has prospered, in the form of our visits to sites of Technical Heritage (aligned along the course of our Heritage walks, but also designed to allow access to key sites by car) and several informal regional lunches and dinners. I am pleased to report that the visits to the Isle of Wight (in

the South), Cardiff (in the West) and Birmingham (in the Midlands) were very well attended. We met and enjoyed fellowship with members who are not able to regularly make the trek up to London, as well as with several new members who were able to 'pick and choose' their particular interests to fit in with their work commitments. My thanks go to Companion Jane Forrest, Liveryman Windsor Coles and partner Sue and Junior Warden Penny and Consort John for the huge amount of effort they each put in to making these events a success, as well as to Senior Warden Raymond for his erudite lecture on the unique architecture of the Lapworth Link Canal. You can read of many of our visits as seen by members in this edition of the Swordsman, but for a personal 'take' please visit my blogs on our re-invigorated website.

Speaking of websites, I am delighted that our new website was released just before the Awards celebration in July. I think I can safely say it has been acclaimed as a huge improvement. Thanks are especially due to the Marketing Committee and in particular to Richard Gearing (in managing the last six months of the project), Simon Evans - who has been a stalwart of the technology throughout - and to Patrick Waterhouse, who continues to do a huge amount of work 'behind the scenes' to keep the site up to date. Separately, I would like to record my thanks to Past Master Gordon who has laboured tirelessly to edit the YouTube videos of our Zoom Soirees to a professional state, as well as to provide editorial assistance to my first ever 'blogs'.

As I write, I am preparing for a visit to the 'East' (the Master's Out of Town to Cambridge and the Fens), making last minute changes to address the guidance on National Mourning. The account of this visit will be found elsewhere in this copy of the Swordsman, including our visits to the Churchill Archives and the Corpus Christi Mediaeval Library, tours of four faculties within the Department of Engineering and the School of Physics, guided tours of the architecture of Ely, the 'quirks and curiosities' of university life and three different Museums, as well as a visit to an abandoned Abbey and to a working farm to 'get up close' with a plethora of autonomous tractors. We also enjoyed two excellent black tie College dinners, as well as a dinner 'Under the Wings of Concorde' in the Imperial War Museum. Beyond that, our next regional visit (with the nights closing in and the threat of a resurgence of Covid) to Glasgow is planned to be over Zoom. The final physical regional visit (to Cheshire in the North) remains to be enjoyed in the Spring.

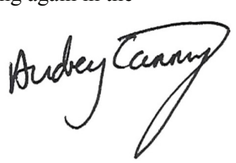
Amongst all this activity, I was delighted to attend the inaugural lecture of our Middle Warden on board HMS Belfast and I was pleased to see a good number of attendees to this thoughtful lecture, developing the theme of how to support innovation and its importance to the UK. As Master for this year I have been fortunate to have a second inaugural Warden's lecture in November from Junior Warden Penny, which will break new ground as a hybrid on-line and physical event.

The principal event for the Company and its Trust in the first quarter of the Master's Year is the Awards Evening. This year we held it in the spectacular environment of the Guildhall, using the Livery Hall for the Awards Ceremony and the Old Library for the Dinner. It was a proud moment to hear of the excellent achievements of our award winners and encouraging to see the comments in my LinkedIn post. I was particularly touched by a comment from the father of one of our Award winners in which he expressed how proud he was of his daughter, pointing her out in our 'team photo'. Judging by the letters I received from our Guests and Award sponsors, the event was both highly impressive and truly appreciated. Sheriff Elect Andrew Marsden, stepping in at very short notice when my guest speaker Warren East, Rolls Royce CEO succumbed to Covid, provided an inspirational talk on the importance of a deep pool of educated engineers to our economy and also of the importance of supporting education and apprenticeships in general. His talk can also be seen on our Company blog.

Finally, I am pleased that the three soirées held so far were well supported, proving a popular vehicle to keep in touch with distant members. Again I have received a number of comments on their high quality and exciting content. The final event, being followed by an impromptu 'wine and cheese' (how late 1970's!), allowed two students to 'interrogate' our members on their careers, which formed a very impressive set of 'thumbnail' talks. I am told the students went away enthused by where an engineering career could take them. My thanks to our members that were willing to share in this event.

The summer break is passed, although the work of the Office has continued as we prepare for the autumn, as well as supporting the City in this period of National Mourning. On this note, please understand that due to pressure of work in the Office in keeping so many 'balls in the air', I have decided that informal events (as opposed to events of our formal Livery year) will now be booked solely through volunteer members. Where I am the lead contact, this will be through the use of the Ticket Taylor website, and I would be very grateful if you would refer enquiries for these events just to John and me (emails and phone numbers below).

I wish all members of the Company, and especially those who have been affected by bereavement, sickness and ill health, a restorative and peaceful time, and look forward to meeting again in the Autumn.



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New Members of the Livery

We are delighted to welcome the following to the Livery:

Mr Jessal Murarji

I am an independent consulting engineer working in civil engineering asset management through my company, My Invention Ltd. I am an inventor with currently one patent granted. I recently resurrected the Military Engineering Experimental Establishment as a team of unpaid volunteer engineers and scientists ready to support Defence. I am also an unpaid volunteer for the Inland Waterways Association, and until 31 May the Army Reserve (in an unusual 'Group B' role).

I have previously had employee roles with the Rail Safety and Standards Board, Network Rail, Capita Symonds, Laing O'Rourke, Mott MacDonald, the TA and the Regular Army after compulsory mobilisation to serve in Afghanistan.

For Capita Symonds, I led the construction planning of Crossrail's Royal Oak Portal during the detailed design stage. I also worked on site on the Limerick Tunnel (immersed tube) during the completion, float out and immersion of the tunnel elements.

During my career I have been disheartened by the lack of ethnical decision making within our profession. Amongst members of the Worshipful Company of Engineers, I have found like-minded people who put their profession first, and I am honoured to have been accepted as a Liveryman.

Mr Anton Gangakumaran

Anton has more than thirty-seven years' experience in the London Construction Industry. His experience covers, design, construction, and client engineering. Responsible as designer or contractor for major projects, projects of national or international significance, whether by virtue of its strategic nature or use of innovative techniques.

With commercial responsibility for pricing and bidding, managing the profitability of work for both major projects or a significant portfolio of smaller works, and an experienced project manager committed to delivering the highest standards on safety, environmental issues, quality of service and product, Anton has extensive technical knowledge and experience gained in rail, civil and building projects both in the United Kingdom and Sri Lanka.

In the last 27 years, Anton has delivered projects in the highly regulated rail industry, including design delivery, engineering management of multidisciplinary teams and identify changing needs and drives for the project and ensure they are successfully delivered.

Outside work, Anton has been a board member of an inner London Housing association since 1995. He has helped the association to grow from a simple social landlord to developer and share ownership partner. Anton is a yoga teacher and the president to develop the organisation from a single centre in 2006 to multi centres to date. Anton is a traveller and foodie.

Eur Ing Colin Howell RD

I started my engineering career in 1984 on a modern apprenticeship with Marconi Space and Defence building communications satellites. On leaving, I was the Deputy Head of the Portsmouth Manufacturing Engineering Department.

During this period, I rose from Junior Radio Operator [RO2(T)] to Lieutenant Commander in the Royal Naval Reserve, and in 1999 I joined the RN on a Full Time Reserve Service contract, first as the Management Planner for the Naval Manning Agency, where I facilitated the introduction and implementation of their Performance Management and Business Improvement initiatives, followed in 2005 by a deployment to Bosnia, and then via the Defence School of Languages, where I spent 18 months learning Pashto, to Afghanistan.

I joined KBR (UK) in 2007 and until 2014 I was Manager of the Camp Bastion Water Bottling Plant, supervising its transformation from a patch of desert into an operational manufacturing facility and supplying over 72 million litres of bottled drinking water to the coalition forces in Southern Helmand.

In 2014, I became a Manufacturing Engineering Supervisor for Cobham Mission Systems, and in 2019 I set up an Aerospace Engineering Consultancy, joining Airbus Defence and Space as Materials and Process Engineer. I retired in January 2022. I own 1988 Ferrari and I am a member of the owners' club, I also enjoy railway modelling and have an extensive

Tri-ang/Hornby 00 gauge model railway with over 90 locomotives.

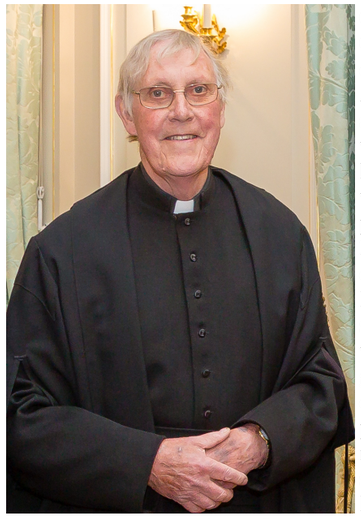
Mr Jonathan Rodgers

Jonathan is a graduate of Mechanical & Manufacturing Engineering from Queens University Belfast and has been a Chartered Engineer and Member of the UK Engineering Council since 2004. He is a Member of the Institution of Diesel & Gas Turbine Engineers since 2008 and has been a Fellow of the Institution of Mechanical Engineers since 2011. Jonathan has also been a Technical Committee member of AMPS (Association of Manufacturers and suppliers of Power Systems).

Jonathan's strong foundations within the energy sector originated through long standing roles with global leaders in the power generation industry, including big brands FG Wilson Engineering Limited and the Caterpillar Corporation. Jonathan relocated to London in 2011, joining the Progress Group, before becoming a founding partner and Managing Partner of his own London based company, RODEng Consulting LLP, in 2014. He has since successfully founded and managed two further engineering support services and manufacturing companies within the energy sector, namely NOxTech Ltd. and NOxProtekt Ltd. and he continues to run all three businesses, alongside a busy extracurricular calendar of family and fitness activities that included the likes of an Ironman competition in 2016.

Obituary

Reverend Peter Mellodew Hartley



Our Honorary Chaplain, Peter, died on the 16th August 2022, aged 80. Most will remember him for this role which he performed since 2011 overseeing our annual Livery and Carol services each year and saying grace at our dinners and prayers at our meetings. But to some of us, Peter occupied a bigger position in our lives. In my journey leading up to, during and following being Master Engineer, I came to rely upon Peter's wise counsel combined with his dry sense of humour through some challenging times. I got to know Peter differently, as a friend and mentor. I know others did too.

Peter graduated from Queen's College, Cambridge with a degree in Civil Engineering and where he met his wife, Fiona who is also well known to the Company. They had four children, fourteen grandchildren and currently one great grandchild – all of whom describe him as a dedicated family man. He was born in Buxton, where his father, Henry, was mayor and successfully fought for the preservation of the Manchester to Buxton railway line. This may have led to his lifelong passion for railways – preferably steam ones. Many members will remember the visit to the Bluebell railway, which he organised in 2016, and where he was then a signalling apprentice. His inquisitiveness and quest for learning continued throughout his life – he was, even at 80, still at university studying Australian Indigenous Culture and doing research on the Tissington and High Peak railways.

His politics were strong, not party driven, but wanting to make the world a better place. This included being a member of West Hoathly Parish Council and showing solidarity with the people of Ukraine.

Peter's involvement with the church extended beyond his chaplaincy of the Company. At his funeral service, it became clear that he also took on the role of 'Vicar's Vicar' to a significant number of the Clergy in his home area.

A man of deep faith, Peter will be remembered for his love of others, accepting of others, understanding of others and forgiving of others. As his niece wrote "a life well-lived and full of love, there are not many in this world who give more than they receive but Peter was one of them."

David Johnson

Obituary

Vice Admiral Sir Robert Walmsley KCB FREng FRSA FIET

Born Aberdeen 1 Feb 1941, died in Cape Cod, USA 4 August 2022

Walmsley won the competed appointment of Chief of Defence Procurement (CDP) in 1996 as the most outstanding candidate, better prepared and informed than any other. His even-handedness was such that it was a year before Secretary of State George Robertson realised that he had been an admiral.

Under Walmsley's leadership, the Challenger 2 main battle tank overcame initial failures and entered army service in 1998, and the last was delivered in 2002. Perhaps his greatest success was signing the US-UK MoU that gave Britain a 15% workshare of 3,000+ F35 strike fighters, supporting more than 25,000 UK jobs. Retiring in 2003, as the longest serving CDP, his brains and his experience were much in demand by industry.

Robert Walmsley was son of anatomist Professor Robert Walmsley and Dr Isabel Walmsley, a GP, and was educated at Fettes College. He was inspired to join the Navy (1958), and the submarine service after a day at sea in the submarine Sleuth. He read mechanical sciences at Queens' College, Cambridge where he coxed the winning 1962 Cambridge Crew, beating Oxford by five lengths.

After surface ship time (carrier Ark Royal 1962–63), he displayed his ingenuity and humour in the diesel-powered submarine Otus (1964–66) where he stopped others tweaking the controls of the prototype, aircraft-like, one-man-control of the hydroplanes and rudder, by fitting a master knob which he said would do everything the other controls did. Only he knew that it was not even connected!

In 1968, he read nuclear science at RN College, Greenwich, and joined nuclear-powered submarine Churchill, building at Barrow, as weapons engineer officer. After a post at MoD Bath, he joined Chatham's nuclear submarine refitting facility, and managed the successful refit of Courageous,1976-78 (where Past Master Barry Brooks first met him). His nuclear submarine experience was a firm foundation for his later career.

In 1981-83, Walmsley chaired the Naval Nuclear Technical Safety Panel. In 1985, he was selected to join Peter (now Lord) Levene, Chief of Defence Procurement, with whom he introduced much needed commercial reforms.

As rear admiral, he was ACDS (Communications, Command, Control and Information Systems) 1990-93, and, in 1993-94, Director General Submarines and Chief Naval Engineer Officer, followed by Controller of the Navy as vice admiral 1994-96, and CDP as a civil servant, 1996-2003.

Admiral Sir Robert inspecting a Royal Marine Guard

After the MOD, he served on the boards of British Energy, General Dynamics, several other trans-Atlantic companies and a bank, and was Chairman of the Board of the Major Projects Association.

Honours included: KCB in 1995, and, unusually for a naval officer, honorary colonel of a regiment, the 71st (City of London) Signals. Member of the Engineer Freedom in 1995 and Livery 1999.

Walmsley was a private, modest man, influenced by his Calvinistic background. His softly-spoken voice was usually accompanied by a glint in his eye, revealing that he probably already knew the answer to his questions.

Walmsley married Christina Melvill in 1967. They divorced 2009, and he married Alex Ashbourne in 2010. His daughter, Dame Emma Walmsley, is CEO of GSK, younger daughter, Victoria, is a leading adolescent mental health specialist, and son James is a barrister.

Original Obituary © Peter Hore, preçis by Barry Brooks

The Company has also been informed about the recent deaths of the following members:

Past Master Sir Francis (Frank) McWilliams GBE FREng on Tuesday 30th August at the age of 96. Sir Frank was a founding member of the Company (Livery No. 12) and Master 1990-91, he was subsequently Lord Mayor 1992-93. A fuller obituary will appear in the next issue.

Non-Active Member of the Freedom John Ryley FIChemE on 29 May 2022 at the age of 91. John joined the Freedom in May 2003 and advanced to the Livery the following July. Sadly, age and ill health prompted him to resign from the Livery in 2015.

Senior officers of the Company at the Installation Court. L-R: Junior Warden, Mrs Penny Taylor; Middle Warden Dr Dolores Byrne; Senior Warden Mr Raymond Joyce; Master Mrs Audrey Canning

Outgoing Clerk Colonel David Swann CBE

Election of the new Lord Mayor

Incoming Master Audrey Canning being clothed in the Master's gown and chain of office

Master Audrey and Consort John Canning

Photos: John Canning and John Williams