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ROYAL SOCIETY DISCUSSION ON THE REDEFINED KELVIN: PROGRESS AND PROSPECTS

Lord Kelvin was born in June 1824, and from 1846 was Professor of Natural Philosophy at the University of Glasgow for 53 years.

To mark the bicentenary of his birth a Royal Society discussion meeting was held in Glasgow 24–25 February 2025 on a topic that would surely have been close to his heart: "The redefined kelvin: progress and prospects". More than 70 world-leading experts in thermometry gathered to take part. The purpose of the meeting was to review the progress made in primary thermometry since the kelvin redefinition in 2019 and to discuss and identify research priorities for the field in the next 5–10 years. The meeting had four technical sessions: "State of the art primary thermometry", "New approaches to temperature traceability", "Quantum and photonic based thermometry" and "Practical impact on users of direct traceability to the kelvin". There was also a poster session, where 20 posters were presented. Very lively debate ensued after each poster, late into the evening. A record of the meeting will appear in a special edition of Philosophical Transactions of the Royal Society, to be published later in 2025. The meeting was organised and led by Professor Graham Machin from NPL, ably assisted by co-organisers Dr Dolores del Campo (CEM, President of the CCT), Dr Christof Gaiser (PTB), Professor Roberto Gavioso (INRiM) and Dr Patrick Rourke (NRC).

Acknowledgements: This work was part funded by the Royal Society (London) and the project Dissemination of the redefined kelvin (DireK-T, 22IEM02), which has received funding from the European Partnership on Metrology, co-financed by the European Union's Horizon Europe research and innovation programme and the participating states. Funded by the European Union.

Professor Graham Machin
Fellow, National Physical Laboratory

Prof Graham Machin opening the meeting

CCT President (Dolores del Campo) leads discussion of paper on "Full range traceability using primary thermometry" by French colleagues Mohamed Sadli and Laurent Pitre (pictured)

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BY PETER NORMAN, MINSTMC, MIET

THE F24 CAMERA SYSTEM FOR UK AERIAL PHOTO RECONNAISSANCE

This year marks the 100th anniversary of the F24 camera system, used for aerial reconnaissance by the RAF up to and throughout World War Two.

Designed in detail and made by Williamson Manufacturing Company in London, the F24 camera's main components are a body with roller blind, a cloth focal plane shutter, a gearbox, a film magazine, and a lens cone. Image film format is 5"×5", on 5" wide roll film, with magazine capacity up to 250 exposures. The shutter speed is preset between 1/100s and 1/1000s.

During World War Two, the F24 was also manufactured by W.Vinten Ltd. (cinematic engineers), in Wardour Street, in London. The RAF saw value in a new era of aerial photography to help it prepare for the challenges of the impending world war, and the F24 became a vital high-altitude camera. It could be mounted in the wings of a Spitfire for low-level, vertical imagery and in the rear fuselage for vertical and oblique imagery. A single oblique camera pointed out of a fuselage porthole, angled at 13° below the horizontal line. Two vertical cameras were set up to point outwards by 8° either side of the vertical, which allowed stereo pairs of photos to be taken by simultaneous image shooting. When printed on the same sheet of photographic paper, photo pairs could be visualised as 3D images using a simple stereoscope magnifying lens device for better interpretation.

The RAF's experimental photo reconnaissance unit (from 1939)

On 22 September 1939, a clandestine photographic unit – the 'Heston Flight' – was absorbed into the RAF and based at Heston Aerodrome. Its persuasive civilian head, F. Sidney Cotton, OBE, was enlisted as Squadron Leader, having pioneered aerial surveillance over Germany using concealed cameras in his private Lockheed 12A Electra civil aircraft during pre-war business flights, and having been contracted by MI6 to monitor German military build-ups. Such a photographic intelligence method was therefore proven, but the new concept was to deploy cameras in high-speed British military aircraft such as the Spitfire. The initial camouflage colour trial was Mountbatten Pink, which was intended to be less visible at dawn and dusk and more visible in daylight. By 1940, the aircraft were painted in No. 1 Sky Blue from the BS 381C:1931 standard colour chart revised from the very first BS 381:1930 for ready-mixed paint colours.

Eventually establishing itself as the Photo Reconnaissance Unit (PRU) under the command of RAF Wing Commander G.W. Tuttle, the unit became a vital supplier of photographic evidence providing intelligence on enemy capabilities and potential targets.

The PRU also used Wick airfield in Caithness as a base for operations over Norway and northern Germany from 1940 to 1942. Many training flights took place over Scotland for both PRU pilots and photographic interpreters. Formed from the merger of two flights of the PRU, No. 540 Squadron was equipped with the longer-ranged de Havilland DH98 Mosquito and operated from Leuchars, Fife, from 19 October 1942. No. 8 OTU was formed in May 1942 and was based initially at Fraserburgh, then at Dyce near Aberdeen.

A Spitfire of No. 1 PRU located and photographed the Würzburg radar station at Bruneval in December 1941 ahead of a British commando raid operation, which gave the Allies significant intelligence on the German radar capability by capturing equipment.

PRU Spitfires also flew many missions, from early 1942, to the Trondheim Fjord region of Norway to keep watch on movements of the KMS Tirpitz for the British Admiralty.

A PRU Mosquito of No. 540 Squadron discovered the terror V-weapons site at Peenemünde, Holland, on the Baltic coast, in November 1943.

Planning for the Allied invasion in Normandy depended on aerial photography of the coast to identify the defences and suitable troop landing sites.

The PRU's fast and long-range Spitfires and Mosquitos

Some early PRU aircraft were modified combat Spitfires, which could be mechanically converted in utmost secrecy at local automobile garages such as Vincent's Garage in Station Square, Reading – ideal for fitting Rolls Royce engines. Many workers were women working long shifts. Such aircraft were stripped of their weapons, armour and radios, particularly since the cameras were loaded into the fuselage port just behind the cockpit, where the radio equipment sat just below the antenna cable mast.

Many improved PR versions were developed, not least because Spitfire fighters underwent continuous type improvements for extra speed. Special wings accommodating sealed fuel tanks in the leading edges came later but had to be factory made and shipped to the distributed assembly workshops. Flight range could then be extended to the order of 2,000 miles, but extra oil reservoirs also had to be accommodated.

The fast Spitfire aircraft type often attracted men from the 1930s racing fraternities to volunteer and train as RAF pilots for performing the solo, non-combat missions, which presented obvious danger if they were detected over enemy territory. The pilots relied on speed and high altitude for survival, as well as good lone navigation skills, with compass and stopwatch, over foreign shores and when returning home over UK territory.

The fast DH98 Mosquito fighter-bomber naturally had size advantage over the Spitfire for carrying more fuel, larger cameras for higher altitude photography, and a two-man crew for sharing operational responsibilities.

Medmenham CIU/ACIU

In April 1941, the Photographic Interpretation Unit (PIU) was renamed the Central Interpretation Unit (CIU) and moved from Wembley to Danesfield House in Medmenham, Bucks. The unit expanded during 1942 and 1943 and was involved in exploiting imagery taken across Europe, to assist in the planning of wartime operations.

Image: IWM (CH 10853) *A ground crew sergeant demonstrates the operation of the photo-reconnaissance camera in a De Havilland Mosquito of No. 540 Squadron RAF at Benson, Oxfordshire, using the Type 35 remote control box in the navigator's position in the nose of the aircraft.*

Image: IWM (CH 1247) *A trainee air observer points a Type F.24 aerial camera at the PRU photographer. When operated by hand, the Type 21 mounting with hand grips and an eye piece was fitted, as seen here.*

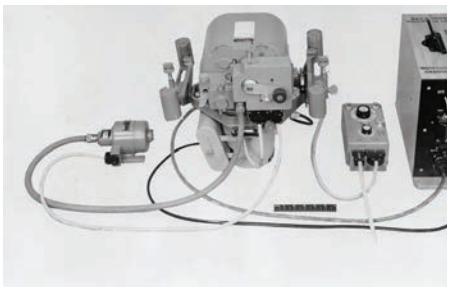


Image: IWM (CH 6300) *A Type F.24 aerial camera Mark I, for night photography. Attached to the lens cone, on the left hand side, is a photo-electric cell, valve amplifier and relay mechanism. To the right is a 24V.DC type 35 camera remote control unit.*

Image: IWM (CH 18399) *Instrument workers line up aerial cameras at Benson, Oxfordshire, before installing them in a De Havilland Mosquito PR Mark IX: (left to right) two Type F.24 (14-inch lens) vertical cameras, one F.24 (14-inch lens) oblique camera, two Type F.52 (36-inch lens) 'split pair' vertical cameras.*

Once the workforce had grown from 231 to more than 1,700, even the expansive Danesfield House had become too small. External huts like those used at Bletchley Park were soon constructed in the grounds to house many of the CIU sections. In the build-up to D-Day and beyond, almost 1,500 intelligence reports and 600,000 prints were being produced every month. This industrial-scale production was made possible by the organisation of Medmenham into 20 photographic intelligence sections with 15 intelligence support sections. Medmenham's photographic interpreters (PIs) worked with basic stereoscopes which presented the offset image pairs separately to the viewer's left and right eye. The human brain would unconsciously combine these to give the illusion of three-dimensional depth. This allowed PIs to extract more detail from the images than was possible with a single two-dimensional photograph.

The involvement of US personnel from 1942 was recognised in 1944 when the title of the CIU was changed to the Allied Central Interpretation Unit (ACIU).

Today

Sandy's Spitfire AA810 project is restoring a 1941-built Mk.1 PRU Spitfire, having recovered some of its 1942 wreckage from a Norwegian peatbog during 2018. F24 camera equipment is being restored by a small team of engineering apprentices at Thales Optronics in Glasgow, who became owners of Vinten Ltd. in 1988. There are three F24 cameras with 1x 8" lens for the oblique F24, plus, 2x 14" lenses for the twin vertical F24s.

BY LIZ NEIMAN,
MANAGING DIRECTOR OF STRATEGIC ENGAGEMENT, INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

STANDARDS AND COLLABORATION IN THE OT CYBERSECURITY COMMUNITY

From power grids and water treatment facilities to manufacturing plants and transportation networks, the systems that support our daily lives are increasingly vulnerable to sophisticated cyber threats.

The convergence of operational technology (OT) with information technology (IT) has allowed for massive gains in efficiency and innovation, but it also introduces new risks to critical assets.

Cybercriminals find more opportunities every day to exploit vulnerabilities in supply chains, remote access points and legacy systems. The stakes have never been higher, and the OT cybersecurity community must work together and share knowledge to safeguard critical infrastructure worldwide.

The Evolution of Industrial Control Systems

Historically, OT systems operated in isolation, using proprietary protocols and air-gapped networks that provided a degree of "security through obscurity". The drive towards digital transformation, however, has led to widespread IT/OT convergence, as previously isolated control systems connect to enterprise networks and, in many cases, to the internet.

This connectivity brings valuable benefits: real-time monitoring, remote access, predictive maintenance and data-driven optimisation. Yet it also exposes critical infrastructure to many threats that have long plagued IT systems – malware, ransomware and targeted attacks from both criminal organisations and nation-state actors.

The High Stakes of OT Security Breaches

When cybersecurity incidents affect operational technology, the consequences extend far beyond financial losses or data breaches. They can disrupt essential functions, damage expensive equipment, halt production, compromise safety systems and even threaten human lives. Recent years have seen numerous high-profile incidents targeting industrial control systems, including the 2015 and 2016 attacks on Ukraine's power grid, which left hundreds of thousands without electricity, and the 2017 Triton malware attack on a petrochemical facility's safety systems. These incidents show the importance of building a robust OT cybersecurity programme.

ISA/IEC 62443: The Global Standard for Industrial Automation Security

At the forefront of efforts to secure industrial control systems is the ISA/IEC 62443 series of standards. This comprehensive framework addresses security for industrial automation and control systems across industrial sectors.

The ISA/IEC 62443 standards provide a framework for securing industrial control systems, defining best practices for security and providing a way to assess the level of security performance. They offer a risk-based approach that allows stakeholder groups – including asset owners (end users), automation product suppliers, integrators and service suppliers – to implement security measures appropriate to their specific operational requirements and threat landscape.

ISASecure®: Certification for Industrial Automation and Control Systems

Complementing the ISA/IEC 62443 standards is the ISASecure® certification programme, which provides independent verification that industrial automation and control products conform to industry-recognised cybersecurity standards. ISASecure's certifications help product suppliers demonstrate their commitment to cybersecurity while giving end users confidence in the security of the products they implement. By measuring conformance with the ISA/IEC 62443 standards, which have proven to be complementary with many international frameworks, ISASecure drives security improvements across the industrial automation supply chain.

The ISA OT Cybersecurity Summit: Driving Industry Collaboration

Effective cybersecurity programmes rely on knowledge sharing and cross-industry collaboration. The International Society of Automation (ISA) OT Cybersecurity Summit brings together OT cybersecurity professionals from multiple critical sectors to discuss emerging threats and share best practices.

This annual event – to be held this year in Brussels 18–21 June 2025 – features presentations from leading experts, panel discussions, technical workshops and networking opportunities along two tracks: threat intelligence, and securing the supply chain. By participating in these cross-industry conversations, attendees can help advance the state of OT cybersecurity practice.

The ISA Global Cybersecurity Alliance: Uniting for Common Defence

Recognising that cybersecurity is a shared responsibility, ISA established the ISA Global Cybersecurity Alliance (ISAGCA) to bring together companies, organisations and individuals committed to securing industrial automation and control systems. This open, collaborative community works to ensure the security and safety of OT environments, expand awareness and education and advocate for the adoption of standards-based approaches. Through these efforts, ISAGCA helps build a more resilient industrial ecosystem that can withstand increasingly sophisticated cyber threats.

ICS4ICS: Protecting Critical Infrastructure Together

Incident Command System for Industrial Control Systems (ICS4ICS) represents an innovative approach to collaborative defence in the industrial sector. This programme – launched by ISAGCA – operates as a community-powered incident response initiative specifically designed for industrial control system environments.

ICS4ICS brings together expertise, resources and intelligence from across the industrial automation community to:

- Improve cyber incident response capabilities by leveraging the US Federal Emergency Management Agency (FEMA)'s Incident Command System to provide a management layer that allows technical staff to be more effective
- Expedite the deployment of technical, management and other processes needed to prepare for and perform work during an incident by leveraging templates
- Enable staff to obtain training and ICS4ICS credentials to prepare them to perform their duties during an incident
- Provide cyber incident response ICS4ICS industry- and sector specific exercise materials that allow participants to practise and demonstrate their skills to fill roles.

By pooling knowledge and resources, ICS4ICS helps ensure that even organisations with limited internal cybersecurity capabilities can benefit from the collective expertise of the broader community when responding to incidents.

Looking Ahead: The Future of OT Cybersecurity

As industrial systems become more connected, intelligent and autonomous, the cybersecurity challenges facing operational technology will only grow more complex. The rise of Industry 4.0 technologies – including industrial IoT devices, edge computing, artificial intelligence and digital twins – introduces new attack surfaces and vulnerabilities that must be addressed.

Meeting these challenges will require continued evolution of standards such as ISA/IEC 62443, expanded collaboration through initiatives such as ISAGCA and ICS4ICS and increased investment in both technology solutions and human expertise. Organisations must view cybersecurity not as a one-time project but as an ongoing programme that adapts to changing threats and evolving operational requirements.

As we continue to integrate digital technologies into our physical world, securing the systems that control our critical infrastructure isn't just good business practice – it's essential to maintaining the safety, reliability and integrity of the services that underpin modern society. We must work together, and the time to act is now.

Q&A

Nicholas Houghton

Nicholas Houghton, Principal Engineer & Group Leader, UK Atomic Energy Authority and new InstMC Standards SIG Chair, shares his thoughts on the future of engineering and how hands-on learning can help tackle real-world challenges.

What was the root of your interest in Engineering?

My interest in engineering began in my childhood. One of my earliest memories is helping my granddad rewire his house, as I was small enough to crawl under the floorboards to run the wires. I didn't fully understand how electrical systems worked, but I was fascinated by the idea of connecting wires and solving practical problems. It amazed me how something as simple as a switch could control lights, and I loved the challenge of figuring out how to make everything work. At home, I'd often take apart devices just to see how they functioned, although I could never manage to put them back together!

When I turned 12, I received my first computer, a ZX Spectrum 128. I remember how excited I was to set it up and explore its features, learning how hardware and software worked together. It wasn't just about playing games – though I have fond memories of playing Manic Miner – it was about understanding the technology behind it all. I spent countless hours with the computer, eager to learn everything I could and write programs.

These early experiences, from rewiring a house to exploring my first computer, laid the groundwork for my passion for engineering. They taught me to approach challenges with curiosity and determination, and to appreciate design, systems and technology. From that point on, I was completely hooked, realising that engineering was the perfect field to combine my love for problem-solving. When I started college and an apprenticeship scheme, I tried disciplines including welding, machining and electrical work. However, the activity I enjoyed the most was the control system exercise during the electrical module. In my second year as an apprentice at a company that specialised in food processing automation, I discovered PLCs on my first day, and knew right then that this was the path for me.

What is your vision of Engineering in Britain for the next ten years?

In the next decade, I envision engineering in Britain focusing on developing and nurturing the essential skills for our country's growth. With technology advancing at an unprecedented pace and significant investments in net zero and AI data centres, we need a skilled workforce that can drive innovation and maintain Britain's competitiveness on the global stage. The future of our engineering sector heavily relies on building talent through improved education, apprenticeships and hands-on training opportunities.

To achieve this, we should invest in STEM education at all levels, from primary school to university. Students need the skills to thrive in fields such as robotics, renewable energy, artificial intelligence and advanced infrastructure. By strengthening the connections between schools and industries, we can bridge the gap between theory and real-world application and ease the transition for young engineers into the workforce.

We also need to place greater emphasis on apprenticeships and vocational training programmes that highlight and uplift skilled trades. Recognising these pathways will help us build a self-sufficient workforce capable of addressing both current and future engineering challenges, ensuring we maximise our talent.

By fostering a culture of innovation and supporting the development of expertise, Britain can position itself as a leader in engineering advancements. Ultimately, focusing on skill development will create a sustainable and forward-thinking engineering sector, paving the way for Britain's success and prosperity in the years to come.

What should the UK government do to address the shortage of UK engineers?

The UK government needs to take decisive action by investing in more apprenticeships and practical skills programmes. With industries nationwide facing an increasing demand for engineering talent, relying solely on university graduates is no longer sufficient. Practical, hands-on experience is essential for developing a workforce capable of managing modern engineering challenges, such as infrastructure development, and new technologies such as AI and renewable energy.

To begin addressing this issue, the government should launch educational initiatives in schools, introduce new programmes for primary and secondary students, and expand apprenticeship opportunities. This approach will allow young people to gain valuable on-the-job training while earning qualifications.

Apprenticeships offer a more accessible pathway into the profession, particularly for those unable to pursue traditional higher education routes. Additionally, degree apprenticeships blend practical skills with academic knowledge. By focusing on hands-on learning, we can prepare engineers for real-world challenges in their fields.

It's crucial to strengthen partnerships between businesses, schools and universities so that apprenticeships align with industry needs and young people are equipped with relevant skills.

What do you do in your free time to relax?

Most Saturdays, you can find me at City Airport Manchester, where I've been continuing my Private Pilot's Licence training since returning to the UK. On Sundays, I eagerly await the start of the Formula 1 race.

During the week, after a day of working on control systems, I find that writing software is the best way to unwind. I have always loved computer game development because it allows me to be creative and enhance my problem-solving skills. I enjoy generating gameplay ideas, crafting engaging stories, and picking up new programming techniques. Watching a concept evolve into something playable is both challenging and fulfilling. I'm currently working on my next big app, so there's still time to develop it!

Recently, I went on a diving trip to Cyprus with my son, which was a fantastic experience, especially diving the Zenobia wreck. We're already planning our next dive for the summer! Exploring wrecks makes diving an exciting way to relax and create amazing memories. Sharing these moments with my son makes it even more special and reminds me of the importance of spending quality time with loved ones, especially since my job requires me to travel weekly from my home in Manchester to the office in Oxford.

Given one wish what would that be?

I have so many ideas, but I need to pick just one. I wish there was more outreach and support for apprentices. Attending university at 16 isn't feasible for everyone, but that doesn't mean you can't progress in your career. During a talk at the UK Atomic Energy Authority (UKAEA), I shared my journey from technician to engineer. Pursuing a degree at 16 wasn't possible for me. However, later in life, while working full-time abroad and during the startup of an oil and gas processing facility in Kazakhstan, I completed my master's degree and achieved my chartered status. I want to emphasise that there are opportunities for everyone who seeks them. It requires hard work, but it's worth it. Even at this stage in my career, I am continuously learning.

I have just taken up the role as the Chair of the Standards SIG, so standards are a large part of my working life. I want to see standards have a greater role in the training curriculum. I have a team of four apprentices and five graduates in my project (LIBRTI Programme), and I have made it a point to include standards as part of their learning goals.

And one final wish: no traffic jams on the M6!

BY PAUL QUINCEY,
RETIRED PRINCIPAL RESEARCH SCIENTIST,
NATIONAL PHYSICAL LABORATORY (NPL)

JOHN HARRISON'S CLOCKS, TOBIAS MAYER'S TABLES, AND NAVIGATING AT SEA

The problem of finding your longitude while at sea had become hugely important at the start of the 18th century. The path to a solution would be long and complicated; it is well described and illustrated in the book Ships, Clocks, and Stars by Richard Dunn and Rebekah Higgitt.

One key event was the loss of at least 1,600 lives when four British naval ships were shipwrecked near the Isles of Scilly on 22 October 1707, which stimulated the government to pass the Longitude Act in 1714 and offer a large reward for a workable solution. This followed earlier reward schemes offered by maritime powers such as Spain and the States of Holland.

It was well understood at the time that several methods should work in principle. As Isaac Newton put it in 1714: "One is by a Watch to keep Time exactly… Another is by the Eclipses of Jupiter's Satellites… A third is by the place of the Moon."

The marine chronometer

The 'watch' route was the nearest one to a purely metrological problem, the challenge being to design and make a time-measuring device that stayed accurate to within around 5 seconds in 10 weeks on a moving ship. Pendulum clocks – a relatively recent innovation by Christiaan Huygens in 1656 – were accurate enough on land but did not work well on a moving ship. Their accuracy on land was significantly improved in around 1721 by George Graham, who used a flask of mercury as the pendulum's bob in a way that meant its length stayed constant as the temperature changed. In 1726, John Harrison, a trained carpenter, ingeniously constructed an all-solid version – a 'gridiron' pendulum – from steel and brass.

Harrison was an extraordinarily skilful clock and watch maker, who tried many ideas over the following decades with the aim of claiming the reward. His first marine chronometer, completed in 1759 and known as H4, could be described as the earliest instrument of complex scientific metrology. When George Graham made the zenith sector instrument used by James Bradley to measure angles to within one arc-second in 1725, the craftsmanship was exceptional but the technical issues were relatively simple. In contrast, Harrison needed to address many factors affecting his chronometer's accuracy – temperature, the effect of a ship's motion, friction, and how torque changes as a spring uncoils – using ingenuity and craftsmanship of many kinds. H4 was tested on a voyage to the West Indies in 1764 and performed very well.

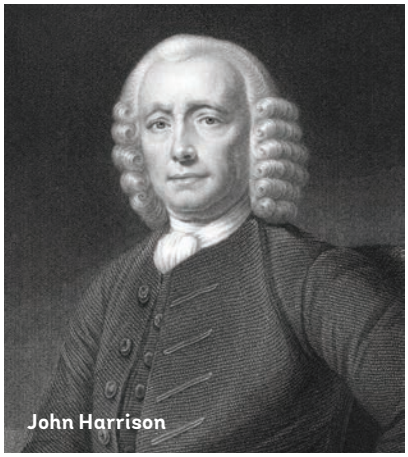
Lunar distance

Using the position of the moon against the stars as a 'clock' that gives the time independent of your location seems an obvious and easier solution. Indeed, the lunar idea had first been published by Johann Werner in 1514. But there were two major problems: measuring angles between the Moon and selected bright stars with an accuracy better than 30 arc-seconds (about a hundredth of a degree) while on a moving ship, and being able to predict the position of the Moon against the stars with a similar accuracy to convert the measured angles into time.

The first problem was a metrological one, with a reasonably simple solution in the form of an octant or sextant (as pictured). Octants measure angles up to 90°, using an ingenious system of mirrors, where the Moon and the star are viewed at the same time and a mirror is moved until they appear to touch. The invention of the octant is credited to both John Hadley and Thomas Godfrey, in around 1730. Sextants can measure angles up to 120°, the larger range making more stars available for the lunar distance method. The first marine sextant was made in London by the instrument maker John Bird in 1758.

Perhaps surprisingly, predicting the Moon's position was much more difficult, even though the Moon had been carefully observed for centuries, and the underlying theory of its motion had been provided in Newton's Principia in 1687.

Unlike the orbit of Mars around the Sun – which Kepler had unravelled in 1609 – where the effect of other planets is negligible, the Moon's elliptical path around the Earth is continually modified by the gravitational pull of the Sun. The axis of the ellipse steadily moves, and its eccentricity (the narrowness of the shape) also changes in a periodic fashion, resulting in a complicated pattern that repeats roughly every 18.6 years. It is no wonder Newton



John Harrison

said this was the only mathematical problem that made his head ache. Edmond Halley dedicated his later years to making precise observations of the Moon from the Greenwich observatory for a complete lunar cycle between 1720 and 1739.

Newton made progress with the problem in the 1690s, but the job of devising a workable technique for computing the Moon's position at specific times, many months ahead, was accomplished by the self-taught German mathematician Tobias Mayer, with crucial help from the eminent Swiss mathematician Leonhard Euler. In 1755, Mayer sent tables predicting the Moon's position to the British government. James Bradley, the then Astronomer Royal, compared these to observations from Greenwich and found them good to within 75 arc-seconds (about a fiftieth of a degree). The accuracy of his tables would soon increase.

Mayer died in 1762, the year before his method was successfully tested on a voyage to Barbados. Annual Nautical Almanacs containing tables calculated using Mayer's method were compiled by a team supervised by the then Astronomer Royal Nevil Maskelyne, and published by the British government from 1767, priced at 2s 6d.

And so, remarkably, around 50 years after the Longitude Act, two quite different solutions to the problem were established. Harrison's clock was the simplest to use, but his method could not be called practical until watches of similar accuracy could be made in large numbers. This was not possible until his design was refined by people such as Thomas Earnshaw. The watch method was therefore not widely used before 1800 and only became the dominant method from around 1840. Even then, it was common to have three chronometers on a ship to avoid relying on one instrument.

The 'lunar distance' method required laborious calculations, even when using published tables, but sextants and the tables were readily available from 1767. Both methods relied on improved accuracy of measurements made on board ships, for time and angle respectively. To their credit, in 1765, Parliament gave a reward of £20,000 to Harrison – some of it delayed until he had demonstrated how his watch could be replicated – while £3,000 was given to Mayer's heirs, and £300 to Euler.

Paul is the author of the blog 'Some Historical Highlights of Scientific Metrology'. To read his articles or get in touch with him, visit https://metrologicalhindsight.wordpress.com

Awards Night

2025

Thursday 3rd July

Join us for InstMC Awards Night, an annual event where prestige awards are presented to individuals for their outstanding contribution and services to the Institute.

• Registration	6.30pm
• Introduction & Welcome: InstMC President, Sheila Smith	7.00pm
• Guest Lecture	7.05pm
• Presentation of Awards - Sheila Smith & Ken Grattan	7.30pm
• Wine & Canapé Reception	8.00pm
• Evening Close	9.00pm

The Royal Institution, 21 Albemarle Street,
London, W1S 4BS

This event is free to attend. Please book your place(s) at www.instmc.org/events

ACCELERATING PR24 GOALS WITH CLAMP-ON ULTRASONIC FLOW MEASUREMENT

Innovation Takes On PR24/ AMP8 Challenges

Ofwat has approved a landmark £104bn investment plan to accelerate the delivery of cleaner rivers and seas, while securing long-term drinking water supplies for customers during the 2024 price review/asset management plan period 2025–2030. As UK water companies gear up for this transformative phase, the focus is clear: improve efficiency, enhance sustainability, and meet stringent environmental goals. These ambitious expectations demand cutting-edge solutions to manage water resources effectively, and clamp-on ultrasonic flow measurement is emerging as a vital tool in achieving these targets. Its versatility, accuracy and non-intrusive nature align seamlessly with the objectives of this critical investment phase.

Enhancing Network Efficiency

Accurate flow measurement is central to reducing leakage and optimising water distribution systems. Clamp-on ultrasonic flow meters provide precise, real-time flow data without costly pipe modifications or shutdowns. This capability enables water companies to monitor flow rates at critical points, quickly detect anomalies, and address inefficiencies. With leakage reduction a key PR24 priority, this technology directly supports network performance improvement and water conservation.

Supporting Sustainability Goals

The environmental focus of PR24 includes reducing carbon emissions and improving wastewater treatment efficiency. Clamp-on ultrasonic flow meters contribute by minimising the need for invasive installations, reducing the carbon footprint of operations. In wastewater applications, these meters enable accurate monitoring of inflows and outflows, optimising treatment processes and ensuring compliance with environmental standards. Their long-term reliability also reduces maintenance requirements, further cutting emissions associated with frequent servicing.

Cost-Effective Asset Management

Because clamp-on technology is non-intrusive, and can be retrofitted to existing infrastructure without disruption, this makes it an attractive and flexible solution for asset management, aligning with PR24's emphasis on cost-effectiveness and resilience. Water companies can deploy these meters across diverse applications, from monitoring abstraction volumes to ensuring compliance with abstraction licences.

A Smart Investment for the Future

As the UK water industry embarks on the PR24/AMP8 journey, clamp-on ultrasonic flow measurement offers a pathway to greater efficiency, sustainability and regulatory compliance. By leveraging this innovative technology, water companies can not only meet Ofwat's ambitious goals but also build a more resilient and environmentally responsible future.

To find out more about the real-world benefits of clamp-on ultrasonic flow measurement in the water industry – for permanent mains-powered installation, or battery-powered rental meters available from one week to long term – contact Andy Hammond: www.emerson.com | flexim-uk@emerson.com | +44 (0)1606 781 420

Flexim Instruments UK is an InstMC Companion Company Scheme member.

INSTMC 2025 AWARD WINNERS

Join us on Thursday 3 July 2025 at the Royal Institution in London for InstMC 2025 Awards Night, to honour our award winners.

The event is free to attend, but please book your place as spaces are limited. Visit https://www.instmc.org/events for details.

We are delighted to present to you the recipients of the InstMC 2025 Awards:

Sir Harold Hartley Award

For outstanding contribution to the technology of measurement and control

Winner: Professor Gilberto Brambilla

Professor Gilberto Brambilla holds a Chair as Professor of Photonics at the University of Southampton and is the recipient of the Sir Harold Hartley Award for his outstanding contribution to the technology of measurement and control through his work in photonics. His extensive experience includes leadership roles in prominent research centres and a strong focus on developing innovative optical fibre sensors and devices.

Gilberto has been responsible for research into optically based platforms in the Future Photonics Hub in the ORC at Southampton. His expertise is in smart lasers and special fibres, optical fibre sensors and devices, and distributed optical fibre sensing and he has led many well-funded research projects in the field. His research interests include material structuring using femtosecond lasers; manufacture of UV fibre lasers; fabrication of devices based on optical fibre nanowires, fibre tapers and couplers; manufacture of silica nanowires for high-strength applications; design and fabrication of rare-earth doped scintillating fibres; fabrication of delivery fibres and systems; and design of special fibres and fibre combiners for the preservation of high brightness in fibre-diode coupled high-power fibre lasers.

Gilberto has published more than 300 papers in international scientific journals and conferences, authored four patents and given more than 30 invited talks over five continents. He has a Google Scholar h-index of 57, reflecting how well cited his work is.

Callendar Award

For outstanding contribution to the art of instruments or measurement

Winner: Professor Stuart Robson

Professor Stuart Robson from University College London is nominated for the Callendar Award for his significant contribution to photogrammetry and measurement instrumentation, particularly in the aerospace industry. He currently holds a Royal Academy of Engineering Research Chair in Photogrammetry and Laser Scanning.

Stuart has developed advanced measurement methods and instrumentation that enhance the manufacturing accuracy of aerostructures – exemplified by his collaboration with Airbus – by ensuring aircraft wings fit perfectly without modifications. With the use of low-cost cameras, such as those in mobile phones, the economics

can be made to check the engineered products match their design at every stage of manufacture. The result is to achieve greater knowledge of what is being manufactured and in turn improve processes to make better use of materials, minimise waste and ultimately produce better designs that are more energy efficient.

Beyond his research, Stuart actively engages with the public through educational initiatives, such as his hosting of In2scienceUK school visits and The American School in London visits, connecting activities in robotics, digital fabrication and metrology. His contributions not only advance academic knowledge but also foster connections between education and industry. Stuart's laboratory appeared in the press as the location for Keir Starmer's 2023 New Year speech, where the then Leader of the Opposition stressed the importance of digitalisation in manufacture.

Oxburgh Award

Awarded to any person whose contribution to measurement, instrumentation and control in the field of environmental science and engineering is of outstanding merit

Winner: Professor Jim Lynch OBE

Professor Jim Lynch has had a distinguished career in government, academia and industry, focused on environmental and health issues. He has held multiple leadership roles, including Chief Executive and Chair, and has a strong track record in generating sustainable policies. He is an accomplished academic, having published numerous works and held professorships at prestigious institutions.

Jim graduated in industrial chemistry from Loughborough University and earned a PhD and DSc from King's College London. His academic career includes roles at Horticulture Research International and at the University of Surrey, where he significantly increased funding and led the institution to prominence in biomedical sciences.

He has served on the boards of the OECD and of the Forestry Commission and has been involved in initiatives promoting sustainability. His contributions have been recognised with awards including the OBE and the UNESCO Microbiology Prize.

Jim has been Visiting Professor in Europe (Oxford, Reading, King's College London, Imperial College and Helsinki) and in the USA employed by USDA (Washington State and Oregon State). He has published 15 books, over 300 papers and given more than 60 keynote international lectures.

Since 2014 he has been Non-Executive Chair of Governors at the University of Chichester (budget £55m pa). His other directorships include the International Institute of Biotechnology and Toxicology, Clifmar, Beacon Bio, Phytobials and C-Questor.

Finkelstein Award

For notable contribution to measurement internationally

Winner: Professor Paolo Carbone

Professor Paolo Carbone is nominated for the Finkelstein Award due to his significant contribution to the field of instrumentation and sensors on an international scale. His extensive research and leadership roles have greatly impacted on the advancement of measurement practices globally.

Paolo has been a Full Professor at the University of Perugia since 2003, with a focus on statistical signal processing and electronic instrumentation. He has coordinated the scientific research group in electronic measurements and has a notable publication record with a Google Scholar h-index of 37. His research into instrumentation focuses on the application of statistical signal processing to real-world problems, with key topics including data conversion (ADC, DAC, TDC); synchronisation and positioning in sensor networks; and the application of statistical signal processing for the improvement of electronic instrumentation performance and reliability and power quality measurements. He coordinates the scientific research group in electronic measurements at the University of Perugia.

Paolo has held visiting positions worldwide and has played a key role within IMEKO – the International Measurement Confederation – as editor of the IMEKO journal Measurement, published by Elsevier, supporting its growth to be a high-impact, top-quartile journal in the field. He has received several prestigious awards, including IEEE fellow status and the IEEE Instrumentation and Measurement Society Technical Award.

Honeywell International Award

For distinguished work in control by chartered measurement and control technologists

Winner: Professor Eric Kerrigan

During his career Professor Eric Kerrigan has focused on developing innovative numerical methods and computer architectures for model predictive control (MPC) to enable real-time optimisation in complex engineering systems. He has held a dual appointment in the Departments of Electrical & Electronic Engineering and Aeronautics at Imperial College, and has leveraged this to develop interdisciplinary collaborations, integrating control engineering in applications including autonomous vehicles, energy-efficient aircraft, and intelligent energy management for smart grids.

In recent years, Eric has developed a novel class of integrated residual methods for solving optimisation problems with nonlinear differential equations. These methods significantly enhance the efficiency and

reliability of solving optimal control and estimation problems. The main novelty is to constrain or penalise errors in the differential equation over the entire domain, which contrasts with traditional techniques. These methods can reduce the computational requirements, measured in terms of time or memory used, by as much as 1,000 times.

Earlier in his career, Eric established an international reputation in MPC and its implementation in field-programmable gate arrays (FPGAs) and embedded computing architectures. He pioneered the co-design of control algorithms with parallel computing hardware, developing novel optimisation algorithms for solving optimal control problems on processors with fixed-point and low-precision floating-point arithmetic. These innovations bridged control theory and computer architecture design, enabling real-time optimisation in applications previously unattainable due to computational limitations. The methods he developed led to some of the fastest and most energy-efficient optimal control solvers available at the time, his team being the first to implement an MPC with sample rates faster than 1kHz.

Cornish Award (sponsored by WCSIM)

Given to an individual, group or company that has excelled in some dimension of scientific instrument making within industry, academia, national or international laboratories

Winner: Renishaw plc, Mr John Deer and (in memory of) Sir David McMurtry

This award is given in recognition of the enormous and sustained scientific contribution made by leading engineering and scientific technology company Renishaw, with expertise in precision measurement and healthcare.

The company was founded by Sir David McMurtry and John Deer in 1973, and the Cornish Award honours the contribution of Sir David, who died recently. Sir David and John grew Renishaw to become the UK's largest supplier of metrology equipment. John and Sir David were members of the four-man team of Renishaw engineers honoured with the RAEng MacRobert Award in 1987.

John's extensive experience ensures Renishaw continues to deliver efficient, high-quality manufacturing – a key component of the company's strategy. He is still instrumental in the strategic decisions for growing the business into new markets and territories, whether organically or by acquisition.

In 2012, John and Sir David were jointly awarded the Swan Medal by the Institute of Physics for their roles in founding Renishaw and leading it to become one of the world's principal manufacturers of metrology equipment. In 2014, they were jointly honoured with a Lifetime Achievement Award at the Gloucestershire Business Awards. In 2019, John was also honoured by the Manufacturing Technologies Association for his outstanding contribution to British engineering.

Institute Award for Exceptional Early Career Engineers

Given to an individual, regardless of age, who is within approximately 10 years of starting work in engineering, in the fields of measurement, instrumentation or control, demonstrating an 'over and above' level of achievement

Winner: Mr Ben Thompson

Ben Thompson is an Operational Technology (OT) engineer at United Utilities, where he has shown exceptional use of measurement technology for the issue of phosphate measurement within the waste water industry. Ben suggested a project to trial different technologies, demonstrating an approach that fits with the aims of the Institute in developing science and measurement technology use to solve problems.

This project, believed to be the first in the UK to use optical technology for phosphate measurement, showed enhanced accuracy, reliability and cost-efficiency compared to conventional methods. The trial achieved a higher level of accuracy, with an R^2 of 0.80 for orthophosphate, significantly outperforming existing wet chemistry analysers, which performed at an R^2 of 0.58. It also introduced a new, sustainable method of measuring total phosphate, something which is typically viewed as 'too hard' to do with current technology.

The optical system could reduce annual maintenance and operational costs by nearly £4,800 per unit and save millions of pounds across United Utilities' assets.

Ben showed exceptional tenacity in proposing the trial. Now that the new funding cycle is being discussed within the waste water industry (three-year cycles), he is developing the technology to see how it can be rolled out to become the standard solution for phosphate monitoring.

L B Lambert Award

For meritorious service to the Institute through involvement with Local Sections, Special Interest Groups and InstMC committees

Winner: Mr Billy Chow

Since Billy Chow joined the Hong Kong Section, there has been a 22% increase in the total number of new members between 2020 and 2024. Billy has also formed two student chapters and contributed to professional registration applications, conducting five assessment interviews in the past two years.

Billy took up key positions in the task force responsible for learned society activities during 2024 and 2025, including Leader of the Delegation of HK CAI

Professionals to Guangxi Province, Member of the Panel Discussion on the Role of CAI Professionals for New Quality Productive Force at the HKIE, and Deputy Chair of the Organizing Committee of the 24/25 Summit (Part 2) at Siemens Smart Manufacturing (Chengdu) Innovation Centre. Billy has helped build quality partnerships with the Hong Kong Institution of Engineers, Guangxi Vocational College of Water Resources and Electric Power, and Shenzhen Polytechnic University.

L B Lambert Award

For meritorious service to the Institute through involvement with Local Sections, Special Interest Groups and InstMC committees

Winner: Ms Claire Jones

Claire Jones became involved with the Central North West Local Section following an appeal at the 2022 Central North West Awards night. The committee was keen to increase diversity, and Claire stepped up to join the committee in September 2023.

Claire agreed to become Chair of the newly established InstMC women's network – Women in Measurement, Automation and Control (WiMAC) – which also led to a place on the InstMC Council.

Claire has shown great enthusiasm in the role and has led the group towards exciting new initiatives designed to raise the profile of women engineers. She has lots of ideas, has provided multiple articles for promotion of the network and works hard to expand the group's members.

L B Lambert Award

For meritorious service to the Institute through involvement with Local Sections, Special Interest Groups and InstMC committees

Winner: Mr Cevn Vibert

Cevn Vibert is a long-standing and highly active Fellow of the InstMC, particularly with the Wessex Local Section, whose profile he has raised through linking with educational establishments and STEM initiatives. Cevn served 21 years as Education Officer – starting the Lego Mindstorms programme with Exxon funding – and five years as Vice Chair. He is also the founding member of the InstMC CyberSecurity Special Interest Group, and served as its Chair for five years.

Cevn is the InstMC representative for the UK Cyber Security Council and UK Cyber Security Alliance – a consortium of 16 organisations constituting a broad representation of the UK cyber security community – which have come together to raise the overall standard of current cyber security practice and to address the government's developing ideas on cyber security skills.

Honorary Fellowship

Recognising distinguished, and normally long, service to the Institute and/or measurement and control

Winner: Dr Eddie Lock

Dr Eddie Lock served as Vice Chairman (Qualifications and Membership) of the Hong Kong Section from 2019 to 2023, becoming Chair in 2023.

With his help, more than one hundred individuals have become full members of the InstMC. Eddie has actively promoted the international recognition of engineering chartership to large local organisations, resulting in the Airport Authority Hong Kong now recognising the Chartered Engineer (CEng) status of MInstMC as a criterion for becoming a professional engineer. Under his leadership, Cyberport has acknowledged MInstMC as a pathway to expertise in artificial intelligence, and Hong Kong Metropolitan University and IVE Engineering have acknowledged MInstMC/FInstMC as an important qualification for their professors and lecturers.

A consistently active InstMC member, Eddie has served as a Council Member of InstMC since 2022 and was awarded the L B Lambert Award in 2021.

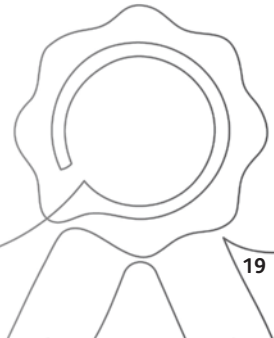
Honorary Fellowship

Recognising distinguished, and normally long, service to the Institute and/or measurement and control

Winner: Mr Martin Belshaw

Martin Belshaw has over 35 years' experience designing and managing process control systems, networks, and systems integration projects in the energy sector. He has expertise in fault-tolerant process controls, safety systems and control room re-instrumentation. A former technical director at international contracting and engineering company Semco Maritime, Martin is also a chartered engineer. Now retired, he runs his own consultancy company providing specialist engineering services to the automation and control industries – principally concept, feasibility and FEED studies, ALE/AIM operations, obsolescence reports, and innovative obsolescence solutions.

Martin is a past President of the Institute of Measurement and Control, serving on the Board of Trustees. He is a member of the Engineering Accreditation Board as an industrialist and is a partner in an innovative Edinburgh techno company. He is also a member of the IET's Engineering Policy Group Scotland (advisers to Holyrood and Stormont).



200 Years of Train Travel Since 1825

An anniversary and an invitation

2025 marks the 200th anniversary of the birth of the modern railway. A British innovation that's continued its journey across the globe. Through a year-long series of events, Railway 200 will explore how rail shaped Britain and the world.

And, as today's railway modernises and gears up for growth, Railway 200 will also look to the future, encouraging more people to take the train and inviting the next generation of pioneering talent to join the railway and become the history-makers of tomorrow.

We'll be uncovering the stories behind the tracks and trains, with an exciting programme that explores four themed pillars.

Skills & education: to encourage people from all communities to consider a career in rail.

Innovation, technology & environment: showing how the railway is one of our most innovative and sustainable sectors.

Heritage, culture & tourism: promoting social and leisure travel that's crucial for people's health, wellbeing and enjoyment.

Celebrating railway people: the everyday heroes who run the railway and the volunteers whose passion makes it even more special.

Throughout the year, our unique exhibition train will criss-cross the country bringing interactive activities and experience to thousands of people. This will be supported by national events highlighting rail's remarkable past, its essential role today, and its ever-growing importance to a sustainable future.

Get involved and find out more at
railway200.co.uk

GEORGE STEPHENSON AND THE INTRODUCTION OF THE STANDARD GAUGE

George Stephenson, often hailed as the "Father of Railways", was a pivotal figure in the development of the steam locomotive and the broader railway system in the early 19th century. His innovations not only facilitated the expansion of railway networks but also played a crucial role in standardising railway gauges, which transformed transportation in Great Britain and beyond.

Early Life and Innovations

Born on 9 June 1781, in Wylam, England, Stephenson grew up in a modest family. His father worked as a fireman for the mine's steam engines, and it was through this early exposure to machinery that Stephenson developed an interest in engineering. Despite limited formal education, he became a coal miner and eventually a mechanic, using his skills to invent and improve machinery used in the mining industry.

Stephenson's most significant breakthrough came in 1814 when he built his first locomotive, "Blücher", named after the Prussian field marshal. This innovative machine was capable of hauling coal on wooden wagonways, demonstrating the potential of steam locomotion for transporting goods over greater distances.

The Birth of the Standard Gauge

As steam locomotion gained traction, railway gauges emerged across the country. A gauge refers to the distance between the inner sides of the tracks, and early railways used gauges of different measurements, making interoperability and standardisation almost impossible. This inconsistency also led to operational complications and inefficiencies.

Recognising the need for a standardised track width, Stephenson proposed a gauge of 4 feet 8.5 inches (1,435 mm), which would become known as the standard gauge". This measurement was derived from several factors: it was slightly wider than the typical gauge used for wooden wagonways, allowing for stability and ease of construction, and it provided the compatibility for locomotive designs emerging at that time.

In 1825, Stephenson's pioneering locomotive, Locomotion No. 1, successfully operated on the Stockton and Darlington Railway – the first public railway to use steam locomotives. The success of this railway, using the standard gauge, proved integral in demonstrating the benefits of a uniform railway system. Westward expansion of the railway network in the UK depended largely on this standardised width, as it allowed for trains to travel smoothly across lines without the inconvenience of transferring cargo or passengers.

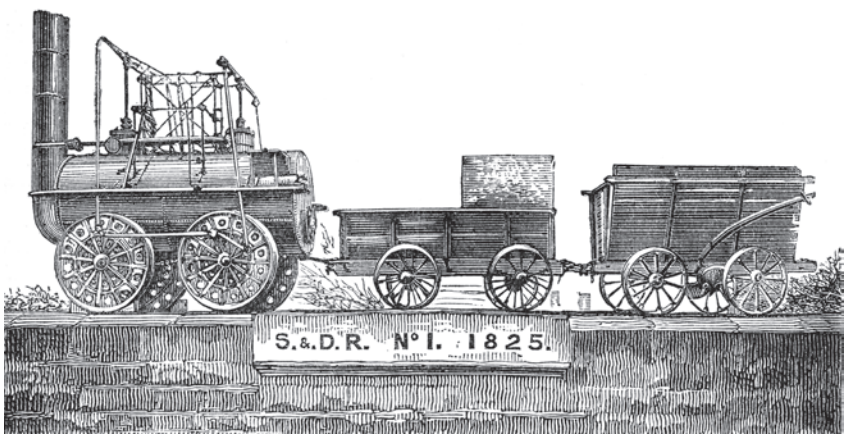
Impact on Rail Networks

The establishment of the standard gauge significantly influenced the growth of the rail network, simplifying the construction and operation of railways. By 1846, when the UK railway network encompassed thousands of miles, the standard gauge had become the norm, not just in Britain but also around the world. This consistency enabled trains to operate across vast distances, ushering in a new era of commerce and travel.

The choice of the standard gauge had lasting implications for global railway development. As nations industrialised, many adopted the standard gauge for their railway systems, facilitating international trade and travel while ensuring compatibility between railcars and locomotives.

Legacy

George Stephenson's contributions to railway engineering were not merely technological; they transformed societal structures, economies, and the very fabric of daily life. The uniform gauge bolstered regional economies and fostered interconnectivity among urban centres. Stephenson's work not only revolutionised the 19th century industrial landscape but also created lasting standards that continue to influence railway systems worldwide.



WE INVITE YOU TO JOIN THE INSTMC EARLY CAREERS NETWORK

ECN is open to all InstMC members, including students, with no prerequisites for age or professional registration. While designed for those within 15 years of qualification, experienced members are also encouraged to participate as mentors, sharing their knowledge and expertise.

Are you:

- A student, graduate, or apprentice looking to connect with like-minded professionals?
- Within 15 years of qualification and eager to advance your career?
- Seeking guidance on Professional Registration or Continuing Professional Development (CPD)?
- Unsure about your next career move?
- An experienced InstMC member looking to mentor and support the next generation?

For further information please vist:
https://www.instmc.org/early_careers_network/about.aspx

Scan QR Code to JOIN

EARLY CAREERS NETWORK

LEADERSHIP TEAM AND PROFILES

Now that our new Early Careers Network is officially up and running, we're pleased to report that we have an established leadership team with five founding members!

They are Ben Thompson (Co-Chair), Kieran Lyons (Co-Chair), Elahe Rostaminikoo (Marketing & Promotions), Norman Chan (Mentor Liaison), Stefan Kent (Mentor Liaison) and Darren Devaney (Mentor Liaison).

We are hugely grateful for their commitment and enthusiasm in leading this new initiative, and we are excited to see how the network develops. If you would like to join the ECN as either a mentor or mentee, visit your membership page on the InstMC website and tick the 'Early Careers Network' box under 'Special Interest Groups'.

By way of introduction, we have asked our founding members to answer some questions on what motivates and inspires them within their own careers, and we kick off with Co-Chair Ben Thompson.

Name: Ben Thompson

Role & Company: Operational Technology (OT) Engineer, United Utilities

What inspired you to pursue a career in engineering/science?

I grew up with the British Army, surrounded by people saying old one liners like 'improvise, adapt, overcome'. Generally, when you found a problem, it wasn't a problem for someone else, it was for you. You're there and now, so find a solution, sort it and learn from it. Growing up surrounded by that mentality pretty much sealed me to becoming an engineer!

If you could revolutionise or change one aspect of your industry, what would it be and why?

Instrumentation forms a key part of the water industry, and more recently, key to how the public perceives it. Sure, there are things that may be able to be improved, but what I would really like to change is people's understanding of data. Sometimes spending money on more sensors, generating more data may not be good! Data without context often leads to misunderstood narratives or even worse: bad data can lead to justified narratives that just aren't representative of what is actually happening. Those narratives may then be used to drive investment! Weird to say from a past instrumentation engineer, sometimes we need to just stop and think – do we really need more instruments? Do we need more data? If the answer is yes, lets really think what we are going to do with the data and how we validate it to show what is genuinely representative of the real world.

Why did you want to join the Early Careers Network (ECN)?

I have been lucky enough to have several key mentors throughout my career who have championed both myself and early career professionals as a whole. Previously, I have never been in a position to be able to reciprocate that, but now I am. If I can help to give somebody the confidence, encouragement or opportunities to help them progress or succeed then I've been successful in passing that torch on and hopefully in years to come, they'll feel the same!

If you could collaborate with any engineer or scientist (past or present), who would it be and why?

I don't speak Italian but I think it would have to be Giovanni Venturi, after whom the Venturi effect is named. Flow measurement is such a crucial part of modern life and it is used for things we enjoy every day. Some of the earliest modern measurement technology was based on the Venturi effect and a lot of it we still use today. I know he would be proud to see so many open channel flumes knocking about in the water industry for sure!

FOCUS ON A SIG CYBER SECURITY

Our InstMC Cyber SIG Exchange Network hosted a presentation by Colin Topping, a renowned figure in the cyber security field and the founder of Ginger Cat Cyber. The subject matter was very topical, coming just days after the Cyber Security and Resilience (CSR) Policy Statement was issued by Parliament (09.04.2025): Developing Incident Response for Third Party Incidents.

The next exchange network presentation will be held on 26 June at 14:00 by Mike Holcomb. Fifteen years ago, Mike had no experience in industrial control systems (ICS)/ operational technology (OT) cyber security. Today, he is a Fellow for ICS/OT cyber security at a leading engineering and construction company, having worked on major critical infrastructure projects. Mike built his expertise by dedicating over 500 hours to specialised courses, creating a free 20+ hour YouTube course, completing a master's degree, delivering 20+ industry presentations, mentoring 30+ professionals, attending 50+ conferences, leading cross-functional projects, conducting risk assessments, earning seven professional certifications, and sharing knowledge on LinkedIn with over 30,000 followers.

Mike will present "How to get started in ICS/OT cyber security". If you're interested, please take a look at our Facebook page. Alternatively, join the Special Interest Group and take the link straight from there.

The presentations are now recorded, meaning you can catch up on any missed information at your convenience. The video of Colin's presentation will be available for download by the time this article is published.

The Cyber SIG shall convene an MS Teams session in May (date TBA – so please monitor the usual social media outlets and our InstMC page at https://www.instmc.org/sigs/cyber_security). We highly value your input on what topics we should cover in the Exchange Network and what other issues we could provide from the SIG. Your active participation is what makes our community thrive, so please join us and feel free to suggest what you see fit.

Elsewhere in this quarter of 2025, we've seen the following:

UK OT Cyber Security Landscape in 2025

UK Regulatory Framework Evolution

The UK is enhancing its cyber security regulatory framework with the CSR Bill in 2025. Announced in July 2024 and expected to be introduced to Parliament in 2025, the CSR Bill aims to expand the Network and Information Systems (NIS) Regulations to include more digital services and supply chains, modernising security requirements for critical infrastructure sectors such as energy, manufacturing and transport.

UK Threat Incidents and Status

The UK Cyber Security Breaches Survey 2025 reports that 43% of UK businesses experienced cyber breaches or attacks in the past year. Medium and large enterprises were particularly affected, with 67% of medium and 74% of large companies reporting incidents. While this is a slight decrease from 2024, the severity of attacks has increased, with ransomware incidents doubling. The National Cyber Security Centre (NCSC) Annual Review noted an increase in the frequency and severity of cyber incidents, with 430 incidents requiring NCSC assistance, up from 371 the previous year. The sectors most affected by ransomware included academia, manufacturing, IT, legal, charities and construction.

Global OT Cyber Security Developments in 2025

Escalating Threat Landscape

Globally, 2025 has seen a sharp rise in OT cyberattacks with physical consequences. The number of affected sites more than doubled, with a 146% increase from 412 sites in 2023 to 1,015 in 2024. Ransomware attacks against industrial organisations surged by 87%, while nation-state threats tripled. State-sponsored actors increasingly targeted critical infrastructure using attack methods including GPS jamming and spoofing. The BAUXITE threat group has been implicated in

multiple global campaigns targeting industrial entities across critical infrastructure sectors.

Global Regulatory Initiatives

Governments worldwide are strengthening cyber security regulations with specific requirements for OT security. Key regulations in 2025 include:

- The final rule for the US Cyber Incident Reporting for Critical Infrastructure Act (CIRCIA) is expected later in 2025.
- The EU's NIS2 Directive expands the scope of cyber security regulations.
- Singapore's Operational Technology Cybersecurity Masterplan provides a strategic blueprint for national OT security.

Emerging Technologies and Strategies in OT Cyber Security

AI Integration in OT Security

AI and machine learning will be central to OT cyber security strategies in 2025. Organisations are leveraging AI to enhance threat detection and response capabilities by analysing vast amounts of network traffic, behaviour patterns and system logs in real time. AI-driven tools can detect behavioural anomalies in OT environments that might indicate a cyberattack. However, while 66% of organisations see AI as a significant cyber security game-changer, only 37% have safeguards to assess AI tools before use, highlighting a gap between awareness and implementation.

Evolving Security Approaches

Zero trust architecture (ZTA) implementation and advanced network segmentation will continue to be priorities in 2025. Organisations will focus on securing legacy systems, improving firewall implementations, and conducting regular risk assessments in ICS environments. The concept of "secure by design" has gained traction, with organisations embedding security considerations into product and system development from the outset.

Industry Trends and Organisational Impact

IT/OT Convergence Challenges

The convergence of IT and OT systems has expanded the industrial attack surface by introducing traditionally isolated OT systems to internet-exposed networks, third-party integrations, and cloud-based platforms. This interconnectivity increases vulnerabilities and potential entry points for attackers. To address these challenges, organisations establish unified security operations centres to monitor physical and digital assets comprehensively. Collaboration across IT and OT teams has become crucial for effective security management.

Workforce Development

The cyber security skills gap increased by 8% in 2024, with two-thirds of organisations facing moderate-to-critical talent shortages. Organisations are implementing targeted training programmes that emphasise practical, scenario-based learning and tabletop exercises to address this. Some organisations are turning to specialised OT virtual CISOs or field OT CISOs to bridge the gap between traditional cyber security leadership and the distinct needs of operational technology. Universities have also started incorporating OT/ICS education into their cyber security programmes to create a direct talent pipeline.

Summary

In 2025, OT cyber security globally faces increasing sophistication in threats, particularly from state-sponsored actors and ransomware groups. The regulatory landscape continues to evolve, with the UK's CSR Bill and global initiatives such as NIS2 and CIRCIA aiming to strengthen critical infrastructure protection. Organisations are responding with advanced technologies such as AI-driven monitoring, zero trust architecture and secure-by-design approaches, while addressing the persistent challenges of IT/OT convergence and cyber security workforce shortages.

David Fisher-Holt
Cyber Security SIG Chair

FOCUS ON A SIG STANDARDS

We are pleased to announce that from April 2025, Nick Houghton took over from Navdeep Mehay as the new Chair of the Standards Special Interest Group.

Nick has been an active volunteer member of the S-SIG, and its steering committee, serving on the BS6739 review committee, where the team was recognised with the prestigious L. B. Lambert Award at the 2024 InstMC Awards Night. Additionally, he plays a key role as Design Lead and Deputy Facility Lead for the UK Atomic Energy Authority LIBRTI Program 2024. Nick is also an esteemed member of multiple GEL/65 standards committees and a Drafting Panel Member for the re-write of BS 4877 - Nuclear Reactor Instrumentation and Control – Code of Practice. We are delighted to have him on board!

Committee & Working Group Opportunities

Why not consider becoming part of the BSI standards-making community representing the Institute? InstMC is one of the nominating bodies for members to join the national standards committees (NCs) and they are currently looking for representation within national and international working groups. Some of these NCs include GEL/65/2 - Measurement and Control devices, GEL/65/3 - Industrial Networks and TPR/1 Technical Product Realization mirrors. This is an opportunity to have your say on the development of important standards.

For full details of the opportunities currently available, visit S-SIG Nomination Opportunities or contact the S-SIG Chair at nicholas.houghton@ukaea.uk

New Work Proposal (NWP) Comments

Interested in having your say in the development of standards or have expert knowledge to offer? Once a draft standard is ready, BSI puts it out for public consultation for viewing and comments. These comments are considered by a relevant panel of experts and BSI staff and the final published standard is updated as appropriate.

To participate in any current BSI standard seeking public comment, visit New Work Proposals.

Get Involved

The Standards SIG exists for the benefit of its members and membership is free. You can join the S-SIG by selecting the relevant box under 'Interests' on your InstMC website membership profile page. For more information on the activities of the S-SIG, visit https://www.instmc.org/sigs/standards/news_activities.aspx.

Why not consider becoming part of the BSI standards-making community representing the Institute? InstMC is one of the nominating bodies for members to join the national standards committees (NCs) and they are currently looking for representation within national and international working groups.

Inst MC

CEng Chartered Engineer

CHARTERED ENGINEERS

(CEng) develop solutions to engineering problems using new or existing technologies, through innovation, creativity and change. May be accountable for complex systems with significant levels of risk.

What is professional registration?

- **Recognition** through membership of a relevant Professional Engineering Institution (PEI), that an individual's knowledge, understanding and competence have been assessed and confirmed through Professional Review.
- **Verification** that they have attained the standard required for inclusion on the national register in the appropriate category of registration.
- **Commitment** by an individual to maintaining their competence through Continuing Professional Development (CPD), professional behaviour for the benefit of society and their commitment to the engineering profession.

Registration is open to any competent practising engineer or technician, with different levels and pathways to registration available.

Why you should become professionally registered?

For yourself
- Recognition of your competence as an engineer or technician.
- Demonstratable evidence of your commitment to the profession.
- Internationally recognised status.
- Enhanced career prospects.

For your employer
- Increased technical/managerial credibility.
- Competent workforce.
- Competitive advantage.

For society
- Ensures the public is safeguarded through provision of independent and trustworthy advice, products and services and safe and reliable infrastructure.
- Assurance of ethical and sustainable behaviour.

Chartered Engineers shall demonstrate

- **The theoretical knowledge to solve problems in new technologies and develop new analytical techniques**
- **Successful application of the knowledge to deliver innovative products and services and/or take technical responsibility for complex engineering systems**
- **Responsibility for financial and planning aspects of projects, sub-projects or tasks**
- **Leading and developing other professional staff through managment, mentoring or coaching**
- **Effective interpersonal skills in communicating technical matters**
- **Commitment to professional engineering values**

www.instmc.org

For further details and application forms, please visit our website or contact the Director of Membership & Registration on +44 (0) 20 7387 4949 Ext 3 or email: membership@instmc.org

Scan QR Code to apply for professional registration via InstMC

LOCAL SECTION NEWS

NORTH CENTRAL - A NEW ERA OF COLLABORATION

Reigniting the North Lincolnshire Local Section

The North Lincolnshire region has long been a powerhouse of industrial activity, home to some of the UK's key manufacturing and processing sites. Engineers in this area are at the forefront of technological advancements, tackling complex regulatory challenges across diverse operational sites. However, in an increasingly demanding financial climate, collaboration has never been more essential. The success of individual engineers, local industrial plants, and ultimately the wider community, depends on our ability to share knowledge and work together.

Recognising this urgent need for cooperation, we are reviving the section. In the boundary changes which were agreed in 2024, we are now the North Central Local Section of InstMC. Our goal is to re-establish a strong, engaged network of engineers who can learn from one another's experiences, navigate common challenges, and drive industrial success in the region.

As the new Chair, I have in my career relied on the support of other engineers as I transitioned from an Instrument Tech through to chartered engineer, and the importance of the InstMC section for networking is why I wanted to take on the challenge.

Our Approach

To ensure the successful revitalisation of the Local Section, we have outlined a structured and strategic plan:

1. Developing an Open Communication Network: We have started reaching out to engineers in the region to gauge interest and establish initial connections. Early responses have been promising, with many expressing enthusiasm for a more structured platform to exchange ideas and expertise.
2. Reforming a committee to drive us forward for the next year.
3. Soft Launch of Section Meetings: Instead of diving straight into large-scale events, we are taking a measured approach with small, focused technical talks. These sessions will leverage the expertise within our region, covering relevant topics such as industrial automation, compliance challenges, and emerging technologies.
4. Engaging with Training and Apprenticeship Providers: The future of engineering in our region depends on the next generation. We are initiating engagement with HETA, CATCH, and local colleges that specialise in instrumentation and control training. By building strong relationships with these institutions, we can help bridge the skills gap and inspire young engineers to take an active role in the industry.

Progress So Far

We have already taken several significant steps toward making this vision a reality:

- Establishing Online Engagement: A new LinkedIn page and newsletter are in development to keep members informed and engaged. Once live, we will encourage all members to participate actively and contribute to discussions.
- Formation of a Core Committee: A dedicated group of engineers has come together to lead this initiative, though we are still looking for additional volunteers to strengthen our efforts.
- Planning for Summer 2025: We are in the early stages of developing an event programme that will provide valuable learning and networking opportunities for engineers across the region.

The Road Ahead

Our vision remains clear: to build a thriving network of engineers who benefit from shared expertise and drive the success of UK industry. By working together, we can strengthen our industrial sector, protect local jobs, and support the wider economy. This is an exciting time for the North Central Local Section, and we invite all engineers in the region to get involved.

If you are interested in contributing, attending meetings, or simply staying informed, reach out to us through our new communication channels. Together, we can make a lasting impact on our industry and our community.

We are looking for:

- Committee Members to support the ongoing work
- Tech Talk Presenters
- Potential Venues for talks and meetings with conference facilities / meeting rooms
- Companies or Individuals that want to increase their networking in the area.

If this is of interest, please get in touch with RobertPetchey_836@hotmail.com.

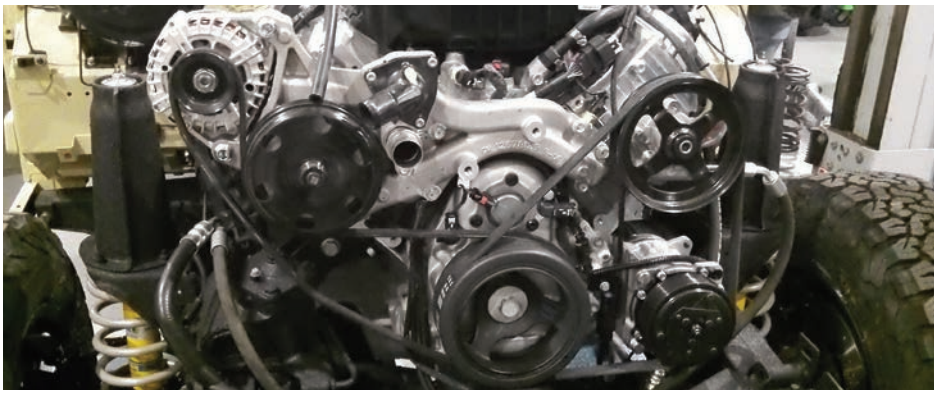
Robert Petchey
Chair, North Central Local Section

LOCAL SECTION NEWS

NORTH EAST

Visit to Twisted Automotive

On 27th February we visited Twisted Automotive in Thirsk, the home of bespoke Land Rover Defender and Suzuki Jimny vehicles. In total, 25 attended and everyone was impressed with the diversity of the modifications that are requested by customers, from custom paint jobs to custom engines. Twisted Auomotive undertakes vehicle servicing and maintenance as well as total strip and refurbishment including brand new chassis and alterations to the bodywork.



NE Section InstMC Annual Dinner and Reunion

Held at Leonardos Middlesbrough on 13th March, the event was attended by 158 guests from 16 companies, 2 representatives of the North Linc's section, 9 members of the NE Section committee and a top table consisting of Toast Master David Otterson, NE Section Treasurer Norman Harrison, InstMC President, Professor Sheila Smith, John Noon NE Section Chair, Rev Peter Ellis, Padre to the Mission to Seafarers, Lea Roberts raconteur and Mike Vowell NE Section Secretary.

The theme of the addresses to the floor was the need to encourage entry into the field of Measurement and Control at all levels, from apprenticeships to Professional Registration, and the need for companies involved in all fields of design, manufacture, installation and maintenance to help provide experience to apprentices and graduates in a changing industrial environment.

Lea Roberts provided the audience with hilarious observations of his experiences of after dinner speaking and life in general.

The raffle raised £860 to be donated to the Mission to Seafarers.

CENTRAL NORTHWEST

Technical Talks

Since our update in the last edition some of the planned activities are now moving forward. The technical programme has continued with the following technical talks:

- Andy Brazier, of AB Consulting, shared the updates to alarm management guidance EEMUA 191 in March.
- Megan Hine, of Draeger, shared details on the upcoming introduction of the Methane Emissions Regulations in April.
- Steve Taylor, of ITI, presented on Deploying Real Time Analytics at Scale to Detect Anomalies in May.

All these sessions were held online and are now available on the Institute's YouTube channel.

The programme has two more sessions before we have a break over the summer, with full details available in the Events calendar:

- 11th June 2025, Fortifying Operational Technology: Navigating Cybersecurity Challenges in an Uncertain World to be presented by Steve Lane of Capula
- 9th July 2025, Control Valve Performance to be presented by Pal Galik; Technical Sales Manager at Emerson Automation Solutions

Chris O'Hara, our Technical Secretary, is looking for a few presentations for the Autumn. Please contact the section chair on cnw_chair@inst-members.org with details so they can be passed on.

2025 Awards

The Early Career Engineer and Apprentice of the Year panels are sifting through the entries for this year's awards. We are currently shortlisting and will be in contact with everyone during June. The winners will attend our awards night in October to receive their awards.

I would like to take this opportunity to thank the companies who continue to support the development of our young engineers by sponsoring these awards.

- Manchester University – Sella Controls, Sella have supported this award for many years and continue to do so for 2025.
- Liverpool John Moores University – ITI Group. ITI started this sponsorship in 2024 and have continued with the sponsorship in 2025.
- Early Career Engineer – NEW sponsor ITI Group.
- Apprentice of the Year Award – NEW sponsor Capula.

Please ensure that you are connected with the section LinkedIn page and newsletter as we'll be sharing more about these sponsorships and the companies behind them in the Autumn.

AGM

We held our AGM in May, check out the section webpage for the officers for the 2025/2026 year.

Endress+Hauser

During April Chris O'Hara and I attended E+H's Manchester facility to see the updates to the space for customer interaction. As a Companion Company they are keen to support the section's work.

We have been invited to hold a session during their customer engagement week in July, and have a tentative date in the diary for a session where we hope to have the ECE presentations, technical talks and networking. The details aren't yet confirmed so please keep your eye on our socials and section webpage / events calendar. The date is the afternoon of 17th July 2025.

Dave Green
Chair, Central North West Local Section

INSTMC ATTENDS TOMORROW'S ENGINEERS LIVE 2025

InstMC was delighted to attend Tomorrow's Engineers Live on Monday 24 February, an inspiring day of thought-provoking discussions and fresh ideas. The event kicked off with a powerful keynote by Professor Rebecca Shipley, Professor of Healthcare Engineering at UCL and Chief Research Officer at UCLPartners.

Her talk, 'Inspiring young people through healthcare engineering', explored the life-changing potential of innovation in healthcare and the vital role young people can play in its future. Drawing from her own journey – starting with a mathematics degree that led her into engineering – Professor Shipley showed how diverse backgrounds can lead to impactful careers.

She shared the remarkable story of the UCL-Ventura CPAP device, developed at speed in response to the ventilator shortage during the early days of the Covid-19 pandemic. This collaboration between engineers, healthcare professionals and manufacturers delivered a timely solution for hospitals across 29 countries, demonstrating engineering at its best: practical, urgent and transformative.

Her address was a powerful call to action for the next generation, highlighting that you don't need a traditional engineering background to make a difference. What matters is curiosity, collaboration, and a drive to solve real-world problems.

Throughout the rest of the day, we heard from speakers and contributors across education, industry and the outreach community. There were practical sessions, evidence-based insights and interactive discussions aimed at helping us collaborate more to build a more diverse and skilled STEM workforce.

Lightning Talks

The event also featured a dynamic series of lightning talks – short presentations that offered fresh insights into current research and bold new ideas shaping the future of engineering and education. Dan Scott, Chief Data Scientist at WSP, opened with a fascinating look at the expanding role of AI in the workforce. He highlighted the urgent need to equip young people with adaptable skills for a future shaped by rapid technological change. Becca Gooch, Head of Research at EngineeringUK, shared findings from the Science Education Tracker. Her talk shed light on how young people are currently engaging with science in schools, and what this means for encouraging future engineers. The next speaker was Laura Hawksworth, Head of Policy and Impact at the Careers and Enterprise Company, whose presentation focused on the impact of careers outreach and

how it can boost young people's confidence and readiness for the future. We were inspired by Professor Becky Parker MBE, leading Project Earth at Queen Mary University of London, who brought the voices of young people to the forefront. She spoke passionately about their views on STEM, and the social and systemic barriers many face in pursuing STEM careers. Finally, Professor Lynne Bianchi and Kate Dodgson from the University of Manchester brought valuable insights from the classroom. Their message was clear: to truly engage young learners, we need inclusive teaching practices and strong support for teachers themselves.

Interactive Workshops

We had the opportunity to take part in two of three practical workshops focused on strengthening STEM engagement: Youth-Proof to Future-Proof, Engaging Underrepresented Voices, and Stronger Together: Unlock Collaborative Success.

First, we attended Engaging Underrepresented Voices, facilitated by Miguel Trenkel Lopez (Megawatt) and Rebecca Hale (EngineeringUK), who shared creative ways to engage new audiences through gamification and ethics-based activities. We had a great time guessing the country by their percentage of reliance on each type of energy and then making recommendations on how they could improve to be more sustainable.

After lunch, we attended Stronger Together: Unlock Collaborative Success, where Maddie Dinwoodie (EngineeringUK) and Phil Ramsden (Imperial) explored how collaboration between organisations leads to stronger, more sustainable engagement programmes.

Introducing Skills England with Q&A

Sarah Maclean, joint CEO of the newly formed Skills England, introduced the vision for a joined-up approach to skills development. Delegates had the chance to ask questions and explore how Skills England could help bridge current gaps in skills, outreach and training.

Unconference: Community-Led Conversations

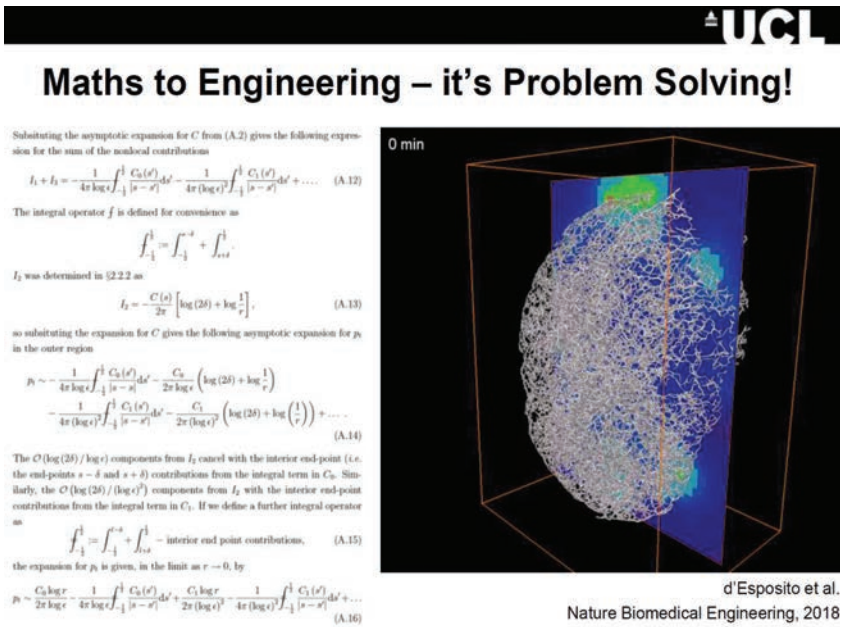
The final session of the day adopted an 'unconference' format; a dynamic, participant-led approach that empowered attendees to explore the issues that mattered most to them. Topics were generated by the participants, who fostered organic, relevant discussions. This flexible structure encouraged collaborative thinking, enabling community members to lead conversations around their own interests and questions. With multiple informal discussions happening in parallel, delegates were free to move between groups, contributing where they felt most inspired and engaged and moving on when they felt they had taken what they needed from the discussion. Topics included: Encouraging employers to collaborate to attract more young people into STEM (Aimee Smith and James Mackay, Thales), Making workplace experiences part of the school journey (Dan Heffernan, AtkinsRéalis), The role of colleges in industry outreach (Ian Evans and Fay Block, United Colleges Group), Opening up apprenticeships for underrepresented groups (Clare Collins-Addy, Causeway Education), Building long-term interest in STEM through cross-sector collaboration (Francisca Chiedu Otu, National Grid), Developing practical workplace skills (Mick Westman, Digital Innovators) and Turning good intentions into action within the Code community, tackling gender gaps, boosting evaluation, and championing practical STEM learning (led by Maddie Dinwoodie, EngineeringUK).

The discussion brought forward recurring themes: the need for inclusive pathways, authentic partnerships, sustained funding, and better evaluation of outreach effectiveness. Above all, there was a shared belief that we need to act together – not in silos – if we are to create meaningful change.

Looking Ahead

From healthcare innovation to ethical outreach, from AI to apprenticeships, this event brought together a passionate community working towards the same goal: making STEM more inclusive, more visible, and more impactful for all young people.

By sharing research, learning from lived experiences, and committing to collaboration, we're one step closer to shaping a future where every young person can see themselves in STEM.



d'Esposito et al.
Nature Biomedical Engineering, 2018

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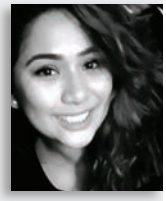

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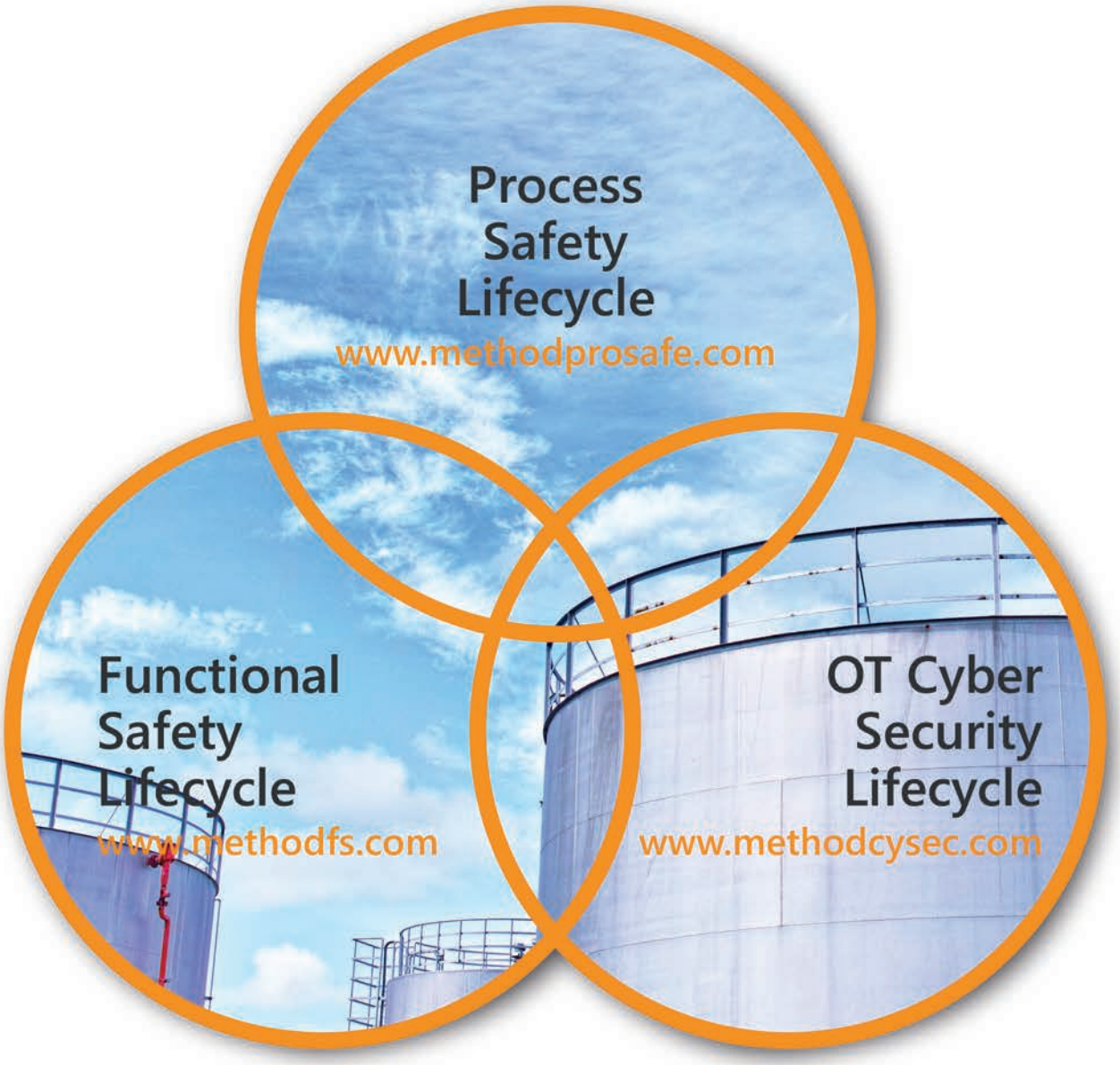

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