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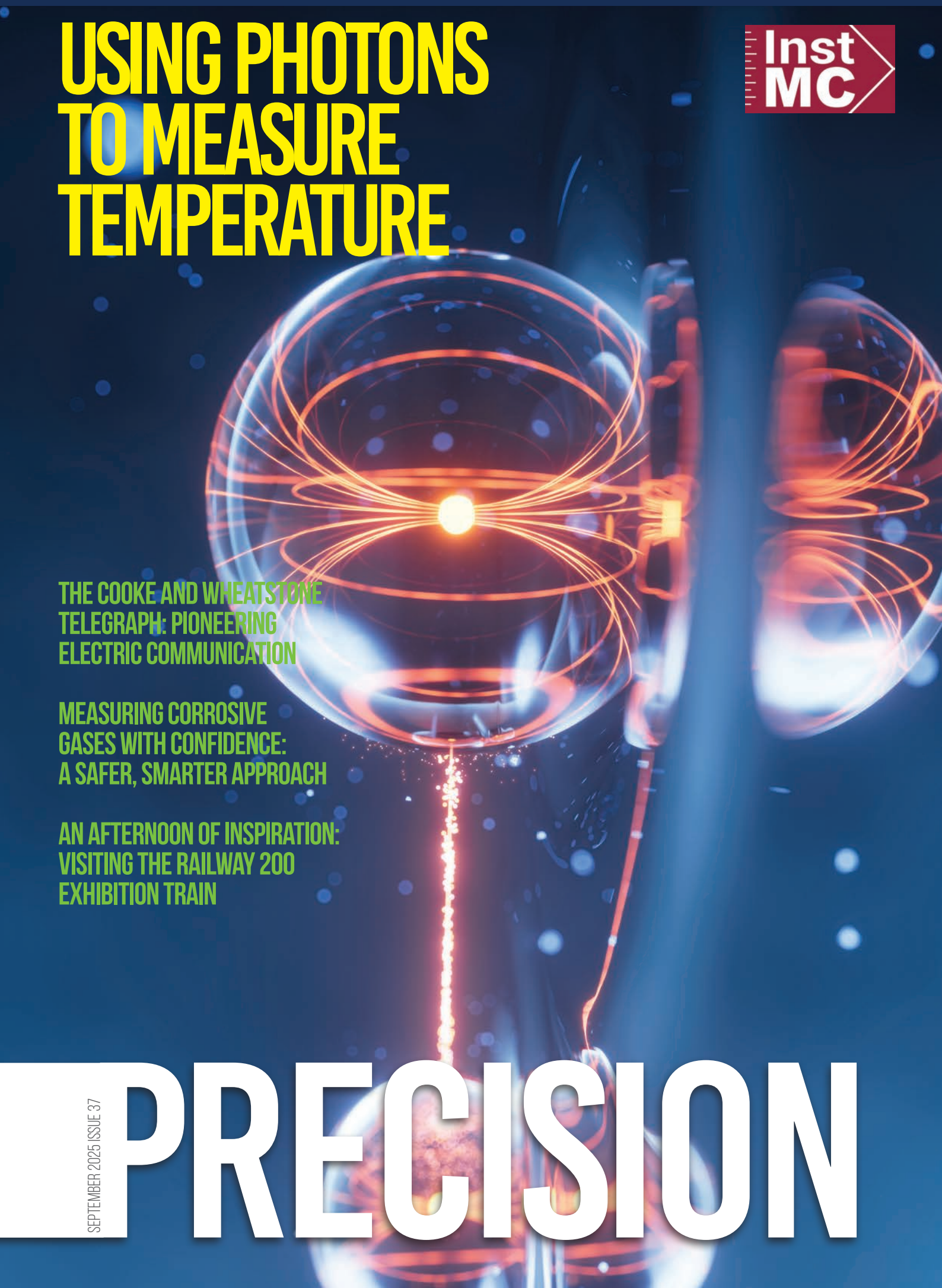
USING PHOTONS TO MEASURE TEMPERATURE



THE COOKE AND WHEATSTONE TELEGRAPH: PIONEERING ELECTRIC COMMUNICATION

MEASURING CORROSIVE GASES WITH CONFIDENCE: A SAFER, SMARTER APPROACH

AN AFTERNOON OF INSPIRATION: VISITING THE RAILWAY 200 EXHIBITION TRAIN

SEPTEMBER 2025 ISSUE 37

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CELEBRATING ENGINEERING

NATIONAL ENGINEERING DAY (5 NOVEMBER 2025)

Engineering has come a long way since the first ingeniator was recorded in the Domesday Book nearly a thousand years ago. From medieval military engineers to the pioneers of the Industrial Revolution, to today's innovators in AI, quantum computing, regenerative medicine and sustainable design, the profession has continually evolved – yet public perceptions have not always kept pace.

It's time to re-engineer what it means to be an engineer.

Many people still picture spanners and hard hats, but today's engineers are shaping the technologies, industries and systems that will define the future. From planetary engineering to sustainable fashion, from robotics to space exploration, engineering today is creative, human-centred, and vital to tackling global challenges.

To help close this gap, on National Engineering Day (5 November 2025), the Royal Academy of Engineering will launch the AI–Z of Engineering: an online guide to the world of engineering careers, from today's roles to the possible jobs of tomorrow.

The AI–Z of Engineering will explain more than 100 current engineering jobs and over 100 future-envisaged ones, in clear, simple language. The guide is being shaped by engineers, who have described their work and what engineering means in the modern world. It's designed to inspire young people and the public, and to show how broad, creative and important engineering really is – from AI and robotics to medicine, fashion, space and sustainability. The guide will be available to view at www.thisisengineering.org.uk/ and will be an evolving resource.

Tomorrow's Engineers Week (10–14 November 2025)

Tomorrow's Engineers Week is an annual campaign run by EngineeringUK to celebrate and showcase careers in engineering and technology for young people. Aimed at 11 to 14 year olds, this event sees thousands of students across the country get involved in activities through free videos, lesson plans and resources. It's an opportunity for them to spark ideas and consider how they could tackle local and global challenges in their future careers, as well as gaining information on the range of roles within engineering and technology.

This year, Tomorrow's Engineers Week will take place 10–14 November. Whether you're an engineer, a STEM expert or an educator, there are many ways to get involved. For more information, visit https://www.tomorrowsengineers.org.uk/tomorrow-s-engineers-week/.

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USING PHOTONS TO MEASURE TEMPERATURE

BY PROFESSOR GRAHAM MACHIN FRS, FRENG, DSC, DPHIL, HONFINSTMC, FINSTP, FIPEM, CPHYS, CENG

The practice of thermometry has evolved to incorporate the findings of research and advances in technology. [1] For example, the liquid-in-glass thermometers of the 19th century progressively gave way to electrical-based sensors such as resistance thermometers and thermocouples of the 20th. In addition, the introduction of temperature scales has ensured reliable thermometry globally for around 100 years.

The first temperature scale was introduced in 1927, followed by improved temperature scales in 1948 and 1968. The most recent scale in widespread use is the International Temperature Scale of 1990 (ITS-90),[2] which has been tremendously successful at facilitating low-uncertainty, consistent temperature measurement around the world for more than 30 years.

However, these defined scales are only ever approximations to "true" temperature, known as thermodynamic temperature, which is the temperature in physical equations, and which was first elaborated by Lord Kelvin (then William Thomson) in the mid-1850s. Since the kelvin redefinition in 2019 [3] there has been global research into determining thermodynamic temperature at the point of measurement. First, one can calibrate practical sensors against thermodynamic temperatures instead of ITS-90 and then use those sensors to measure thermodynamic temperature directly. [4] However, this approach has all the drawbacks of classical thermometry, in that sensors would still drift in use and require periodic recalibration to deliver reliable temperature values. Second, one can use the physics associated with the sensor, which relates temperature to another measurable quantity, to determine thermodynamic temperature directly without recourse to sensor calibration. This approach is loosely known as in-situ traceability [5] because it delivers and maintains traceability direct to thermodynamic temperature (that is, to the kelvin definition) in process. Significant advances have been made, both electron-based [6] and photon-based, and it is photon-based that I shall focus on today.

Photon-based approaches to thermometry

Readers may be familiar with one widespread form of photon-based thermometry, namely non-contact or IR thermometry. Probably the best-known types of non-contact thermometers are the ones used by clinicians to determine body temperature, such as ear thermometers or forehead thermometers. Most people are also familiar with thermal imagers, which extract temperatures using the same principles. All these devices sense the emitted (and reflected) thermal radiation from a surface and through calibration convert that measurement into a temperature. Though they are widely used, getting reliable temperatures from such devices requires great care because they are unable to distinguish between the thermal radiation emitted from the surface and the thermal radiation reflected from the surface. All real surfaces are not perfect emitters of thermal radiation, and a correction must be applied to account for this. Both problems can lead to large and not easily quantifiable errors, and the technique does not lend itself to giving in-situ traceability.

Next, I will describe two forms

of photon-based thermometry which are radically different from traditional non-contact thermometry: ring resonator thermometry (RRT) and Doppler broadening thermometry (DBT). In fact, even though they are based on photons, they are in essence "contact" thermometry approaches.

Ring resonator thermometry (RRT)

Here, you need to think very small. These thermometers are significantly less than the diameter of a hair and can't be seen with the unaided eye. They are microfabricated from and on semiconductor material, usually silicon.

Figure 1 shows the working principle that light (i.e. photons) is sent from an activator (usually a laser) down an optical channel (waveguide) into a microfabricated ring. The frequency (note that frequency is inversely related to wavelength) of the light is then adjusted until a resonance is established in the ring (like a tuning fork). Photons then "leak" (strictly evanescently couple) from the waveguide into the ring and a resonance is established. The resonance is detected as a drop in light intensity at the other end of the waveguide (transmission dip). This is the heart of the thermometer because the frequency of the resonance is a function of temperature. As the temperature of the thermometer increases, the frequency of the resonance decreases. Ring resonator thermometers have the potential for in-situ thermodynamic temperature measurement because there is a clear physical relation between temperature and frequency of resonance. Silicon ring-based thermometers are in an advanced stage of development. [7, 8]

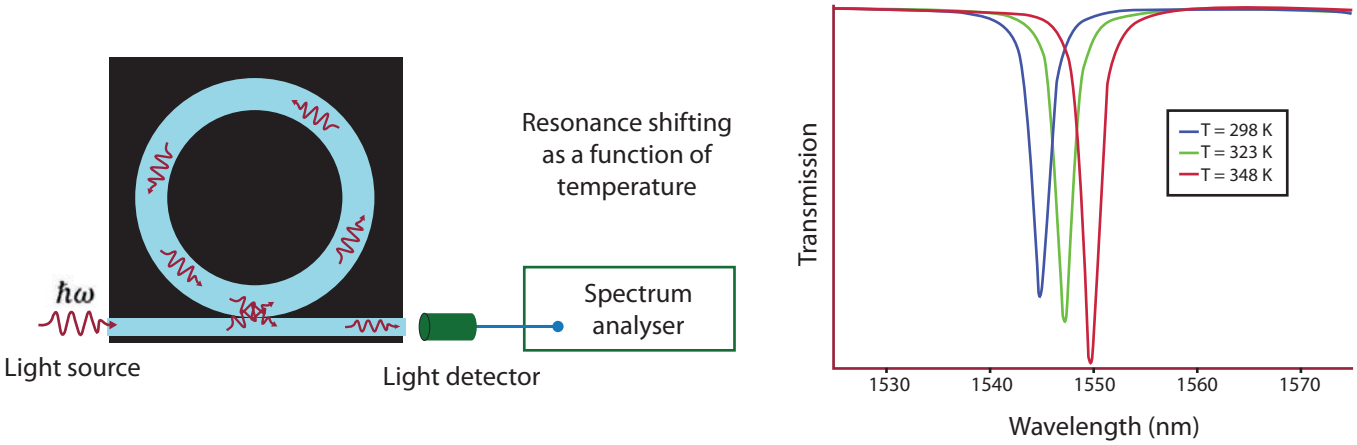

Figure 1: Schematic diagram of a ring resonator thermometer

However, thermometers based on silicon have significant drawbacks in that they need external activation and detection. Hence, a new stream of research has been initiated by NPL and the University of Glasgow which, instead of using the semiconductor silicon, uses a III-V semiconductor, specifically indium phosphide (InP) alloys, which efficiently produces light. (These materials are key to sending optical data signals over optical fibres, forming the internet.) The benefit is that the composition can be modified during manufacture to allow an activator and a detector to be microfabricated on the same semiconductor chip so a fully integrated thermometer, still less than the diameter of a hair, can be made. [9, 10, 11,12]

These developments are important for improving the thermal management of semiconductor devices. Thermal management is essential for the efficient performance of many of the devices we rely on in our daily lives, from mobile phones to computers.

Doppler broadening thermometry (DBT)

Doppler broadening thermometry is completely different to ring resonator thermometry. Here, the average thermal motion of atoms (or molecules) is sensed optically to determine their temperature. An optically transparent container with two windows is evacuated and filled with an atomic or molecular species.

Let's take for example rubidium vapour. In the vapour, the rubidium atoms, by virtue of their motion and continual interaction between themselves and the container walls, have an inherent thermodynamic temperature. Figure 2 shows how a laser is shone through the optical cell at a wavelength close to an atomic transition of the rubidium. The operating wavelength of the laser is then scanned to cross the atomic transition, which yields a spectral line, whose characteristic half-width is only a function of thermodynamic temperature. In principle, the line width is very narrow, but because of the ceaseless rapid motion of the rubidium atoms the actual measured line width is broadened by the phenomena known as Doppler broadening (hence DB thermometry). The line half-width increases as a function of temperature, and as there is a relatively simple function that relates Doppler half-width to temperature, any thermometer based on Doppler broadening would be able to determine in-situ thermodynamic temperatures.

Figure 2 next page

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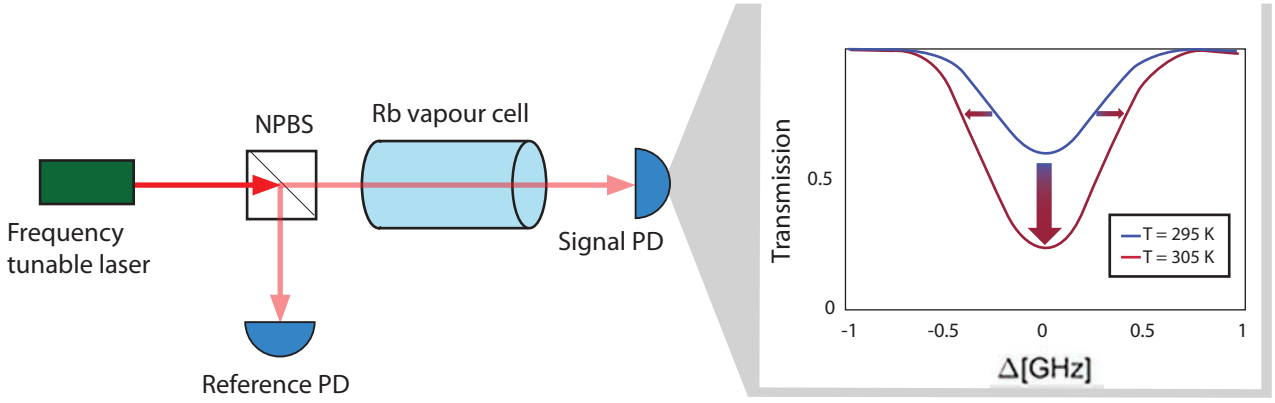

Figure 2: Schematic diagram of Doppler broadening thermometry (NPBS = non-polarising beam splitter, PD = photodiode)

Research is underway between NPL and the University of Strathclyde (Glasgow) to establish a demonstration practical Doppler broadening thermometer in the next three years. [9, 13, 14] The longer-term aim is to package the sensor into the same format as a conventional thermometer – yielding a direct replacement – but capable of delivering direct in-situ traceability to the kelvin. This will potentially give temperatures that are always right, no matter the condition the sensor is used in, over the lifetime of the device/process. Such a sensor should have very wide applicability across sectors – wherever reliable temperature measurement is required.

Prospects

Of course, these novel approaches to thermometry are in their infancy and won't be on the shelf tomorrow. However, in the long term, in-situ thermodynamic temperature measurement by the approaches we've described, or by other means, may lead to a paradigm shift in the way thermometry is performed around the world.

Acknowledgements

Some of the work described in this article is funded by UKRI and the European Partnership on Metrology project PhoQuS-T. The project (23FUN01 PhoQuS-T) has received funding from the European Partnership on Metrology, co-financed by the European Union's Horizon Europe research and innovation programme and by the participating states. The PhD students' work is funded through EPSRC iCASE studentships.

Thanks to Professor Stephen Sweeney for reviewing this text and to Anoma Yamsiri (both at the University of Glasgow) for producing Figure 1. Thanks also to Nicola Agnew and Veronika Vohníková (both at the University of Strathclyde) for reviewing the DBT text and producing Figure 2.

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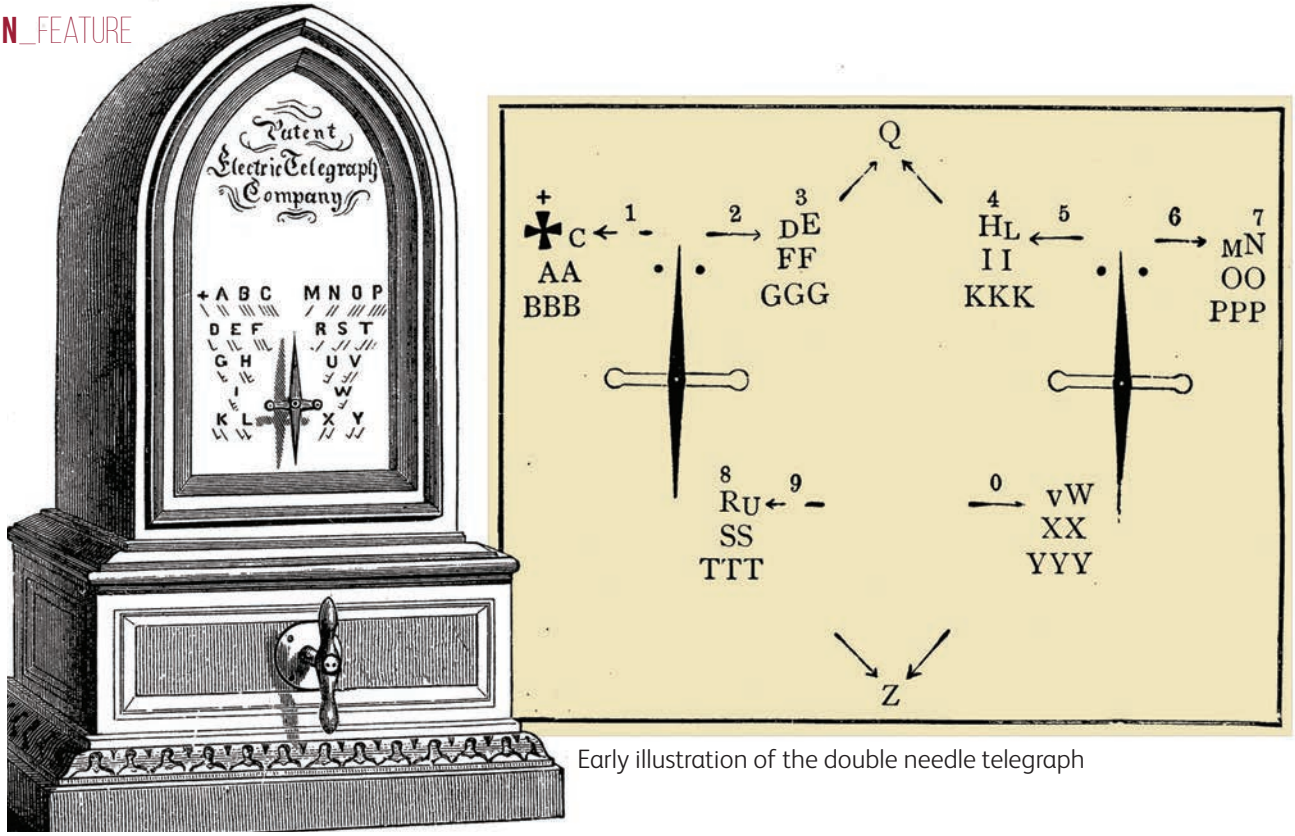
Meet the author

Professor Graham Machin is a Fellow of the Royal Society, and of the Royal Academy of Engineering, and a Senior NPL Fellow in Temperature Measurement. He has more than 35 years' experience in thermometry research, has published and spoken widely about temperature measurement, and is a globally recognised expert in the field. Professor Machin is a past president of the Institute of Measurement and Control (2018–2019) and received the Institute's Sir Harold Hartley Award in 2021 for "outstanding contributions to measurement and control".



Early illustration of the double needle telegraph

THE COOKE AND WHEATSTONE TELEGRAPH: PIONEERING ELECTRIC COMMUNICATION

BY PETER NORMAN, MINSTMC, MIET

Few inventions have transformed human interaction and communication technology as profoundly as the telegraph. The Cooke and Wheatstone telegraph stands out as a significant design milestone in the 19th century, playing a crucial role in the evolution of long-distance communication.

The telegraph's development came during a period of rapid advancement in electrical science. The collaborative work of inventors Sir Charles Wheatstone and William Fothergill Cooke culminated in a system that laid the groundwork for modern telecommunications. Their 1837 design enabled the fast transmission of messages over long distances, employing the galvanometer principle from previous researchers. Using a series of wires and electromagnets to switch the DC polarity from a battery, operators were able to send coded signals by deflecting the needle pointers clockwise/counterclockwise with reference to the diagonal letter grid.

Five pointers working to the angles grid covered most alphabetic characters. Missing characters could be represented by other characters, e.g. available KS = omitted X, and KW = omitted Q. Leaving out certain letters enabled five pointers instead of six, which was cheaper and needed only five copper wires, and spelling mistakes had to be accepted by human message readers. Copper wires and the installation between points of communication was very expensive, and insulated wires even more so. Therefore, the five bare copper wires were ideally run overhead on wooden telegraph poles for adequate wire spacing.

Expensive systems could only be afforded by rich institutions such as the railways for messaging over distance between stations, with a line of telegraph poles erected along the trackside. The receiving instrument would be the same as the transmitting instrument.

Various telegraph indicators were built with only one or two pointers,

with suitable codes worked out for adequate messaging. This helped reduce the wiring costs, especially when wires had to be run at ground level and crudely insulated in terms of weather resistance.

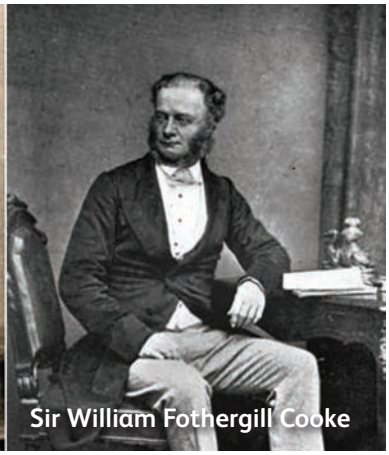
In January 1845, the instrument enabled a warning message to be sent to the police in London to arrest a known murderer, who was seen boarding a train from Slough to Paddington. This incident brought the telegraph greater public attention, which led to its wider adoption.

Robert Stephenson was a strong supporter of the electric telegraph and advocate for its development, having used it on railway lines of increasing length. In February 1845, he played a significant role in the completion of an 88-mile London and South Western railway line from Nine Elms to Gosport using the technology. Stephenson was also involved in forming the Electric Telegraph Company in 1845.

This represented the birth of telegraphy for non-military purposes. Previous, non-electric devices provided warnings of invasions or the status of distant battles. From this new milestone, telegraphy developed using robust cable designs, Morse code, telephony and wireless/radio transmissions. Samuel Morse, Lord Kelvin (William Thomson), Alexander Graham Bell and Guglielmo Marconi enter the list of names for credits.

It did not, however, resolve all railway safety problems, especially for single-track working of bi-directional rail traffic with long tunnels. Sometimes the indicators failed when the outdoor insulation failed. Human factors caused errors in message reading/sending for correct flag signals to train drivers. Sometimes there were too many humans multi-tasking when too many trains were running close order. Between 1840 and 1842, the Board of Trade recruited railway inspecting officers from the Corps of Royal Engineers to investigate the causes of the accidents. The railway system then needed mechanical interlocking logic to reduce avoidable human errors.

Sir Charles Wheatstone



Sir William Fothergill Cooke

William Fothergill Cooke and Charles Wheatstone's electric telegraph ("needle telegraph") from 1837 now in the London Science Museum. By Geni - Photo by User:geni, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=6503269

Q&A

Andy Augousti

Andy Augousti, Professor of Applied Physics & Instrumentation at Kingston University and incoming InstMC President from 2026, shares his thoughts on strategy and future plans for the Institute and how the development of apprenticeships is key to the future of engineering.

What was the root of your interest in Engineering?

My background is originally theoretical. In fact, my first degree was in theoretical physics and my PhD was also theoretically based, but I've always been interested in practical things too. I've been working in jobs of one kind or another, usually of a manual nature, from an early age and that translated into a hands-on practical approach in many areas. In 1981 I was excited to get my first computer, a Sinclair ZX81, which at that time came with 1 kilobyte of RAM (but could be expanded to a "massive" 16 kilobytes!) and I enjoyed getting to grips with this new technology. After my PhD I felt that I really wanted to be involved in activities that would result in more practical outcomes, so I switched to the field of applied physics, a move that I was very happy to develop and build a career upon. There is a great deal of satisfaction to be had from seeing practical results from your work, with real-world outcomes that are clearly visible. However, I have never lost my interest in theory, and I still enjoy attacking some of the work I do from a theoretical perspective, often building up a model from scratch. More generally, those familiar with me will know that I have a broad range of interests, which is reflected partly in my research, and sometimes in my conversations. I do not like the separation of rational thought and endeavour into disciplines which can often be divisive rather than collaborative and inclusive, and which can sometimes limit seeing the richness that nature offers, including its embodiment in a wide range of human activities including engineering. I also think it is important to recognise that engineering is indeed a human activity, and therefore reflects the tastes, approaches and uncertainties associated with people, a fact that I often try to get across to students when I am teaching.

> I also think it is important to recognise that engineering is indeed a human activity, and therefore reflects the tastes, approaches and uncertainties associated with people, a fact that I often try to get across to students when I am teaching.

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

Over the last few years in particular, the development, implementation and gradual working through of apprenticeships at all levels, up to and including degree apprenticeships, has, in my view, been very positive. I think that the training that many apprentices get, especially in some of our blue-chip engineering companies is second to none. Combining this with the theoretical knowledge and practical hands-on experience at universities and colleges means that Degree Apprentice graduates are extremely well-placed to contribute to the engineering industry now and in the future. I also believe diversity, particularly with more international

students, can bring a broader perspective and help change the culture, with a fresh outlook. There is a much stronger emphasis these days on health and safety aspects during training which is also a very positive development.

I'm really looking forward to taking up my role as President next year and believe that the InstMC and other professional engineering institutions can play their part in shaping how the industry adapts and develops. I would like to take the opportunity here to thank Professor Sheila Smith, our outgoing president, for everything she has done for the Institute, and I hope to continue working on the strategic developments she has helped put in place. I should also like to thank the staff, led by Steff Smith, for their hard work in helping to modernise some of its processes, which have helped in the recent successful renewal of our Engineering Council licence. One of our key priorities is to reverse the decline in our membership numbers, which ties in with potential recruitment of apprentice members. We also need to look at corporate members and seek to make the InstMC their natural home. One of our strengths is the networking opportunities available through the Local Sections and Special Interest Groups and it is positive to see the formation of new networks such as Early Careers and WiMAC. I would also like to build on closer collaboration with organisations such as the Worshipful Company of Scientific Instrument Makers, a pertinent organisation with which we have increasing joint membership, and the National Physical Laboratory as well as others.

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

Well, I think it is easy to say simply invest more and train more! However, I think there is truth in this, and it goes back to the earlier question around a vision for the future and the important role to be played by apprenticeships. Investing time and money into people and skills, particularly over a range of apprentice levels from Engineering Technician to Degree Apprentice, is extremely important. In my interactions with apprentices at all levels I can see how the community that is building up is gradually shaping and improving the culture in British industry, both in terms of upskilling the workforce but also in modernising attitudes, for instance towards diversity and inclusion, as well as placing a greater emphasis on safe systems of working than in the past, and I see these developments and the forward trend as very positive.

What do you do in your free time to relax?

I do like to watch TV and, where possible, I like to listen to music very loudly in my car! My cars have always been very old, following on from my original aim to learn some car mechanics. I certainly did that, learning to replace a wide range of vehicle systems eventually leading up to a whole engine – the old Haines Motor Manuals were so very handy! These days I do almost nothing mechanically because the Engineering Management Systems are so complex there's hardly anything you can do. I also like to play chess online (very badly), primarily in the form of lightning chess, which is fun but if anything it has made me a worse player.

Given one wish what would that be?

I would like to make everyone realise that ultimately there is more to be gained from cooperation than from competition or conflict.

There is a much stronger emphasis these days on health and safety aspects during training which is also a very positive development.

CONGRATULATIONS TO OUR 2025 INSTMC AWARD WINNERS

Professor Stuart Robson, winner of the Callendar Award

We had a fantastic evening honouring our InstMC Award winners on 3 July 2025. Around 55 guests attended The Royal Institution in London to celebrate their achievements as InstMC President Professor Sheila Smith and Prizes & Awards Committee Chair Professor Ken Grattan presented the awards.

Professor Gilberto Brambilla, winner of the Sir Harold Hartley Award for outstanding contribution to the technology of measurement and control, presented the Guest Lecture. We were treated to a fascinating presentation on 'Listening with Light', how optical fibres perform an important role in monitoring the sounds and vibrations of the surrounding environment. We rounded off the evening with a wine and canapé reception, catching up with friends and colleagues. Huge thanks to everyone who attended and congratulations to all our award winners:

Professor Gilberto Brambilla, Professor Stuart Robson, Professor Jim Lynch OBE, Professor Paolo Carbone, Professor Eric Kerrigan, Renishaw plc, Mr John Deer & (in memory of) Sir David McMurtry, Mr Ben Thompson, Dr Eddie Lock, Mr Martin Belshaw, Mr Billy Chow, Ms Claire Jones and Mr Cevn Vibert.

Professor Gilberto Brambilla, winner of the Sir Harold Hartley Award

Ben Thompson receiving the Institute Award for Exceptional Early Career Engineers from Professor Sheila Smith

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MEASURING CORROSIVE GASES WITH CONFIDENCE: A SAFER, SMARTER APPROACH

RETHINKING FLOW MEASUREMENT FOR HYDROGEN GAS

Flow measurement plays a critical role in industrial processes, particularly in the chemical industry, where accuracy and safety are paramount. Traditional flow measurement methods often pose challenges when dealing with highly corrosive gases such as hydrogen chloride (HCl). To overcome these difficulties, clamp-on ultrasonic flow measurement has emerged as a non-intrusive, efficient and safer alternative.

Overcoming the Challenges of Hydrogen Chloride (HCl) Gas Flow Measurement

Hydrochloric acid is a fundamental chemical used across multiple industries, from ore processing to pharmaceuticals. Its production involves the absorption of hydrogen chloride gas into water, with precise control over the gas and water flow rates being essential for achieving the target concentration of 38 % HCl.

At an industrial site producing high-purity hydrochloric acid, the flow of HCl gas into an absorption column was traditionally measured using a differential pressure-based flow meter. However, this method presented several challenges:

- **Low Pressure:** The HCl gas had low pressure.
- **Corrosive Nature:** The gas's high corrosiveness necessitated plastic pipelines and specialised equipment.
- **Complex Maintenance:** The previous system required two shut-off valves for maintenance, which demanded extensive protective measures, including full breathing apparatus for personnel.

In the pursuit of enhanced plant safety and operational efficiency, engineers sought an alternative measurement solution.

Clamp-On Ultrasonic Flow Measurement

Non-intrusive clamp-on ultrasonic flow measurement technology provided a simple yet highly effective option. This method operates by transmitting ultrasonic signals through the pipe walls and analysing their interaction with the gas flow inside. Since there is no direct contact with the medium, maintenance issues are reduced.

Given the low-pressure conditions of HCl gas, there was initial scepticism around the feasibility of ultrasonic flow measurement. However, a four-week trial demonstrated that the technology could reliably and accurately measure gas flow under these conditions. The success was largely attributed to the acoustic properties of the plastic piping, which facilitated effective ultrasonic signal transmission even at atmospheric or negative pressure.

Improved Safety and Operational Benefits

Adopting clamp-on ultrasonic flow measurement delivered several key advantages:

- **Enhanced Safety:** Eliminating invasive components reduced exposure risk, thereby improving workplace safety.
- **Lower Maintenance Costs:** No direct contact with the corrosive gas eliminated the need for frequent equipment replacement and complex maintenance procedures.
- **Accurate Measurement Across All Operating States:** Unlike differential pressure methods, ultrasonic flow measurement technology provided consistent readings across varying flow rates, from system start-up to shutdown.

By leveraging clamp-on ultrasonic flow measurement technology, plant engineers successfully improved both operational reliability and safety while maintaining precise control over hydrochloric acid production. This innovative approach exemplifies how modern measurement technologies can address industry challenges while enhancing efficiency and workplace safety.

To find out more about the capabilities of clamp-on ultrasonic flow measurement in the chemical industry, or to discuss short- or long-term portable flow meter rental options, contact Simon Millington – www.emerson.com | flexim-uk@emerson.com | +44 (0)1606 781 420.

Flexim Instruments UK is an InstMC Companion Company Scheme member.

AN AFTERNOON OF INSPIRATION: VISITING THE RAILWAY 200 EXHIBITION TRAIN

2025 marks the 200th anniversary of the modern railway – a British innovation that's continued its journey across the globe. Through a year-long series of activities and events, Railway 200 is exploring how rail has shaped Britain and the world.

A key part of this celebration is 'Inspiration', a specially designed train featuring memorabilia and exhibits that trace the evolution of rail transport. From the iconic steam engines that revolutionised travel in the 19th century to the high-speed trains of today, the story of our railway is brought to life through engaging displays and fun, interactive tasks for children.

Here at Precision, we set out to see for ourselves what was on offer at the Inspiration train!

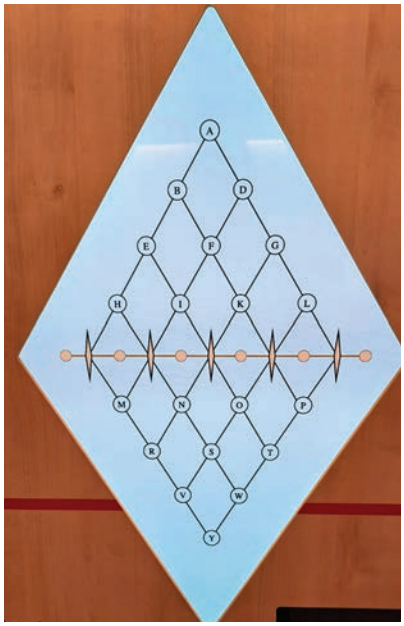
Four themed carriages make up the exhibition: 'Railway Firsts', focusing on key moments in the development of the railway; 'Wonderlab on Wheels', offering hands-on tasks to test your engineering skills; 'Your Railway Future,' showcasing the diverse roles available in rail, with information to encourage visitors to consider careers in the industry; and a 'Partner Zone', which changes with each destination and offers an exhibition space for local stories and activities.

On boarding, visitors are encouraged to process and clip their own tickets, for a nice memento of the experience.

Railway Firsts (Past) sets the scene with technological achievements and fun facts from the Cooke and Wheatstone telegraph invention (which this issue of Precision goes into deeper) and a first drawing of a train by a child in 1825.

Wonderlab on Wheels (Present) – the second stage of the journey – has plenty to satisfy the curiosity of any young, budding engineer!

Shrieks of excitement filled the carriage as youngsters tried their



manager, the exhibition offers lots of information and mini tasks to get a flavour of what is involved in each role.

Inspiration has extended its tour around the country and is now heading towards the North of England and Scotland before making its way back down to the South and South West in November and December. More locations are due to be announced for 2026. To view all the destinations Inspiration is visiting, and to book your free tickets, visit https://railway200.co.uk/inspiration/.

hands at making their own sets of train wheels and testing them on a 'coded' model track with coloured transponders for controlling the journey. A table of kinetic sand, with a holographic train and railway scene projected onto it attracted great attention. When the terrain is moved higher or lower, the trains on the track and the cars on the road either speed up or come to a standstill. It's fascinating to watch and clearly one of the more popular displays in the exhibition.

Your Railway Future (Future) reflects the diverse roles available within the rail industry, in the hope of attracting new talent. From engineer to ecologist, weather analyst to coder, timetable planner to project

WOMEN IN MEASUREMENT, AUTOMATION & CONTROL (WiMAC)

Women in Measurement, Automation & Control (WiMAC) is an InstMC group aimed at raising the profile of women engineers through networking, mentoring and discussion across topics and activities including Leadership, Professional Development, Outreach, Technical Knowledge, Diversity, and Public Speaking. We have asked some of our members and supporters to introduce themselves through a series of short profiles highlighting their career journeys – what inspires them, the skills and knowledge that have helped them develop their roles, and some useful advice on starting out.

We're pleased to introduce two WiMAC supporters – Carolina De la Cruz and Megan Hine – who give us an insight into their roles at Dräger.

NAME: Carolina De la Cruz

ROLE & COMPANY: Account Manager, Fixed Gas Detection Systems

NAME: Megan Hine

ROLE & COMPANY: Senior Business Development Manager – Clean Energy

What originally sparked your interest in engineering?

CDC: I've always been interested in science, which led me to study chemistry for two years. However, I found it too theoretical and lab-oriented for my liking. That's when I decided to switch to engineering, and things became much more engaging and practical. It turned out to be a great decision. My path into engineering was more of a gradual realisation than a clear-cut choice from day one.

MH: Engineering sort of sneaked up on me. I would describe myself as a translator between engineering and lay people – my job in sales is communication focused, and it requires people of all disciplines to understand both the end goal and the process to get there. When you work in an engineering industry such as energy, you need to be able to understand a wide variety of topics and explain them to people who don't. I started working in an outdoor sports shop and was fascinated by the technology that goes into equipment to keep things

> My path into engineering was more of a gradual realisation than a clear-cut choice from day one.

lightweight or strong. Explaining the technology to the general public was a great apprenticeship. From there, I moved into the oil and gas industry and learned on the job, whether it was valves and metallurgy or gas and flame detection and physics.

What do you enjoy most about your role?

CDC: I enjoy helping customers and making complex systems or concepts easier to understand. Being able to explain things clearly and see that 'aha' moment from the customer is very rewarding.

MH: Teaching. My most recent role has seen me responsible for the clean energy strategy for Dräger in the UK and a pioneer for the European methodology. I felt the best approach would be to educate the market about the safety challenges of some new clean energy technologies (because a gas is a gas) to help engineers make the right decision first time. We can't afford to feel our way through an energy transition blindfolded, and nature has made it clear that we don't have the time for trial and error. Many of these gases (hydrogen, CO2, ammonia) exist in other industries, and we are familiar with the hazards. That knowledge just needs to permeate from the food or manufacturing industry into the energy industry.

What skills and/or knowledge do you bring to your current role?

CDC: My engineering background helps me greatly when working with customers, as I can understand both their processes and our instrumentation technology. I've been in instrumentation sales for several years now, so I'm familiar with the technical language and terminology. Combined with strong sales and customer service skills, I believe I bring significant value to my company.

MH: My key skill is communication. I deliver complex information to people who may be more widely qualified than me in the field of engineering, but don't have the depth of knowledge in my niche. People can't make the right choice if they don't understand why the choice is necessary. I translate complex information from Dräger's scientists and engineers to efficiently communicate it to engineers for whom fire and gas hazards make up only a small part of their responsibilities.

What advice would you give to someone starting their career, based on your own experiences and lessons learned along the way?

CDC: My advice would be to remember that everyone starts off without experience and it's something you build as you go. Try not to fall into the trap of thinking "I'm not experienced enough to do that." That mindset can stick with you for years, even when you've gained plenty of experience. It can hold you back from trying new things or going for opportunities that could really help you grow.

MH: Don't underestimate what you can learn on the job. Stay as curious as you can, document your learning where possible, and remember that an idea is only brilliant if other people understand it enough to help make it happen.

If you are interested in joining or supporting WiMAC, visit the website at www.instmc.org/sigs/womens_network/about.aspx or get in touch with us at wimac.chair@members-instmc.org.

> We can't afford to feel our way through an energy transition blindfolded, and nature has made it clear that we don't have the time for trial and error. Many of these gases (hydrogen, CO2, ammonia) exist in other industries, and we are familiar with the hazards. That knowledge just needs to permeate from the food or manufacturing industry into the energy industry.

WE INVITE YOU TO JOIN THE

InstMC Early Careers Network

ECN

Early Careers Network 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.

- 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

As part of our regular introductions to the InstMC Early Careers Network Leadership Team, we are pleased to introduce Co-Chair, Kieran Lyons, who shares what inspired him towards a career in engineering and why he was keen to get involved in the ECN.

Name: Kieran Lyons

Role & Company:
Air Products,
Senior Project Engineer

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

It was quite simple really. I like mathematics, and I like making things work; engineering was a natural choice. I also enjoy the huge range of applicability. I have had the good fortune to work on telecommunications, software development, scientific instrumentation, combustion physics, industrial gases, cryogenics and more. This sort of variety is rare in professions, contributing to how fulfilling an engineering career can be.

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

Engineers tend to form deep specialisms in their career. This has benefits but can risk siloed thinking, both within organisations and across sectors. I would like to see more engineers take up multiple specialisms or get training outside of their areas of expertise. I think it has the potential of sparking more creativity.

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

My colleagues and the wider engineering community supported me a great deal while I was applying for Chartership through the individual route. After passing that milestone in my career, I wanted to return the favour and support others. The Early Careers Network aims to support engineers at a few critical moments: getting the first few jobs, applying for chartership and deciding on a management or specialist path. I am delighted to be a part of the network and hope that it can be a forum that enables people to give and receive guidance.

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

It would have to be one of the old greats like Leonardo da Vinci. His mastery over such a broad range of topics, his curiosity, and his clear drive would be something to behold. On top of that, the ingenuity and beauty of many of his designs mix form and function in a very pleasing way.

> Engineers tend to form deep specialisms in their career. This has benefits but can risk siloed thinking, both within organisations and across sectors.

For more information on the activities and upcoming plans for the Early Careers Network, see the Focus on a SIG feature in this issue. If you would like to join ECN, visit your membership account page on the InstMC website and tick the 'Early Careers Network' box under Special Interest Groups.

FOCUS ON A SIG NEWS ROUND-UP

Find out all the latest news, plus upcoming activities from the InstMC Special Interest Groups.

Early Careers Network

The Early Careers Network (ECN) continues to grow and support early-career professionals across the UK, with a busy summer of activity, engagement and development.

As a quick reminder – at the InstMC, "early career" typically refers to anyone working towards professional qualification or who is within 15 years of starting their career.

Representation at Council

We're pleased to share that ECN representatives have now exercised our newly granted voting rights at the InstMC Council. This marks a significant milestone in ensuring early-career voices are heard at the highest level of the Institute.

Industry Engagement

Our team has been actively promoting the value of professional registration and early-career development through visits and events at major organisations including Siemens, Endress+Hauser, Amazon and United Utilities. These activities raise awareness of the ECN and the broader benefits of InstMC membership, particularly among apprentices, graduates, and those just starting out.

Educational Outreach

We proudly supported the Manchester Minesweeper Competition at The University of Manchester, which brought together Year 9–11 students to explore careers in measurement and control. Initiatives like this are key to inspiring the next generation of engineers and technicians.

Apprenticeship Recognition

As part of our ongoing commitment to vocational pathways, the ECN was involved in judging the Central North-West Local Section's Apprentice of the Year 2025. We look forward to presenting the award at the ceremony later this year and continuing to champion apprentice achievement.

Promotional Activity

In collaboration with the North Central Local Section, we've rolled out ECN-branded materials across Chesterfield College to raise the visibility of both the Network and the wider Institute.

Mentoring Programme Launch

We're currently developing a structured mentoring programme to connect early-career members with experienced professionals across the Institute. The initiative will support members through professional registration, career challenges, and long-term development. If you're interested in becoming a mentor, or would benefit from having one, please contact us at ECN@members-instmc.org.

Spread the Word

Another quick reminder: student membership is free, and members under 35 receive discounted rates. Full membership for under 30s is just £89. If you know an apprentice, graduate or early-career colleague who could benefit from ECN support, please encourage them to join the InstMC.

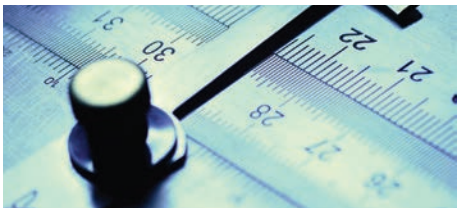
Get Involved

We're always keen to hear from members who want to contribute – whether that's representing your local area, supporting outreach, or sharing your career story at events. There are plenty of ways to be part of our growing network.

Thank you to everyone who continues to support ECN activities. We look forward to building on this momentum in the months ahead.

Ben Thompson
Co-Chair, InstMC Early Careers Network
ECN@members-instmc.org

Measurement



Active membership of the InstMC SIGs is a fantastic way to maintain an external perspective. It brings opportunities to be part of the future of your profession while developing your CPD in a direction you choose, without the restrictions that come with a corporate role. New perspectives and ideas are always welcome – and with networking and support, you can make a huge impact on the UK and beyond.

The Measurement SIG aims to be a cross-sector group delivering improved implementation and understanding of robust and reliable measurement and associated best practice. So, as we push ahead with this mission, we are keen to engage people from diverse backgrounds who share our passion for delivering confidence in measurement.

This year, our in-person meeting was open to anyone with an interest in measurement and metrology. It was a great success, with a fantastic mix of disciplines and career length represented. The focus of discussions was on identifying gaps, and the Measurement SIG's potential role in fixing the gaps, in awareness of measurement as a career, involvement in developing international standards, with a focus on ISO 10012, and national recognition of skills and techniques.

The outcomes of the meeting have shaped the Measurement SIG's activities going forward. We already had a strong relationship with the NMSA SIG, but have built a closer relationship with the Standards SIG and developed ideas on how to support one another, which is helping define the difference in our roles. We look forward to building similar relationships with the other InstMC SIGs.

Although the landscape has changed since the Measurement SIG was set up, our mission remains the same: to be a cross-sector group delivering improved implementation and understanding of robust and reliable measurement, and associated best practice.

We are now building a series of online seminars which will focus on the International Measurement System (including international standards), Technology Transfer (cross-industry), Recognising Career Options (and how many people really are measurement professionals!). These will be launched in the autumn. We hope you will be able to join us, listen to an inspiring new perspective on the importance of robust measurement, and discuss the material with cross-sector scientists, engineers, academics and more.

If you would like to give a talk (we're open to suggestions!), join the seminar meetings or working groups (focused on careers and technology transfer), or perhaps get involved behind the scenes, we look forward to hearing from you at measurement.sig@members-instmc.org.

Claire Elliott
Deputy Chair, Measurement SIG

National Metrology Skills Alliance (NMSA)

The NMSA-1 and NMSA-2 standards have now been in place for just over a year, with great take-up from NMSA members and beyond. Several companies have been updating their internal skill and role standards to align with the NMSA. The NMSA-3 standard is the process by which individuals can become qualified as metrologists to the NMSA-1 and NMSA-2 standards. There has been some great progress on this, with a pilot of the process complete. Based on this the process and forms have been revised and a further pilot is planned. The NMSA group is expecting the NMSA-3 process to be available later in 2025, with a more formal launch early in 2026. This will give metrologists a standard route to recognising their skills and enable employers to quickly identify candidates with the right skills.

Phil Bamforth
Chair, NMSA

Women in Measurement, Automation & Control (WiMAC)

Our group has been actively working on several exciting initiatives. We are continuing to explore mentoring opportunities and are in discussions about rolling out a comprehensive mentoring programme aligning with the ECN. This initiative will connect experienced professionals with those seeking guidance and support in their careers. If you are interested in becoming a mentor or being mentored, please reach out to the WiMAC Chair at Wimac.Chair@members-instmc.org.

We are also dedicated to showcasing the incredible talent within our industry. Through our Q&A sessions featured on the WiMAC section of the InstMC website, we highlight the achievements and insights of women in measurement and control. These stories not only celebrate individual successes but also inspire others in the field.

In addition, we are focused on growing our presence within the industry and aligning with similar initiatives from other engineering societies. By collaborating, we aim to amplify our impact and foster a more inclusive and supportive environment for women in engineering.

Looking ahead, our next project involves creating an educational package for schools. This initiative will highlight the importance of women in engineering, the value of diversity in the sector, and the many benefits of a career in engineering. We believe that by reaching out to young students, we can inspire the next generation of engineers and promote a more diverse and innovative industry.

We are excited about these initiatives and look forward to making a positive impact.

If you would like to be involved or have any comments, feedback or suggestions, please reach out to Wimac.Chair@members-instmc.org

Claire Jones
Chair, WiMAC

If you are interested in joining, or finding out more about the InstMC Special Interest Groups, please visit https://www.instmc.org/sigs/about_sigs.

LOCAL SECTION NEWS

CENTRAL NORTHWEST

Technical Talks

Since the last edition of Precision, our technical programme activities have moved forward, with the following talks held online:

- Fortifying Operational Technology: Navigating Cybersecurity Challenges in an Uncertain World, by Steve Lane of Capula
- Control Valve Performance, by Pal Galik of Emerson

All sessions are now available on the Institute's YouTube channel: https://www.youtube.com/channel/UCM-SCCcAMxM7LfMzVgGCq0A

The autumn programme will be confirmed after the summer break.

Chris O'Hara, our Technical Secretary, is looking for presentations for the autumn and is developing the programme for 2026. If you are interested, please contact the section chair at CNW_chair@members-instmc.org

Company Engagement

We've been working with companies to share the importance of professional engineering institutes, particularly the InstMC.

- In June, we teamed up with the Early Career Network (ECN) to present to apprentices at Siemens (including Amazon apprentices) on the benefits of membership and professional registration.
- In July, Endress+Hauser invited us along to their customer week, where I gave the keynote on the customer day and the student day. We had many interesting conversations about greater engagement between academia, industry and the InstMC.

2025 Awards

Apprentice of the Year – At the Endress+Hauser customer week, I was delighted to inform Harvey O'Rourke that he had won Apprentice of the Year. Harvey had been nominated by Endress+Hauser without his knowledge. We look forward to welcoming Harvey to the Awards Night in October and we'll share more about why he won the award in future updates.

Early Career Engineer Award – At the time of writing, the winner of the Early Career Engineer Award has not been announced, but we look forward to welcoming them in October.

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.

- University of Manchester – Sella Controls
- Liverpool John Moores University – ITI Group
- Early Career Engineer Award – NEW sponsor of ITI Group
- Apprentice of the Year Award – NEW sponsor of Capula

Please follow the section LinkedIn page and newsletter, where we'll share more about these sponsorships and the companies behind them in the autumn.

Podcast

Following the launch at the end of 2024, we're evaluating how we create, share and administrate our podcast. This took us a little longer than hoped, but fear not, episodes 2 and 3 are now 'in the can' and will be launched before the end of the year.

- 'What's it like to be on a standards committee?'
- 'The history of IEC 61508'

We are delighted that these both include the contributions of Ron Bell OBE, who was instrumental in the development of standards in functional safety. Ron led the teams who developed the programmable electronic systems (PES) guides, which then migrated to the development of IEC 61508. Tune into episode 3 to hear Ron share his fascinating story.

Episode 4 will explore the role of women in engineering, with Claire Jones from Endress+Hauser and Megan Hine from Dräger.

The ECN is keen for one on early careers or apprenticeships.

We'd love to hear what instrument, measurement and automation topics you'd like us to explore. Note that episodes 3 and 4 include functional safety content.

Our podcasts are available on YouTube, YouTube podcasts and Spotify. Links are available from the News page of the local section on the InstMC website: https://www.instmc.org/sections/north_west/news.aspx.

Committee News

The Chair position will change by year end, but I shall continue until I take up my Vice-President role on 1 January 2026. More news on the team make-up will be shared in the next edition.

Dave Green
Chair, Central North-West
CNW_chair@members-instmc.org

LOCAL SECTION NEWS

CENTRAL SCOTLAND

The Central Scotland Local Section was invited to a tour of Stewart-Buchanan Gauges in Kilsyth on 2 April. An employee-owned, 150-year-old company, Stewarts specialise in the design and manufacture of gauges and manifolds for measuring pressure and temperature. 98% of all components used in their products are designed, manufactured and assembled in house.

Steven Biggs
Chair, Central Scotland

NORTH OF SCOTLAND

All seats were taken for the North of Scotland Local Section Technical Bite Night with Erik Blok of Phoenix Contact, who develop and produce components, systems and solutions for distributing and controlling power and data flow across industries. The topic of conversation was Ethernet-APL (advanced physical layer), which is fast becoming the new standard to supersede HART and fieldbuses.

If you're interested in attending our technical events, make sure you're on our mailing list and that our notifications are not going into your spam folders. There's always great networking to be had! Visit https://www.instmc.org/sections/north_of_scotland/events.aspx to keep updated on our upcoming activities.

Sandy Leitch
Chair, North of Scotland

NORTH-EAST

Technical Visit to I'Anson Bros – Animal Feed Mill, Thirsk

We were initially concerned whether a visit to an animal feed mill would be of interest to our members and guests. As it turned out, the mill had advanced process control and measurement systems that made the tour very interesting.

Their CEO was scheduled to give a 15-minute overview of the history of the company and how the new mill came about. His enthusiasm led to an enjoyable one-hour review of his family business!

The tour began with the control system, and we then followed the raw materials through the process right to the final loading of the wagons ready for delivery.

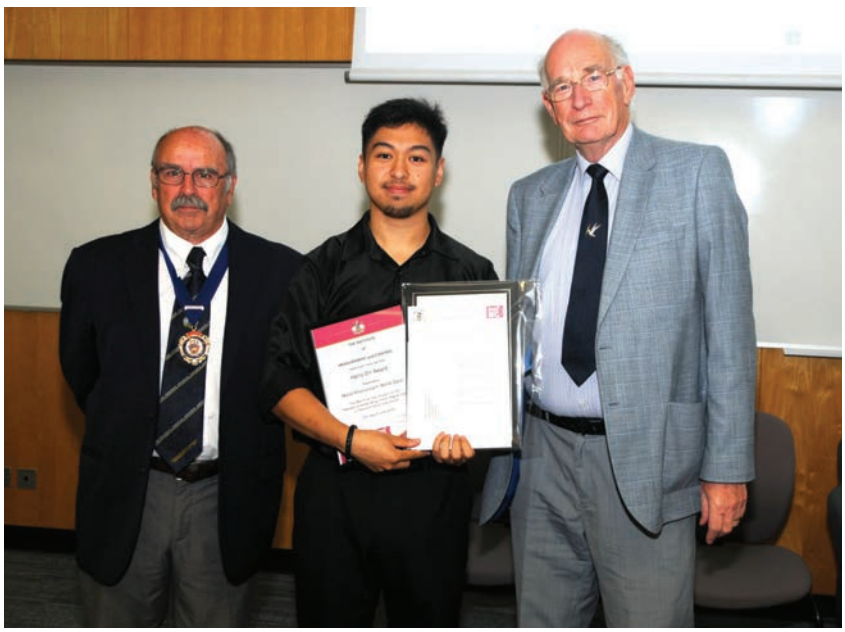
Quality control of the source ingredients is very important for I'Anson Brothers. Ingredients are inspected and tested before offloading and any that fail are rejected and thrown away. The ingredients are then chosen for their individual nutritional benefits for the product being manufactured. The recipe is determined by animal type, because certain animals are susceptible to certain minerals and chemicals. Sheep, for example, can't be fed feed stuff containing copper.

Recipes are processed in such a way that the machinery clears unwanted mineral content. An automated weighing system works out the quantity of each ingredient before sending it through the blending, grinding, mixing and cooking phases. The final product is then extruded into pellets, loaded into wagons and dispatched to the customers.

We are very pleased with how the visit went, other than the talk running over and making it a late finish. The attendees we spoke to said they enjoyed the tour. Seventeen of the 18 people who had registered attended.

Harry Orr Award 2025

Each year, the North-East Local Section presents the Harry Orr Award to the best student completing an HNC or BEng in Instrumentation and Control Engineering at a local college or university. This year's recipient is Mohd Khoirunzaim Mohd Daud, who achieved BEng (Hons) Instrumentation and Control Engineering with first-class honours. Khoirunzaim was presented with his award on 12 June 2025 by John Noon (Section Chair) and Colin Howard.



Mike Vowell
Hon Secretary, North-East

LOCAL SECTION NEWS

SOUTH-EAST

Our South-East Local Section have had a successful year of events, hosting webinars in a series dominated by net zero, telecoms and cybersecurity.

Our final lecture was our first hybrid presentation on 'Green Hydrogen Design, Control and Optimisation'. Rudi Bott from Honeywell presented on the enabling technologies of digital twins, AI/ML optimisation and predictive analytics aiming to make green hydrogen production more efficient, cost-effective and scalable.

In January, we co-sponsored the 6th National Symposium on Developing Socially Responsible Professionals at City St George's, University of London. A mix of keynote speakers, workshops and panel discussions, the event aims to develop a generation of professionals aware of the impact of their decisions and the role their ethical behaviour has on society, the environment and resources. We hope to grow our relationship with the university through further shared activities and events.

In June, a group from the Section attended the NPL Public Open Day as our Site Visit. The display of measurement science technology was overwhelming. We were there for the gates opening, and even after we were herded out six hours later, we hadn't seen it all! Sadly, cameras were not permitted.

We concluded our 2024/25 season with a social networking evening at The Union, Paddington station, which is rapidly becoming a popular annual event.

Our 2025/26 season kicks off in September, with Neil Golding of EIC presenting the big picture with 'Economics in the Energy Industries', followed by a presentation on robotics by Julian Ware in October, and Robert West of the CBI presenting on 'Development of Socially Responsible Engineers' in November.

We'll have our AGM in November and will be looking for volunteers to refresh our ageing Committee, from top to bottom. For all the latest on the South-East Local Section activities, visit https://www.instmc.org/sections/london/events.aspx.

Malcolm George
Chair, South-East

OUR CORE TEAM

OFFICERS

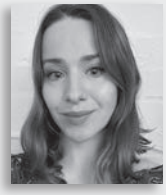
President
Sheila Smith

Honorary Secretary
Billy Milligan

Honorary Treasurer
Stewart Macfarlane

Chief Executive
Steff Smith
steff.smith@instmc.org

Marketing Executive
Ernest Kyei
ernest.kyei@instmc.org



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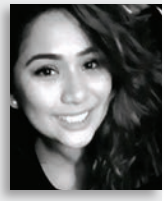

Project Manager
Caroline Trabasas
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To contact us by telephone please call our office number: +44 (0) 20 7387 4949

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Functional Safety

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Do it Once

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Topic 3 Double Jeopardy on Trial - A common HazOp misconception examined

Topic 4 Debate - BPCS failures and BPCS independent protection layers

Topic 5 What's new with IEC 61511 Edition 3

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