THE MAGAZINE OF THE INSTITUTE OF MEASUREMENT AND CONTROL INSTMC.ORG

JAMES BRADLEY'S MEASUREMENT OF THE SPEED OF LIGHT

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MARCH 2025 ISSUE 35

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MEASURING THE MONUMENT

Late last year, the Lord Mayor of the City of London, Michael Mainelli, held a set of scientific trials as part of his mayoral theme, 'Connect to Prosper'.

The Experiment Series brought together academic researchers and industry experts to underscore the City's strength as a knowledge hub where academia and business unite to solve complex challenges. Over 40 learned societies, 70 higher education institutions, and 130 research institutes exist in and around the City of London, making it the world's most successful concentration of interconnected knowledge networks. A place where science and finance meet to find and to fund the solutions to global challenges.

To end the series, City St George's, University of London helped to settle a 350-year-old question about the Monument to the Great Fire of London – could the Monument really be used to show that the Earth revolves around the Sun? The great polymath, Robert Hooke (1635 – 1703) originally put forward the idea that the Monument, erected to celebrate London's recovery from the Great Fire of 1666, could also act as a giant telescope for viewing the stars and measuring their movements.

Specifically, Hooke wanted to try and prove what was then the controversial theory that the Earth revolves around the Sun and not the other way around.

The 'Measuring the Monument' initiative was led overall by Past Master of the Worshipful Society of Scientific Instrument Makers and InstMC Honorary Fellow, Professor Philip Thomas, with contribution from the InstMC's Professor Ken Grattan (through City Optotech Ltd) measuring the pillar's movement directly using a contact fibre optic method, and also Imetrum, a sensor company who used their own novel non-contact technology, employing very sensitive cameras to observe the movement of structures over time.

All those involved, then presented their findings at an evening event hosted at the Guildhall Art Gallery. Together, the 'Measuring the Monument' experiments showed that the Monument pillar, was indeed, unsuitable for measuring the stars' movements. This is because, although the tower was built to be as rigid as possible, its tall structure would always make it prone to vibrations, and those vibrations are big enough to stop the positions of the stars being measured accurately.

Up to now, the limiting factor has been thought to be road traffic – with this theory dating back to the 1670s – but the advanced measurement methods show that wind gusts, even moderate breezes, pose an even greater problem. Robert Hooke was up against the forces of nature as well as human-made vibrations. The Monument could not, in the end, double up as the telescope Hooke had designed it to be.

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BRIDGING THE GAP BETWEEN DATA AND ACTION

Lead Engineer, Ercihan Kiraci, talks about his role at Warwick Manufacturing Group (WMG), University of Warwick.

"Don't worry, everyone does it", Ercihan recalls being told, as his first measurement job resulted in a smashed probe head straight into a workpiece. "It's never been easy to be a metrologist", he says, "whether you are programming hundreds of thousands of pounds of equipment, or telling your superiors, again, that they are out of tolerance and there is no way to mate these two components and measuring it again won't help." Many different skills are required as well as a tolerance for working under pressure.

Metrology forms the bedrock of modern engineering and as we look to the future, it will become an increasingly important area of development. It was back in 2006 that Clive Humby coined the phrase "data is the new oil", and whether companies realise it or not, they are sitting on massive reserves in their metrology department. "The skills and technology requirements to tap into this reserve are only going to increase", says Erichan, "and this presents an opportunity for the UK High-Value Manufacturing sector to embrace and lead the way in the future of metrology. Recently we have seen the UK government pledge significant investment into AI, and this is a very reassuring development. To get value from these models though, we need to provide it with high-quality, reliable data, something that has always been demanded from metrologists."

In the ever-evolving world of measurement and control, Ercihan Kiraci is at the forefront of innovation, shaping the future of digital metrology, his work is influencing industry standards and shaping best practices across high-value manufacturing sectors. At WMG, he oversees all metrology activities within the Centre for Imaging, Metrology, and Additive Technologies (CIMAT) Laboratory at the University of Warwick, a High Value Manufacturing Catapult centre. With nearly two decades of experience, he has focused on implementing cutting-edge metrology solutions to support research and industrial collaborations. Bridging the gap between research and industry, he has successfully implemented digital twin strategies, metrology-driven product validation, and advanced quality control methodologies, developing in-line measurement systems and pioneering precision metrology for EV powertrains.

"The role of metrology is evolving from a mere data supplier to an integral part of Industry 4.0, bridging the gap between the cyber and physical worlds", he says. "Reliable measurement data is crucial for generating value and driving efficiency in manufacturing." By ensuring data quality and security, he believes that manufacturers can optimise design and test cycles, reduce waste, and achieve zero-defect manufacturing. The increasing adoption of IIoT and advanced metrology solutions enables manufacturers to harness the power of data and transition towards knowledge-based organisations. However, challenges such as standardisation, AI investment, data capture, and cybersecurity need to be addressed to fully realise the potential of Industry 4.0.

WMG recognises the necessity of developing engineers who align with future industry trends. Located on the Warwick University campus, the WMG facility boasts state-of-the-art metrology equipment, including an LK twin-column Cordinate Measuring Machine (CMM) and a Kuka robot and rail system, designed for advanced in-line measurement applications. "Our researchers are actively comparing results from these two systems to evaluate their potential for factory-floor implementation,

where significant benefits—such as reduced rework and improved customer satisfaction—could be realised" Ercihan continues and highlights that with increasing automation in high-value manufacturing, vehicle producers are prioritising data collection and process optimisation. WMG with cutting-edge measurement technologies, and strong Industry 4.0 focus, serves as an ideal testbed for in-process inspection solutions, fostering collaboration among OEMs, technology providers, and researchers to tackle manufacturing quality challenges. This setup enables real-world trials of advanced measurement technologies, with performance verification against industry benchmarks. By integrating and independently assessing solutions, WMG helps industry partners select and deploy optimal measurement technologies, driving innovation in manufacturing quality assurance.

At WMG, Ercihan has led the implementation and management of multi-million-pound product projects within a Catapult High Value Manufacturing laboratory. He has overseen substantial investments in metrology equipment and developed new measurement solutions to improve quality, particularly for EV applications. He has been instrumental in developing technology roadmaps and specifications to expand measurement and digital capabilities. Notably, he has worked on projects such as a new in-line measurement cell for automotive Body-In-White (BIW) applications, and an E-Machine metrology facility under one roof, collaborating with major UK-based manufacturers. For Ercihan Kiraci, "Measurement is not just about data collection; it's about deriving actionable insights that drive innovation and efficiency. By leveraging digital twins and AI-driven analytics, we can redefine quality assurance in manufacturing and cybersecurity."

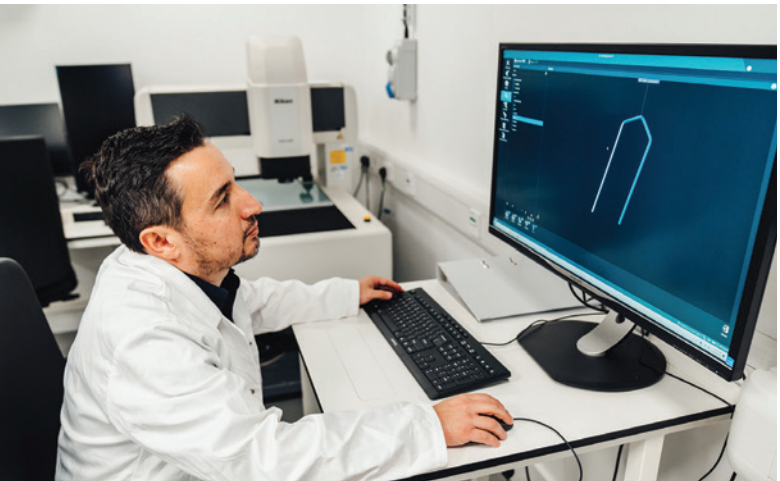
He has led the Dimensional Measurement Management module and other teaching activities at WMG, equipping engineers with the skills needed to navigate the complexities of modern measurement science and solutions. He actively collaborates with industry leaders to drive best practices in smart metrology and as a representative of WMG in key industry working groups such as the Model-Based Enterprise (MBE), Smart Design, Cybersecurity in Manufacturing initiatives, is influencing national and international metrology strategies.

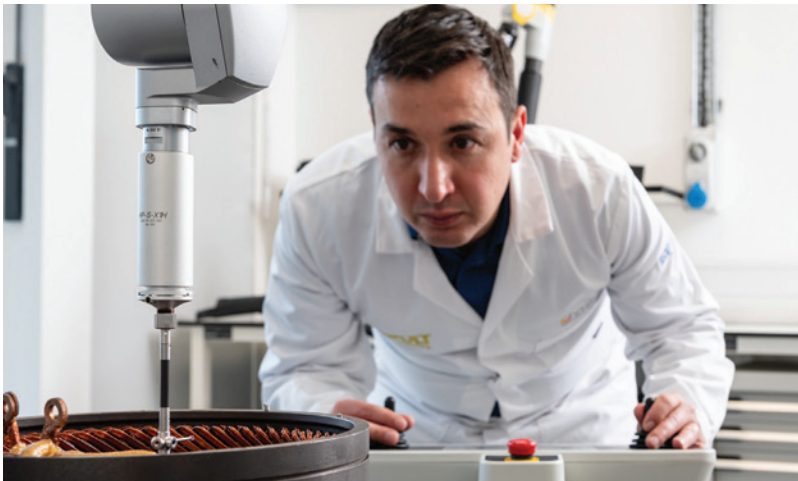
Looking ahead, Ercihan envisions a future where metrology is seamlessly integrated into the broader digital ecosystem. His research continues to explore new frontiers in data-driven quality assurance, AI-enhanced measurement systems, and the role of cybersecurity in metrology. By pioneering advancements in measurement science, he is ensuring that manufacturing remains at the cutting edge of precision, efficiency, and security. As industries worldwide strive for greater precision and resilience, professionals like Ercihan Kiraci remain at the helm of technological progress. His work is not only shaping the present but laying the foundation for the smart factories and interconnected systems of the future.

As manufacturing becomes increasingly digitised, Ercihan recognises the importance of secure and traceable measurement data. His research focuses on integrating metrology with digital thread and digital twin applications, ensuring that data captured from real-world manufacturing environments remains accurate, traceable, and secure. His growing involvement in cybersecurity research highlights a critical challenge: ensuring robust protection of industrial data as it becomes more interconnected.

"Given the growing importance of cybersecurity in digital transformation applications, protecting digital assets and ensuring robust data traceability are key challenges for modern manufacturing," Ercihan explains. His collaborative efforts with WMG's world-leading Cybersecurity Team have resulted in new cross-disciplinary initiatives, hoping to foster innovation and bring a competitive edge to the UK by securing funding to explore cybersecurity frameworks for digital manufacturing. He aims to bridge this gap, leveraging his deep understanding of industrial metrology and data capture to enhance cybersecurity within manufacturing processes. "This aligns perfectly with WMG's focus on Manufacturing: Productive and Resilience and Data and AI Connectivity and Resilience."

For more information on the work produced by WMG, visit https://warwick.ac.uk/fac/sci/wmg/.





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

JAMES BRADLEY'S MEASUREMENT OF THE SPEED OF LIGHT

We now know that the best way to find out where you are is to let your smartphone plot your location on a map. Before atomic clocks and satellite navigation, the problem had been a huge technological challenge for many centuries.

Galileo had proposed a viable solution in around 1610. Soon after observing 4 moons orbiting Jupiter, he realised that their regular movements could be used as a celestial clock. By comparing 'Jupiter moon time' to local mean time, as found by observing the sun, your longitude could be determined.

This was a genuine breakthrough and was used by mapmakers like Giovanni Domenico Cassini when he mapped France in 1668. Sadly, it was never practical at sea because of the need for a steady telescope. A stabilised chair for the purpose was tested unsuccessfully in the 1763 voyage to Barbados at around the time that John Harrison's clocks, and the lunar distance method, were both shown to be effective ways to determine longitude at sea: the lunar distance method using the position of the moon relative to the stars, measured with a sextant, as the celestial clock.

Accurate, long-term observations of the moons of Jupiter were a high priority when the national observatories in Paris and Greenwich were established in the 1670s. Ole Romer, working in Paris, noticed in 1676 that the timing of the moons had a systematic annual shift depending on whether the Earth was moving towards or away from Jupiter. He rightly attributed this to a finite speed of light, c. He calculated c to be 1 Astronomical Unit (AU) in 10 or 11 minutes, 1 AU being the distance from the Earth to the Sun.

We now know that light travels 1 AU in 8 min 19 s, so Romer's work was a good rough estimate. His method required only a basic telescope and a decent clock, regularly calibrated to fit the length of a day, and it was not long before better estimates were available. Newton mentions a value of 1 AU in 7 or 8 minutes, without saying whose observations this was based on.

James Bradley's much improved measurement of the speed of light came from an unexpected direction. He was hoping to measure stellar parallax, which would demonstrate both the motion of the Earth around the Sun, for which there was only indirect evidence at the time, and indicate the distance of some nearby stars. His wealthy friend Samuel Molyneux commissioned a highly accurate zenith sector instrument, which allows you to measure how close a star passes to the vertical. Looking vertically means that the effect of atmospheric refraction on the apparent position of a star is minimised. The instrument was made by George Graham, the best instrument maker of the day, and was 24½ feet long. Moving the telescope with a micrometer allowed the angles to be measured to about 1 arcsecond (a sixtieth of a sixtieth of a degree), but only up to an eighth of a degree from the vertical. It was designed so that one particular bright star (Gamma Draconis) could be observed passing overhead, even when this happened during the day. Stellar parallax would cause an annual variation in this angle.

Bradley found an annual variation, with an amplitude of just over 20 arcseconds, but the timing didn't correspond to parallax, and he realised that the apparent change in direction was the effect of a moving Earth and a finite speed of light. He published his estimate of c in 1728 as 1 AU in 8 min 12 ± 10 s. Not only was this considerably more precise than the previous '7 or 8 minutes', but we can now see that his 2 % uncertainty estimate was remarkably realistic.

Bradley had reached his final result after repeating the exercise with a second zenith sector instrument, 12½ feet long. This one could be accurately moved up to a few degrees from the vertical, allowing more stars to be observed. The second instrument was installed in the observatory of Bradley's uncle, James Pound, in Wanstead, north-east London. The first had been installed in Samuel Molyneux's rather grand home near Kew Palace, within what is now Kew Gardens. It was fixed to the chimney and looked through a hole in the roof.

This Kew building has been knocked down, and the instrument lost, but a sundial was placed at the site to mark its importance. The Wanstead instrument can be seen at the Greenwich observatory, where it was moved to after Bradley became Astronomer Royal.

With hindsight we can see this work as the birth of modern scientific metrology: state-of-the-art instruments, careful independent checks, and realistic uncertainty estimates, combined with the broader scientific understanding to realise that a systematic error which he called 'stellar aberration' – a nuisance for the measurement of parallax – was in fact a measure of a fundamental physical constant.

Next to the sundial in Kew Gardens there is a newly-renovated engraved stone slab that mentions stellar aberration, but not the speed of light, nor the fact that this was the first direct evidence that the Earth orbits the Sun. The sundial was put there in 1852, following the wishes of the late King William IV.

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/

Q&A

Kieran Lyons

Kieran Lyons, Senior Project Engineer at Air Products and Co-Chair of InstMC Early Careers Network, shares his thoughts on the future of engineering and how to harness interest in engineering from an early age.

What was the root of your interest in Engineering?

Being honest, I never had a particular drive to be an engineer when I was younger – my appreciation of the career has grown as I have experienced more of it. Now, I can't see myself doing anything else.

I enjoyed mathematics when I was younger, particularly when the results were tangible and applicable to real-world problems. I didn't have a deep understanding of engineering when I applied to university, and I chose Aerospace Engineering for quite arbitrary reasons. At the time, it simply seemed interesting. While studying, I gravitated towards control theory, thermodynamics, and fluid mechanics as their broad applicability captured my imagination.

Throughout my career, I have been blessed to experience a wide range of sectors and roles within engineering, from leading a team supporting telecommunications, to conducting practical experimentation on explosive atmospheres. Most recently, I have joined Air Products to deliver industrial gas projects. I find it extremely fulfilling to apply my skills to new challenges in new contexts and hope to continue for many years to come.

Beyond the technical challenges, what has truly stood out is the wider engineering community. I have had the great pleasure to work with professional, diligent, and kind engineers and scientists throughout my career, and am grateful for the opportunity to learn from each of them. I have also had the privilege to present my work on hydrogen safety at international conferences and collaborate with my peers at the International Association for Hydrogen Safety. I have found engineering as a sector to be extremely open and supportive, especially through my journey to Chartership via the individual route. I am eager to reciprocate by engaging with the InstMC and the Royal Academy of Engineering in support of early-career engineers.

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

It is an exciting time to be an engineer in the UK. The next ten years are full of uncertainty, and we could see substantial change that impacts all aspects of society, but engineers are uniquely positioned to face the inevitable challenges and seize any opportunities that arise. Combine this with a large contingent of UK engineers set to retire in the next decade, and current early-career engineers, students, and apprentices are likely to hold leading roles.

Between the ambitions of Net Zero, the potential of artificial intelligence, and the economic challenges looming over the entire globe, I find it difficult to make definitive statements about the future. Anything could happen.

Converting the national energy network to sustainable alternatives is a colossal-scale undertaking with very deep and nuanced complexities. Electrification of heating and transport would place too high a burden on the current infrastructure, meaning not only new electricity generation is required, but new transmission and distribution to cope with the additional load. This leaves a gap for competitive alternative energy carriers such as hydrogen. The conversion of the Victorian gas network to hydrogen could alleviate the electricity demand for heating; however, this is also not trivial. Upgrading domestic boilers alone could keep all the Gas Safe technicians busy for a very long time! Transport faces similar challenges in balancing efficiency, accessibility, and safety. Perhaps the solution will be clear with hindsight, but I cannot see it from where we are.

Similarly, the rapid advancement of AI presents its own set of challenges and opportunities. AI developers have grand expectations for the technology. Visions of nuclear-powered supercomputers outperforming professionals in all sectors and accelerating innovation to unparalleled levels. Such success would not only change how we live, but even challenge our conception of what it is to be human. The ramifications could be dramatic. However, engineers will be instrumental in the development and implementation, as well as being early adopters.

Overshadowing all this: the economic risks. How will these changes be funded? How can the repercussions be mitigated? The reality is that failure is an option, particularly considering the current progress towards the climate goals. The good news for engineers is that even a shift from preventative to adaptive strategies will still require our expertise.

I am eager to plunge into the uncertainty ahead. I hope you will join me in the Early Careers Network at the InstMC where, together, we can navigate the challenges of the coming decade.

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

A fully trained engineer takes a long time to form, so to address the immediate shortage, the UK could consider attracting engineers from abroad as a pragmatic step. However, to cultivate a sustainable pipeline of talent, I believe the key lies in reforming the education system, with a focus on primary and secondary levels.

> I have had the great pleasure to work with professional, diligent, and kind engineers and scientists throughout my career...

While I personally enjoyed mathematics at school, it is no secret that many students develop a lifelong aversion to the subject. This often stems from a one-size-fits-all teaching approach that doesn't consider the learning styles of each student. Some thrive in competitive environments, while others need patient, one-on-one support, and some benefit from independent exploration. The key is to individualise education to cater to these different needs, allowing each student to reach their full potential. In my view, the time has come to move away from outdated educational models that prioritise conformity over creativity and critical thinking. By encouraging curiosity, problem-solving, and numeracy skills from an early age, we can inspire more students to consider engineering as a viable and rewarding career path.

What do you do in your free time to relax?

I would say I have great ambitions to relax! Living near the Peak District, I would love to spend more time in nature exploring the beautiful landscapes. I also have a reading list that grows every year. My greatest passion, however, is sailing on the ocean - I relish the sense of freedom and adventure! One of my long-term aspirations is to go island-hopping on the Mediterranean.

The reality, though? I spend all my free time with my young family, mostly building towers out of blocks and reading picture books. Perhaps I'll find time for a hobby once I've caught up on sleep!

Given one wish what would that be?

I definitely should not be trusted with my wishes! If I managed to not be entirely self-serving, I would wish for something clichéd like world peace. A lot of effort goes into destruction, and I wonder how much greater the world could be if that effort was channelled into building structures, systems, and relationships.

COMPANION COMPANY SCHEME

Raise your profile amongst our membership of 3000+ professional engineers

Since our Companion Company Scheme (CCS) was launched in 1992, hundreds of large, medium and small enterprises have become members, enjoying a range of benefits. We offer opportunities to network with other businesses, InstMC accredited universities and with individual members at local and regional level through our Local Sections and Special Interest Groups. Company membership is open to universities, research and development organisations and companies with an involvement in measurement, control and automation.

Benefits include

- Opportunity to promote networking events and services to the wider membership
- Introduction to all the InstMC Local Sections with the potential to give technical presentations and sponsor events
- Participate in Special Interest Groups to develop company knowledge
- Opportunity for qualified employees to apply for specialist engineer status; RFSE (Registered Functional Safety Engineer) and RExE (Registered Explosives Atmosphere Engineer)
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- Use of InstMC logo on your website, stationery and marketing materials
- Receive a copy of the Institute's quarterly magazine, Precision
- Discount on cost of training approval and endorsement

About the InstMC

The Institute of Measurement and Control (InstMC) is a Professional Engineering Institute (PEI) and international network of engineers and scientists working within the measurement, automation and control fields. Founded in 1944, the InstMC is recognised by Royal Charter as a learned society and is licensed by the Engineering Council to assess individuals for professional registration.

www.instmc.org

For further details about the Companion Company Scheme, please visit our website or contact Ernest Kyei: ernest.kyei@instmc.org

Scan QR Code for direct access to the Companion Company Scheme web page

IMC/CCS101-042023

MONITORING POLLUTED HIGHWAY RUNOFF: A MODERN ENVIRONMENTAL SOLUTION

Polluted water from motorways and highways is a significant environmental concern, contributing to the degradation of aquatic ecosystems and posing risks to human health. When vehicles travel on these roads, they deposit various pollutants such as oil, heavy metals, and tyre particles. Rainwater washes these contaminants into nearby waterways, resulting in polluted runoff. This runoff can then lead to the deterioration of water quality, harm aquatic life, and disrupt natural habitats.

Clamp-on ultrasonic flow measurement – an innovative solution

One innovative solution to monitor and manage this runoff is clamp-on ultrasonic flow measurement technology. Unlike traditional flow measurement methods, which often require invasive installation techniques, clamp-on ultrasonic flow meters offer a non-intrusive alternative. These devices are easily attached to the exterior of pipes, allowing for accurate flow measurement without the need for pipe modifications or system shutdowns.

Successful implementation in Belgium

As a leader in this technology, Emerson's Flexim clamp-on flow measurement systems are being implemented across Belgium to monitor highway runoff. By providing precise data on the volume and flow rate of runoff water, authorities are able to assess the extent of pollution and take timely action to mitigate its impact. The data collected helps in devising effective strategies for water treatment and pollution control, ultimately protecting the environment and public health.

Benefits of clamp-on ultrasonic flow measurement

The benefits of clamp-on ultrasonic flow measurement are manifold. The installation is straightforward and cost-effective, eliminating the need for any pipe modifications. Additionally, the technology is highly accurate and reliable, capable of measuring flow rates in various pipe materials and sizes. It also provides real-time data, which is crucial for timely decision-making and environmental management.

A call to action

Those facing similar challenges with highway runoff, could benefit greatly from adopting the Flexim approach. Implementing clamp-on ultrasonic flow measurement systems would allow for comprehensive monitoring of this runoff, helping to identify pollution hotspots and prioritise remediation efforts. By investing in such advanced technology, environmental protection measures can be enhanced, ensuring cleaner waterways and healthier ecosystems.

The integration of clamp-on ultrasonic flow measurement presents a practical and efficient solution for monitoring polluted water runoff from motorways and highways. With the successful deployment of Flexim technology in Belgium serving as a model, others have a clear path to improving their own environmental monitoring and protection initiatives.

To find out more about the real-world water and wastewater management benefits of clamp-on ultrasonic flow measurement, for permanent mains-powered installation, or battery-powered rental meters available from 1 week or longer, contact Andy Hammond – www.emerson.com | flexim-uk@emerson.com | +44 (0)1606 781 420

BY PETER NORMAN MINSTMC MIET

BACKGROUND TO BS 7671 WIRING REGULATIONS AS A BRITISH STANDARD WITH INTERNATIONAL INPUT

As a precursor to Amendment 4 of BS 7671, to be expected during 2026, here's a brief on the standard and what the revision process entails for understanding the rigorous and collaborative process behind the British Standard.

The Wiring Regulations date right back to the first edition wiring rules and regulations published in 1882; but, as BS 7671, have only been a British Standard since 1992. The original document only consisted of four pages and contained 21 regulations, focused on 'the prevention of fire risks arising from electric lighting'.

BS 7671 is a unique standard reflecting numerous changes to its constituent parts, as well as constant advances in technology and practice to keep pace with the practical, electrical safety best practices that electricians must perform. Contents now occupy over 650 pages and include a range of new energy infrastructure technologies.

International standardisation co-operation

International co-operation to develop common electrotechnical standards has continued since the first International Electrotechnical Commission (IEC) council meeting took place in London in 1908.

BS 7671 changes are frequent because the UK is a member of both the IEC, responsible for global standards, as well as, the European Committee for Electrotechnical Standardization (CENELEC), which sets European standards.

Most of the changes to BS 7671 begin at the IEC level, and progress to CENELEC, although sometimes the development work occurs in parallel. The international standard is IEC 60364, while the European standard is CENELEC HD 60364.

Electrical installations in the UK must meet the technical intent of CENELEC's HD 60364, making the UK bound to take on any technical amendments from the European level. This doesn't mean following the standard verbatim, but it does mean adopting its spirit of intent.

BS 7671 contains all parts of the 60364 standard in a single document. It includes a list of all the IEC and CENELEC standards (currently 41) that form the basis for the various parts of BS 7671. These standards are subject to a maintenance cycle which can differ to thereby add complexity to the task.

Standards development framework

Various committees are responsible for electrotechnical standards.

Globally, it is IEC Technical Committee 64 (IEC TC 64). At the European level, the CENELEC has Technical Committee 64 (CLC TC 64).

The UK's national committee is the Joint Power and Electrotechnical Committee (JPEL/64), run by the IET and British Standards Institution (BSI), which oversees the work of four further sub-committees.

Standards development at the IEC or CENELEC level includes issuing drafts for comment, reviewing comments, then producing drafts for voting, followed by publication of the final standard. UK experts sit on both the IEC and CENELEC committees, and JPEL/64 reviews and submits comments, as well as voting on the standards.

Where individual countries are unable to fully adopt IEC or CENELEC requirements, agreed processes recognise differences. At the IEC level, the national committee can request a 'certain countries note'. These notes apply in cases where there are particular, permanent conditions, such as a requirement conflicting with national legislation; or, where long established differing practices exist such as the UK's use of the BS 1363 standard 13A plug.

CENELEC also recognises country-specific needs through a 'deviation' (a clash with national regulations) or a 'special national condition' where there is a permanent, national characteristic or practice. For instance, permanently frozen ground in northern countries would exclude certain safety earthing condition requirements.

British Standards requirements

As the InstMC's BS 6739 update SIG team discovered, trying to deal with about 250 revised pages, British Standards have a specific status and structure which can make the process of updating BS 7671 both intricate and time-consuming. BS 7671 largely follows the standard BSI structure, although is slightly atypical in some places, mainly due to its Wiring Regulations history.

Strict BSI rules apply around use of language in the standard. Largely based on the 'Rules for the structure and drafting of UK standards', the following conventions offer some insight into why new and updated requirements can take time for revised wording to be accepted for UK publication:

When writing a standard, one of the rules is that requirements must use 'shall' or 'shall not' in the sentence; whereas, it must be 'should' or 'should not' for a recommendation. Other conventions require people to 'comply' with a standard, while non-human things 'conform' to a standard. The word 'must' cannot be used, and 'will' should be avoided. Careful phrasing is a requirement. Requirements must be achievable, and wording must also ensure it doesn't undermine itself.

Options for revisions

Changes to BS 7671 can be made through: amendments, corrigenda, or the publication of a new edition.

Amendments alter or add significantly to previously agreed technical provisions in an existing standard. Generally, the more changes required, the more likely they are to be in a new edition instead of an amendment.

Irrespective of quantity, amendments must retain the original publication date, with an amendment date added. Only new or changed text is edited and issued for public comment. Additions, changes and deletions are marked with amendment tags.

Corrigenda, which already exist for the current BS 7671 edition, are different from amendments as they are published to rectify errors inadvertently introduced during drafting or production of a standard that could lead to incorrect interpretation or unsafe application. Trivial errors are usually left uncorrected until the need for a more substantial amendment arises.

New editions are issued where many changes are introduced that affect a large proportion of the content, making an amendment unsuitable. Only new or changed text is edited and available for public comment, and each new edition takes a new publication date.

Commenting on drafts

Drafts incorporating proposed changes to British Standards are made available for public comment. There is a similar process for IEC and CENELEC standards.

In the case of a British Standard, BSI publishes a Draft for Public Consultation (DPC) made available for comment by anyone. Length of the consultation period can vary but is made clear at the DPC launch. Amendment 4's DPC period was from 7 August to 3 November 2024.

All comments are compiled and directed to the relevant JPEL/64 sub-committee for consideration. Only comments providing a rationale and proposal will be considered.

JOIN THE INSTMC EARLY CAREERS NETWORK

The Early Careers Network held its first meeting on 30 January 2025, marking the launch of an exciting initiative to support engineers at the beginning of their professional journeys.

What is the Network About?

The Network is still in its early stages, and we're shaping it based on the needs of our members.

A recent survey highlighted key priorities:

- **83%** of members are seeking mentoring
- **75%** are focused on career development
- **72%** want support with professional registration

Using these insights, we are building a structure that will provide meaningful support to early-career professionals.

Who is the Network For?

At our first meeting, we outlined key audiences who would benefit from the Network:

- **Newly Qualified Professionals** (in their first or second job): Looking for CV support, career guidance, and exposure to different engineering fields.
- **Pre-Chartership Engineers**: Seeking guidance on achieving professional registration.
- **Chartered Engineer**s: Exploring further career progression or pursuing a Fellowship.
- **Engineers at a Career Crossroads**: Deciding between a technical specialist or management path.
- **Mentees & Mentors**: Whether you're looking for support or keen to give back, the network will connect experienced engineers with those seeking guidance in career development, professional registration and leadership skills.

A Space for Growth, Guidance, and Networking

Whether you're refining your CV, working towards chartership, or considering your next career move, the Early Careers Network aims to support you. As we grow, we plan to offer mentorship, events, technical conferences and career resources—creating valuable opportunities for both professional and personal development.

What's Next for the Network?

The network will meet quarterly to keep members engaged and connected.

Want to play a key role in shaping this initiative? We're looking for **founding members** to help drive the network forward! We need volunteers for roles such as **Secretariat, Marketing & Promotion**, and **Mentor Liaison** to ensure the network's success and sustainability. Plus, volunteering is a great way to boost your CV!

If you're not ready to take on a role but want to benefit from the network—stay tuned, we're just getting started!

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

LOCAL SECTION NEWS

CENTRAL NORTH-WEST

Since our update in the December 2024 issue, the team have been beavering away; like the proverbial swan gracefully gliding on the surface with feet paddling furiously below! Activity continues as I write this update in 2025, with the technical talk program in the midst of being added to the event calendar.

The first technical talk of the year took place in January as Dr Paul Oram of Ortomation Limited shared his vision on 'As Simple as PID - A New Approach to Closed Loop Real-time Optimisation'. In February, the first face-to-face technical talk since the Covid pandemic, was hosted by Sella Controls. The session covered the challenges being faced in Functional Safety and how digitalisation can help alleviate these challenges and our thanks go out to Chris Parr and Ian Dolan. I'm hoping that by the time this is published, all of our talks until July will be in the calendar.

We are still accepting nominations for the following 2025 Awards:

- Early Career Engineer 2025
- Apprentice of the Year 2025

Closing date for nominations is 30th April 2025 and details can be found on our 'Students and Awards' page on the InstMC website.

On the subject of our awards, I'm pleased to announce

the date for the 2025 Awards Night as Thursday 9th October 2025 at Innside Hotel, Manchester. Tickets will be on sale in due course, so please save the date and watch our socials for details.

Advance notice that our AGM will be held on Tuesday 13th May 2025 with the following positions up for election:

- Chair (2025 – 2028)
- Treasurer (2025 – 2026)
- Secretary (2025 – 2026)

That's all for this edition and other items which we are still working on will be reported in the next issue of Precision.

Dave Green,
Chair, Central North-West Local Section

SOUTH EAST

Earlier this year, the South East Local Section, along with the Worshipful Company of Scientific Instrument Makers (WCSIM), co-sponsored an annual event at City St George's University of London.

The 'National Symposium on Developing Socially Responsible Professionals' brought together experts and stakeholders from academia, industry, charities and government organisations to debate different aspects of developing the next generation of socially responsible professionals (SRP). The aim of the event is to develop the next generation of professionals that are aware of the impact of their decisions, the role of ethical behaviour and professional activities on the society, environment, resources and people and to have working knowledge on how to use tools that will help them to optimise the impact.

The event offered a mix of keynote speakers and workshops opening with a panel discussion on "Healthcare Ethics and Law". Some of the subjects featured in the discussions and debates included; Corporate social responsibility, global sustainable programmes, legislation, cultural differences and practice and business and research ethics.

Malcolm George,
Chair, South East Local Section


Professor Raj Roy, Executive Dean, School of Science & Technology, City St George's, University of London

Awards Night

2025

SAVE THE DATE

Thursday 3rd July

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

REGISTERED FUNCTIONAL SAFETY ENGINEER (RFSE)

If you are an experienced engineer working within the Functional Safety discipline, the InstMC RFSE qualification could be the right choice for you

This professional level qualification is aimed at those individuals that can demonstrate competence & commitment with a professional level of engagement within the relevant field. They cannot be gained through attendance on a short course. Registration as CEng with the Engineering Council UK is a pre-requisite in demonstration of professional standing. It is also a requirement that you are, or become, a member of the Institute of Measurement and Control.

www.instmc.org

To find out if you qualify and for further information on applying, please or visit:
www.instmc.org/careers_learning/professional_registration/rfse_rexe_qualifications.aspx

Scan QR Code for direct access to the RFSE web page

InstMC/RFSE/F01.03.05.2023

FOCUS ON A SIG THE FOUNDATION OF FS-SIG

Competence is critical in all professions, including Functional Safety, and consists of learned knowledge, acquired skills and practices.

Competence Management Systems (CMS) are there to define company standards and ensure that individuals meet them. Over the past decade I have experienced the full spectrum of CMS, from infancy to excellence. I used to believe that all that was needed to implement what I had learnt previously was good knowledge of the requirements and people's openness to change. That was wrong. To paraphrase Hari Seldon in Issac Asimov's Foundation, "the trend of a company full of people contains a huge inertia. To be changed it must be met with something possessing a similar inertia. Either as many people must be concerned, or if the number of people be relatively small, enormous time for change must be allowed."

The discussion around functional safety competence is a complex one. The various levels, succession planning, its management and continuous development are just few of the challenges that the industry faces. Moreover, the impending effect of new technologies, such as artificial intelligence, make it even more critical that duty holders stay up to date. For some organisations, the journey began decades ago, whilst others are just starting. That, however, is of no consequence to the level of diligence required for full compliance. How do we make it so that all duty holders implement and maintain their own management systems and achieve the same degree of competence internally? Difficult to say, and it certainly will not happen overnight.

The answer, for many, is resorting to third party expertise. But, as much as it is needed, it is not the complete answer. Others, and I am sure this comes as no surprise, believe that sending their engineers on a course, culminating in successfully passing an exam, suffices. But as often as not the training merely scratches the surface of what functional safety is. Training is but one of the elements that demonstrate competence. It must be corroborated with experience, appropriate attitude and behaviour, and underpinning knowledge of the application domain. The problem now is the need for a competent competence assessor, and it almost becomes a Catch 22. In an age of lean organisations forever getting leaner this can be a tough one to crack.

The InstMC Registered Functional Safety Engineer (RFSE) qualification is aimed at filling these gaps. As a peer review type assessment, tailored towards those with technical authority level responsibilities, it not only focuses on the evaluation of the individual's technical knowledge of functional safety as applied to their industry sector, but also takes a deep dive into their experience and attitude towards competence development and professional excellence.

The Functional Safety SIG recently held a webinar centred around the qualification, to explain in more detail to our wider audiences, the benefits of pursuing the title. The format was a Q&A covering the background and frequently asked questions, where a few of our most experienced RFSEs shared their knowledge. The video can be viewed on the InstMC You Tube channel at https://youtu.be/C4Etbuvztf0?si=_lttvcX6XRvkosCy

Tudor Balan MEng (Hons), FSEng (TUV Rheinland), MInstMC
Functional Safety Engineer
Technical Governance

PUPILS AND ENGINEERS FROM ACROSS THE UK HONOURED FOR INNOVATION AT PRIMARY ENGINEER MACROBERT MEDAL CEREMONY

Innovators of all ages gathered at the prestigious Primary Engineer MacRobert Medal Award Ceremony in Glasgow last November to celebrate the collaborative achievements of school pupils, university students, and engineers. Hosted at the stunning Barony Hall, the event showcased cutting-edge prototypes developed from young students' imaginative engineering ideas.

The Primary Engineer MacRobert Medal is a collaboration between The MacRobert Trust and Primary Engineer, with support from The WEIR Group PLC, and the awards highlight the culmination of the Leaders Award competition. The national competition challenges pupils aged 3–19 to answer the question: "If you were an engineer, what would you do?". Pupils are tasked with interviewing an engineer, which gives them the inspiration to come up with their own engineering ideas. They identify a problem in the world around them and come up with a creative solution to that problem. They then create an annotated drawing of their idea and write a letter to an engineer asking them to select their idea to build.

Selected ideas are brought to life by our ProtoTeams, which are made up of students, early careers engineers and industry professionals from our Industry and University Partners. These ProtoTeams are tasked with turning a pupil's idea into reality, and they must collaborate with the pupils throughout the process to ensure the prototype is built to the designers' specifications – essentially treating the school pupil as the client.

In 2024, 24 prototypes were built, 17 shortlisted and at the Award Ceremony in November, 10 were awarded medals.

Dr Susan Scurlock MBE, Founder and Chief Executive of Primary Engineer, expressed her gratitude during the ceremony:

"We are so delighted to be able to honour everyone who has been involved in bringing these prototypes to life – the pupils, parents & carers, engineers, teachers, judges, and our dedicated supporters. We extend our deepest gratitude to The MacRobert Trust and WEIR Group for their essential support and spirit of innovation, The University of Strathclyde School of Engineering for providing us with the stunning Barony Hall, and of course a massive thank you to Tunnocks for providing us with the Caramel Wafers!"

Distinguished speakers, including Andrew Everett (CEO, ERA Foundation), Paula Cousins (Chief Strategy & Sustainability Officer, Weir Group PLC), and Ivan McKee MSP (Scottish Government Minister for Finance), also addressed the audience, celebrating the creativity and dedication of the winners.

Jon Stanton, Chief Executive of The Weir Group and part of this year's judging panel, praised the initiative:

"Creating mining technology for a more sustainable future lies at the heart of what we do at Weir. We must think differently and challenge the way things have always been done. That aligns well with Primary Engineer's initiative to harness the imagination and creativity of school children to innovate and invent solutions to everyday challenges. It has been incredible to see first-hand how the ProtoTeams use their engineering skills to bring the best ideas to life, and then to recognise and celebrate the best innovations with the prestigious Primary Engineer MacRobert Medals. Weir has been working with Primary Engineer since 2018 to develop innovation and I'm personally delighted to be involved again. We can't wait to see how the next generation of talent develops novel solutions for the world's most pressing economic and sustainability challenges."

At the event itself, ten ProtoTeams were honoured with Bronze, Silver, and Gold Medals, recognising their ingenuity and collaboration. It's a testament to the power of collaboration and the boundless potential of young minds!

ENGINEERING COUNCIL

RISK

GUIDANCE ON RISK

for the engineering profession

www.engc.org.uk/risk

Engineering Council

The Clean Water Access Bot (C.W.A.B.) was the brainchild of Ben Miles, a student from Countess Gytha Primary School and built into a prototype by GKN Aerospace. Ben's idea was simple yet impactful: a robot that could travel to remote locations, collect and purify water, and deliver it to people in need. The GKN Aerospace ProtoTeam was captivated by Ben's thoughtful design, seeing both the humanitarian potential and the engineering challenge it posed. This prototype went on to win a Gold Medal at the Primary Engineer MacRobert Medal.

Also winning a Gold Medal was The University of Southampton with their Seed Planting Drone prototype which was inspired by Emily Jackson, a student from St. James' C of E Primary Academy. Emily wanted to address the pressing issue of soil degradation and biodiversity loss. She envisioned a robot that could plant seeds in areas where manual planting was difficult, with the goal of regenerating soil and restoring ecosystems. Her thoughtful design sparked the interest of the ProtoTeam at the University of Southampton, who saw its potential to make a meaningful environmental impact.

Brand new for 2024 was the Primary Engineer MacRobert Medal Commendation Award which voted for by the general public and was awarded to The Solar Powered Heated Blanket prototype. It was designed by Rebecca Young, a student from Kelvinside Academy, with the thoughtful intention of helping the homeless stay warm during cold nights. Rebecca's idea was simple yet impactful: a heated blanket powered by solar panels, ensuring that users who lack access to mains electricity could still stay warm using a sustainable power source. This clever concept immediately inspired the Thales Glasgow ProtoTeam, who saw the potential to make a real difference.

The 2025 Prototype builds are under way with several University and Industry partners already starting the project, you can see which ideas have been selected on the Primary Engineer website: https://www.primaryengineer.com/category/prototeams/

Over the past twenty years, the perception of engineering has been transformed but there's still more work to be done. Engineering shapes the world, and you can help shape its future. Whether you're an industry professional, a university student, or an aspiring engineer, your expertise and enthusiasm can bring young innovators' ideas to life. Join us in mentoring, prototyping, or supporting the next generation. Be part of the movement today.

https://leadersaward.com/join-us/

THE MAGAZINE OF THE INSTITUTE OF MEASUREMENT AND CONTROL

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We are always on the lookout for fresh exciting content, so if you would like to contribute an article, please email us with your ideas or finished article of approximately 1000 words.

For all advertising and content enquiries, please email jane.seery@instmc.org.

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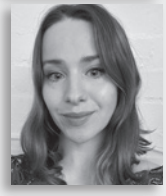

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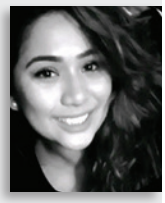

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