

INSPIRE THE NEXT GENERATION OF ENGINEERS WITH PRIMARY ENGINEER



**CLIMATE SCHOOLS PROGRAMME
— HELP NEEDED**

**TYCHO BRAHE AND THE
MEASUREMENTS THAT
LAUNCHED MODERN SCIENCE**

**THE RISE OF SEWER
NETWORK MONITORING**

**FOCUS ON A SIG:
SIG NEWS ROUND UP**

MARCH 2024 ISSUE 31

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CLIMATE SCHOOLS PROGRAMME — HELP NEEDED

Our colleagues at Engineering UK are running a brand-new pilot programme for schools, to help students explore solutions to tackling climate change. The Climate Schools Programme has been developed together with industry and inspires young people by showing role models working in green jobs. The programme offers science, geography and english lessons as part of a resource pack, that not only align with each nation's curriculum, but will also inspire the next generation to consider green engineering careers. Through taking part, students will develop skills such as teamwork, problem solving and communication – all vital to future employability.

Engineering UK is currently developing content for this programme and is seeking help from members who may be able to help contribute as part of the curriculum-linked resources. The programme is centred on sustainable energy and how engineering and technology can provide solutions to the climate issues the world is facing. Young people care about the environment but, whilst the curriculum covers causes and impacts of climate change, it has less on solutions. They want to make sure that

young people see how engineering and technology can help with mitigation and adaptation, enabling them to feel positive about their futures and empowered to make a difference by working in these areas.

Engineering UK is looking for role models who are working in energy or climate action related roles who'd be interested to work with them to add the following types of content to the programme:

- **Name, job title, and short description** of what they do, and their **route** into engineering/technology.
- **Quotes** to inspire young people, in text, audio, or video format.
- **Photos and/or videos** of them at work, showcasing the things they do, and or things they think are important for a young person to know about.

The table below contains an overview of some of the types of roles that they are looking for, but this just guidance and they are open to more suggestions from you.



Wind Power Research and Development Engineer - Research and development into floating wind, turbine blade materials, vertical axis turbines, etc.	Biofuels Research and Development / Lab Technician - Researching generation of electricity from waste (2nd generation) or from algae and other microorganisms (3rd generation)
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Wind Power Construction Manager - Manufactures turbine parts (tower, nacelle, blades); builds foundation and constructs turbine in situ; connects to grid	Energy Storage Designer - Designing, for example, large-scale battery backups to cater for intermittency of renewable energy / peaks & troughs in demand
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Solar Power Designer - Designs the solar farm: location, number, size, layout, and type of panels	Heat Pump Technician - Inspects, maintains, and repairs heat pumps ensuring that they work at maximum efficiency
Solar Power Installer - Installs, connects, tests and commissions new solar farm; connects to grid	Energy Modeller - Models energy demand of buildings, cities or nations; models future energy supply over time (hours, months, years) to estimate impact of different energy mix scenarios.
Nuclear Decommissioner - Removing fuel from a nuclear power station, taking down the plant, and restoring site ready for re-use	

If you are interested in getting involved, visit www.climateschoolsprogramme.org.uk/contact-us to get directly in touch with the programme. For more information, visit www.climateschoolsprogramme.org.uk/.

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Chief Executive Steff Smith
E: steff.smith@instmc.org
Design, print & mail fulfilment by HMCA Services Ltd
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BY PAUL QUINCEY

TYCHO BRAHE AND THE MEASUREMENTS THAT LAUNCHED MODERN SCIENCE

The first scientific measurements with a strong emphasis on accuracy were probably made by Islamic astronomers in around the 10th century.

Specifically, they found the accurate positions of the moon, planets and stars by precise measurements of angles. Angle measurements are much less important these days, but until the 19th century they were at the heart of many developments in physics, as we will see, and also of applied sciences such as navigation and map-making.

From the earliest times, the sky provided an abundance of angles

to measure, both by day and by night, some constant and some changing. These could help with practical things, such as telling the time of day and time of year, or your latitude and the direction of North when travelling. The measurements could also be more curiosity-driven, looking at the behaviour of the wandering objects called planets and helping to predict eclipses; or more dubious, for astrology, which was perhaps promoted to encourage funding for the curiosity-driven activities.

Angle measurements benefit from a natural unit for angle, known as a rotation, revolution, or turn, which anyone can make use of and which needs no discussion. The Babylonians divided a rotation into 360 degrees. A second fortunate feature is that angles are easy to measure using some variation of a protractor, with an accuracy that can, in principle, be increased simply by increasing the size of the protractor.

The first user of this early Big Science seems to have been Abu-Mahmud Khojandi, who built an observatory

in the late 10th century near Ray, close to present-day Tehran. His instrument had a radius of 20 m, though no trace of it remains. He measured the Earth's axial tilt as $23^{\circ} 32.3'$ – about 1.5' too small, an error of only about 0.1%. (1' is an arcminute, a sixtieth of a degree).

In 1424 a truly huge instrument was built at Samarkand, in present-day Uzbekistan, with a radius of 40 m – the Ulugh Beg Observatory. Some of the structure is still visible, as can be seen from the photo (Figure 1), though we do not know much about the results it provided.

Even before the arrival of telescopes, and the ability to move them by precise amounts using micrometers, it was realised that the size of the instrument was not the only factor affecting the accuracy of the results. Indeed, it is one of the eternal truths of metrology that the more accurate the measurement, the more subtle the factors that need to be understood and accounted for. For a large angle-measuring instrument, factors like the effects of wind and temperature, the distortion under its own weight,

Figure 1: Part of the Samarkand Observatory



and the accuracy of the markings on the scale, become paramount.

The Danish astronomer Tycho Brahe, built on the Islamic metrological groundwork and took capabilities to a higher level in around 1580. Royal patronage from the Danish King Frederick II meant that he could build an observatory to his own specifications on the island of Hven, not far from Copenhagen. He used a range of instruments, typically about 2 m in radius. His mural quadrant is shown in the picture (right). With them he could reliably chart the positions of stars, planets, and the moon to within 1' or 2'.

His tables of accurate celestial angles, together with not-so-accurate but adequate timings – the pendulum clock was to be invented by Christiaan Huygens in 1656 – provided excellent raw data for more mathematically inclined scientists to work on.

Specifically, based on the analysis of Brahe's observations of Mars, Johannes Kepler published his 1st and 2nd laws in 1609, observing



Illustration of Tycho Brahe's observatory on Hven

that the planets moved in ellipses, with the Sun at one of the two mathematical points inside the ellipse called a focus, and that the speed of the planet varied around the orbit in a particular way.

It cannot be overemphasised that these laws were not scholarly speculation, postulating an

explanation of the complicated apparent movement of planets using philosophical thoughts about how they ought to move. Kepler's laws were true without any reasonable room for doubt, because Brahe's measurements were accurate enough to support them, and to rule out other possibilities. Accurate measurements had settled a question that had been posed ever since people had started observing the planets.

In his book *Principia*, published in 1687, Isaac Newton would show how Kepler's laws could be seen as the consequence of a simple law of gravity and simple laws of motion. The modern idea of the exact sciences, where precise mathematical theories can be tested and supported by highly accurate measurements, was established.

Paul Quincey, previously a Principal Research Scientist at NPL, writes the blog 'Some Historical Highlights of Scientific Metrology'. To read more of his articles, visit metrologicalhindsight.wordpress.com

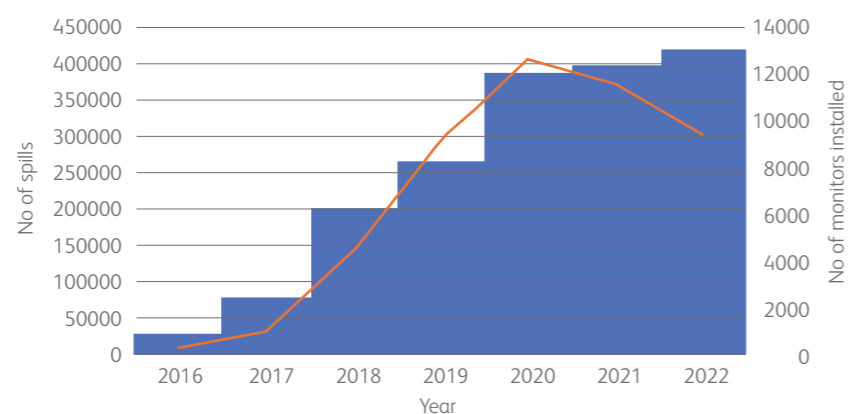
THE RISE OF SEWER NETWORK MONITORING

BY OLIVER GRIEVSON,
ATKINS REALIS

Before 2015, the wastewater collection network was typically very poorly monitored. Apart from monitors to control wastewater pumping stations and floats on emergency overflows, there was a scant amount of monitoring. There were of course exceptions, but this was generally the rule.

However, there were already plans in place to change this and the Event Duration Monitoring programme, as raised by a ministerial direction,

Figure 1 shows the number of monitors installed (in blue) versus the number of spills reported (from data reported to the EA)



saw the vast majority of combined storm overflows monitored over the next seven years. The monitoring of these overflows has led to public outcry as evidence was openly shared with the public how many times overflows were “storming” to the river environment.

This was the first time that the industry had seen actual data of the number of overflows to the environment although there is no quality control of the data as the monitoring was not put under the Environment Agency quality control scheme or MCERTS (Monitoring Certification Scheme). In real terms, as the installations were rushed the quality of the data and thus, the number of overflows, are likely to be being over-estimated currently. Time will tell on this as the Monitoring Certification Scheme is retrospectively

being applied to all network event duration monitors. This network monitoring is currently being expanded to overflows as wastewater treatment works and in the next investment period to all emergency overflows on pumping stations within the pumped wastewater collection network.

This is only part of the story though as the water companies themselves are also installing level monitoring (the same technology with a different purpose) in wastewater collection networks and this is all a part of the medium-term strategy to limit overflows to the environment. Members of the public will be well aware of the menace of wet-wipes and fatbergs in sewers and how they cause blockages. The last published cost for sewer blockages was £100 million released by Water UK in 2017



but what is not included in this figure is the environmental cost of sewer blockages and how this impacts on the environment.

To combat this, water companies have been installing sewer monitors within the wastewater network to inform machine learning systems, developed by technology companies, to help identify where sewer blockages are. This is needed as there are approximately 220,000 miles of sewers in the UK and to understand where sewage blockages are at any one time is a momentous task.

The rise of tools to help water companies identify where blockages are developing help them to identify exactly where to target the resources to reduce the risk of sewage either backing up into people’s homes or into the environment. There are approximately 90,000 monitors already installed across the UK monitoring sewer level and some of the best machine learning systems are showing a 92% accuracy in identifying early forming blockages, allowing the water companies to take a pro-active approach to limit the risk of storm overflows happening due to sewer blockages.

This is a great example of water companies using technology to limit the environmental risk.

Of course, the monitoring of the wastewater network and the receiving rivers is only set to increase. The Environment Act 2021 saw water quality monitoring of rivers become enshrined in law. Section 82 of the Act stated:

A sewerage undertaker whose area is wholly or mainly in England must continuously monitor the quality of water upstream and downstream of an asset within subsection² for the purpose of obtaining the information referred to in subsection

This will see monitoring installed across storm overflows and sewage discharge points across England & Wales over the next ten years. The challenge that the water industry faces to do this cannot be understated and it is a monumental task to achieve. The question is though, what will be done with the data and how can this be used to help the water environment? The investment that is necessary has been estimated in the billions of pounds just for the initial installation, let alone the ongoing cost of maintaining the monitoring points.

However, to get the true value of the data there must be a wider idea by both the government, the regulators and the water companies of what is going to be achieved by undertaking the monitoring.

In real terms the monitoring under Section 82 is short-sighted and really needs to be monitoring the full river environment which can in turn be used, as part of the National Digital Twin strategy, to complete a digital twin of river basins and their environmental quality. This would give a much more powerful outcome to inform the overall health of our river environments whilst also allowing us to understand, in almost real time, the level of pollution being contributed by which polluter and where, to target the Environment Agencies limited resources in policing environmental quality.

What is evident is the amount of monitoring has increased exponentially over the past decade and is set to increase even further over the next decade. This will hopefully have the outcome of enabling both the regulators and the water companies, as well as other polluters, the opportunity to restore our precious river environments.

HOW ACCURATE FISCAL 3 BAR STEAM MEASUREMENT REDUCES UTILITY SPEND

Non-invasive, clamp-on ultrasonic flow measurement is transforming the way that the chemical industry monitors and manages utility services.

Once considered an almost insurmountable measuring task for clamp-on flowmeters, this innovative technology is accurately and reliably measuring steam without interrupting normal system processes.

Two pairs of ultrasonic sensors are mounted on the pipe at a defined distance from each other, forming two acoustic measuring 'gates'. Ultrasonic signals are then radiated into the pipe and modulated by the vortices of the turbulently flowing steam. Because the vortices are carried along by the flow, they pass between the two measurement gates with a time delay. And through cross-correlation of the modulation signals over time, the flow velocity of the steam can be determined, with the mass flow being calculated based on the geometry of the measuring point and the physical parameters.

Low accuracy results in paying more for consumption

At a sprawling chemical hub in the southeast of the Netherlands, a cooperative approach to utility

services is in operation, including the supply of essential energy sources such as electricity, compressed air, natural gas, pure gases, water and steam. The utilities are meticulously tracked and accounted for in a document known as the 'measuring book' – setting the rules for utility transactions on the industrial park.

Operators were searching for a more cost-effective and reliable steam measurement system, as previously installed meters were proving unreliable. In fact, they were classified as the lowest accuracy class (D). This meant that a significant amount was paid for steam consumption, while less revenue was received for the steam contributed to the network.

FLEXIM was tasked with proving the effectiveness of clamp-on steam meters as a viable alternative. Following a detailed technical review and discussions with the utility provider, it was clear that clamp-on technology would require verification in order to be accepted.

Tests, calibration, on-site testing and implementation

The calibration process involved using compressed air as the medium, and ensuring that the conditions closely matched the actual steam application. The calibration setup differed from the customer's in terms of medium, pipe size and temperature, but this was not critical for validation. The calibration process ran for two days and effectively showcased the technology's accuracy, with all test points well within its accuracy statement.

Following the successful calibration



and additional on-site tests, the purchase and installation of two clamp-on steam meters went ahead. The meticulous installation process took into account factors that can influence accuracy, such as pipe diameter and wall thickness. With the meters connected to the process computer, the total uncertainty of the measurement was calculated, classifying the meter solution as a class B (better than 5%) solution.

Reduced costs and increased revenue

Ever since installation, the clamp-on flowmeters have continued to prove their reliability, with the measurements typically agreeing within a 1% margin. This level of accuracy has been invaluable to the utility provider, reducing the cost of steam import and increasing revenue from steam production. The implementation of clamp-on technology has delivered a much clearer picture of the 3 bar steam network across the chemical site, helping to recover the mass balance.

To find out more about the capabilities and benefits of clamp-on ultrasonic steam measurement in the chemical industry, contact Simon Millington - www.flexim.co.uk sales@flexim.co.uk +44 (0)1606 781 420



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Endress+Hauser 
People for Process Automation

Q&A

Claire Jones

In the hot seat this issue is **Claire Jones**, Application Consultant – Flow, Endress + Hauser and Women in Measurement, Automation and Control (WiMAC) Chair, the InstMC's new network for Women members.



ESG will be at the forefront of growing the engineering talent pool, which is needed to address workforce shortages.



What was the root of your interest in Engineering?

My route into engineering was different from many as I didn't go down the traditional route of university or an apprenticeship. I didn't know what I wanted to do when I was at school and there wasn't any help to find something I was passionate about. STEM wasn't mentioned as a possible career to me, so I had never really thought about it.

I decided to find a company I enjoyed working at and take it from there. I started at Endress+Hauser in 2011 in an order admin role – processing orders, working in customer care – and loved the family culture. I worked closely with the engineers and this sparked my curiosity to learn about the products and applications they were working on. I was lucky to be supported by my colleagues and management who nurtured this new interest.

I asked if I could go down a technical route for my career development and Endress+Hauser were incredibly supportive with this. I went to college to study mechanical and electrical engineering while going through Endress+Hauser's internal graduate programme to learn about the products and technical side of the role. I graduated from both college and the graduate scheme in 2018 and became an internal sales engineer. After a few years working in sales, I progressed to my new role in marketing as an application consultant for flow. I now get to combine working in the office with travelling around the UK, so it's the best of both worlds.

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

More companies within engineering are developing initiatives like the Women's Integrated Network (WIN) from Endress+Hauser and WiMAC from the InstMC, stemming from ESG/CSR strategies. ESG will be at the forefront of growing the engineering talent pool, which is needed to address workforce shortages. Additionally, only 12% of engineering graduates are women. Companies need a diverse workforce to share experiences from all aspects of life.

The UK needs to be a world leader in responsible engineering to ensure a sustainable future. A framework for collaboration between universities and our industry is important as knowledge transfer between experienced engineers and the younger generation is a must. We all have a part to play over the next 10 years to diversify engineering and make it the best it can possibly be. I see this going from strength to strength over the next 10 years.

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

One cause of the shortage is a lack of students pursuing STEM subjects from an early age. Engineering is often viewed by young people as strictly a hands-on job, but there are so many other avenues that are not being promoted: repair and maintenance, design, safety, projects and so on. When I talk to students they are often surprised at how varied the options are.

STEM is also promoted as a very difficult subject, which can put people off if they don't see

themselves as academic. But we need to show it can be interesting, rewarding and achievable for people from all backgrounds. The government also needs to provide incentives for industry to encourage the growth and provision of apprenticeship places and graduate training. Not everyone learns best in a degree setting at university, and this should be acknowledged and accommodated.

There is also work to do around diversity and inclusion within engineering. There are still conscious and unconscious biases within the industry that the government could address by providing initiatives to overcome these barriers, opening discussions on inclusion and diversity. This in turn will make engineering more attractive as a job role. It is why I am so passionate and heavily involved in Endress+Hauser's WIN initiative and have helped create WiMAC with the InstMC. I never saw the incredible role models we have in the industry, and if we don't show this to the younger generation things will never change.

What do you do in your free time to relax?

I have a five-year-old daughter who keeps me incredibly busy! I wouldn't call life with a five-year-old relaxing as such, but it makes life more fun! She really helps me switch off outside of work when I need some downtime. She is also a huge reason

why I am so passionate about WIN and WiMAC, which I am happy to be involved with in my free time.

I also run a support group for perinatal mental health in my local area under the UK charity PANDAS Foundation. It is a peer-to-peer support group where parents come to relax and talk to others who may be struggling with any aspect of the pre- and postnatal journey. I love networking and speaking to people so I thoroughly enjoy it, and I've met some truly inspiring people.

Given one wish what would that be?

I feel very lucky that I found a company that has supported me. I found school lacked this support system and drive to help students find a passion – especially those who are seen to be in the middle

academically, which is often due to not being pushed or not learning in an environment that supports their needs.

My wish would be to see initiatives such as WiMAC working with universities and other government bodies to get into schools to drive change from the bottom up to show students, especially women and girls, that this is such a great career. We need to showcase the incredible diversity that we have out there and give these students a voice. Luckily this is changing, and I have worked with several schools and groups such as Girls Out Loud who are driving this forward, but there is more work that needs to be done. I do hope that WiMAC is able to drive real positive change within the industry and I am sure that this will happen.





INSPIRE THE NEXT GENERATION OF ENGINEERS WITH PRIMARY ENGINEER

Primary Engineer is an educational not-for-profit organisation bringing engineering into classrooms across the UK. We connect engineering and technology professionals with schools so they can provide a real-world link to engineering, helping to break stereotypes and expand pupil understanding of what an engineer is and the opportunities and possibilities within industry.

We are always looking for volunteers to support our programmes and competitions, helping to inspire the next generation of engineers.

Young people cannot be what they cannot see and, with engineering not being an integral part of any curriculum, engineering as a sector needs to be proactive when it comes to school engagement. The engineers we work with act as a real-life example of what an engineer is, and help showcase the wonderful, interesting and exciting things that happen when you work in engineering.

We pride ourselves on our national reach, and our impact across the UK continues to grow. In the 2022/23 academic year we worked with **79,058 pupils, 3,649 teachers, 1,256 schools and 1,185 engineers.** But what is most impactful is the **737,696 pupil hours of engineering** – our activities are designed to leave a lasting impact, and this is the total number of hours pupils have spent working on engineering as part of their work with Primary Engineer.

We offer a range of Programmes and Competitions designed to bring

engineering into the classroom, and each one of them offer opportunities for engineers to engage with pupils.

Primary Engineer Programmes

Our Primary Engineer programmes take several forms – Vehicle, Rail, Construction, Early Years and Fluid Power – and allow classes in primary school to take part in a practical CPD (continuing professional development) project, building the confidence of teachers delivering STEM-based classroom activities and raising aspirations in pupils for their future careers. Two teachers are trained per school and provided with comprehensive classroom resources, curriculum mapping, links to engineers and enough kit for 60 pupils.

The culmination of our programmes sees pupils and teachers come together for a real celebration of engineering. In a morning that can only be described as 'organised chaos and fun', pupils are encouraged to talk to industry professionals about their experience, what they enjoyed most and how they would improve next time. Our celebration events are about showing recognition for the pupils' and

teachers' incredible hard work.

Through supporting our teacher training, in-school engagement and Celebration Events, engineers can engage with schools taking part in these programmes through:

- **Training day:** Attend a local training day with teachers from programme enrolled schools and be partnered with them as they learn how to build and deliver the programme into the classroom, with the opportunity to visit the school and support them thereafter.
- **In school engagement:** Following completion of training you can liaise directly with teachers to discuss a visit to the school and support the roll out of the programme with the pupils.
- **Celebration event:** Attend our Celebration Event where pupils from multiple schools put their engineering skills to the test by putting their models through a series of challenges, as well as show off what they have learned by being interviewed by engineers.



Pupils are interested, absorbed and more aware of careers in engineering as a result of this work. We are helping to break down engineering stereotypes and are delighted to represent a 50/50 gender split of participants. We have heard incredible, inspiring stories of pupils who ran home to show off their builds to parents, those who want to become engineers when they grow up and how the programme has even helped with pupils' behavioural issues.

“If you were an engineer, what would you do?”

The Leaders Award Competition is a national STEM competition open to all pupils aged 3–19 and asks the question, ‘If you were an engineer, what would you do?’. Pupils are tasked with interviewing an engineer, where they can ask the questions that matter to them, inspiring them to come up with their own engineering ideas.

They are asked to identify a problem in the world around them and come up with a creative solution for it. They create an annotated drawing of their idea and write a letter to an engineer persuading them to select their idea as a winner. Every pupil who takes part receives a personalised graded certificate, with all submitted entries being read and graded by professional engineers. They are graded based on the quality of the idea, not the art skills

or spelling of the letter. Shortlisted entries are then sent to exclusive judging days, where the judges select two Winners and two Highly Commended entries from each region.

There are several opportunities for engineers to be involved throughout the competition:

- **Be interviewed by a school:** *Deliver a short presentation on your engineering journey and answer questions from the school pupils. This can be done either in person or virtually.*
- **Take part in our grading days:** *Every single entry is graded by an engineer, and we are always looking for engineers to join us as graders. It's all hands-on deck and a great day of engagement with fellow industry professionals.*
- **Attend our Exhibitions & Awards:** *We host Public Exhibitions and Award Ceremonies across the UK to celebrate the engineering achievements of pupils who take part in the competition. We encourage engineers to attend so they can meet with pupils, parents and teachers from a variety of schools, furthering that engineering engagement*

STATWARS: Climate Change Challenge

Our other national competition is STATWARS: Climate Change Challenge, a data project with multiple curriculum links to science, mathematics, computing and engineering, as well as english and geography. The competition empowers and educates pupils aged 8–14 to tackle climate change using data they capture

themselves. Pupils use our carbon footprint calculator to calculate their carbon footprint, then use this data to identify three changes they can make in their daily lives to help tackle climate change

Can you help inspire the next generation of engineers?

We work with tens of thousands of school pupils every year, but what makes a lasting impact is the engagement with someone from the engineering industry. Young people cannot be what they cannot see, and being able to engage with engineers and learn that anyone can grow up to work in the industry can have a profound effect.

As one parent told us after her daughter won Highly Commended in our Leaders Award competition:

“Although she didn't win 1st place, the recognition of effort has had the same impact. Being invited to the awards ceremony and being celebrated has meant the world to her. This has sparked a fire in her and has really boosted her self-esteem. She has such a bright spark, with so many ideas and questions. This competition is so nice as it celebrates imagination, creativity, and uniqueness. So much of school time is focused on writing letters and reading, but this competition encourages children to explore, appreciate and express their imagination in a different way that gives all children the opportunity to shine.”

So, if you want to be involved and help inspire the next generation of engineers get in touch today. As recognition of your involvement, we welcome you as a Primary Engineer ‘Engineer Inspirer’ and we will support your involvement and provide you with recognition of engagement for your own professional development.

If you would like to get involved you can register here www.primaryengineer.com/engineers-join-us/ or you can learn more by reaching out to us at engineers@primaryengineer.com.



Women in Measurement, Automation & Control is a new InstMC network, aiming to raise the profile of women engineers.

JOIN WOMEN IN MEASUREMENT AND CONTROL

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FOCUS ON A SIG

NEWS ROUND UP

FLOW MEASUREMENT



The FMSIG offered two Horizon scan proposals for funding under the UK Flow Programme in 2024. One was concerned with the measurement of the flow rate of Ammonia. The second was about flow field measurements inside nuclear reactor plants.

Ammonia is a clean fuel option. About 70% is used for fertilisers, the remainder for various industrial applications, such as plastics, explosives and synthetic fibres. There are well-developed value chains for production and transport. There are no traceable reference flow measurement facilities for testing meter performance on Ammonia for the effects of its properties and for calibrations.

The resolution of computational models of fluid flow (CFD) has increased substantially with advance in computer power. In regulated industries such as nuclear and aerospace, validation of models is essential to ensure outputs meet safety case requirements. Methods for point measurement of flow fields are no longer sufficient to validate modern CFD analyses. The proposed horizon scan was intended to identify the gaps in this domain and options to fill these.

At the Programme Expert Group (PEG) meeting in November 2023, Ammonia flow measurement was selected to be reviewed by TUV-SUD National Engineering Laboratory Ltd in 2024. The flow field measurement study for the nuclear industry is currently

on hold, and the FMSIG is seeking to identify institutions capable of conducting such flow field measurements and sources of UK funding.

Horizon Commentary

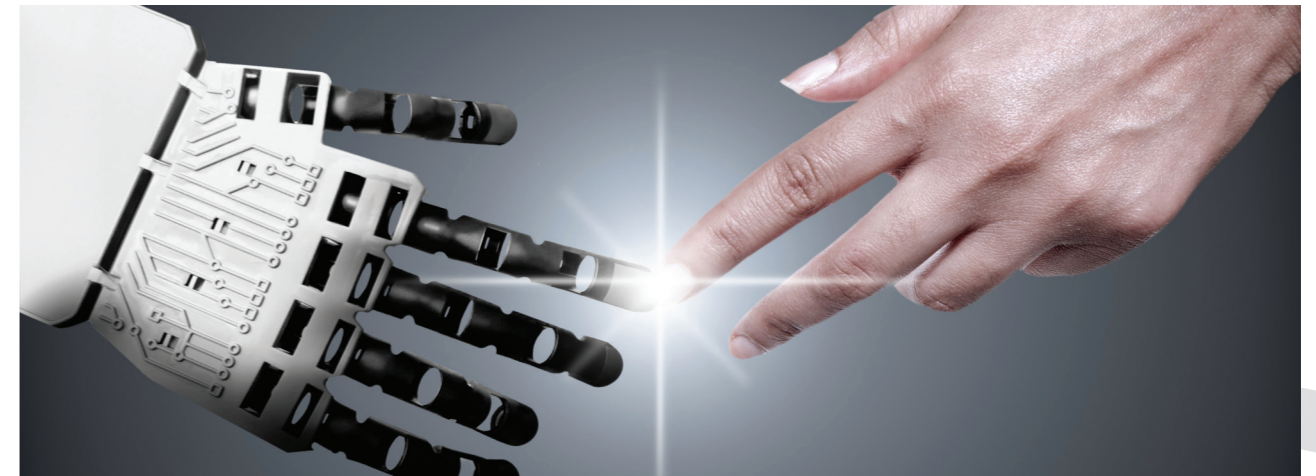
At a recent South East Physics Network meeting, a Director of Universal Quantum claimed that the first quantum computer will emerge within ten years and would be a billion times more powerful than today's most powerful super computers. He said one of the first applications would be to "solve" the fluid dynamic equations for flows over aircraft surfaces and through turbomachinery: a continuation of a decades-long quest to increase thermal and mechanical efficiency, power-to-weight ratio and, reduce emissions. This is, however, impossible. The Navier-Stokes equations are a linked infinite series which do not close – known as *The Closure Problem*. Perhaps a quantum physicist could be forgiven for not understanding the nature of fluid dynamics. Additionally, small variations in initial and boundary conditions lead to widely diverging fluid flow outcomes (coined as the "butterfly effect"). This was demonstrated during an FMSIG seminar back in 2016. Two nominally identical, simple, adjacent, enclosed rotating cylinders were interrogated by the technique of Positron Emission Particle Tracking (PEPT), developed at Birmingham University. Within minutes, the two flow path structures diverged significantly.

This begs questions of computational resolution. How will flow measurement capability keep pace to validate computations, indeed, to develop and test flow models to truncate the Navier-Stokes equations? Further, what advances in metrology will be needed to gauge and manufacture sufficiently reproducible and repeatable components (boundary conditions) that also do not

change or degrade in service? This anticipated progress is against the enduring business and engineering contexts of the law of diminishing returns and judgement about designs being fit for purpose.

Bill Priddy,
Chair, Flow Measurement SIG

FUNCTIONAL SAFETY



The FS-SIG will continue on the positive path laid out under the previous leadership of Harvey Dearden. We will carry on working on generating and publishing guidance on various functional safety related hot topics such as cybersecurity, SIS maintenance or safety related alarms. This year's HazardEx Live event took place on February 28th & 29th in Harrogate, and we're pleased to report that Harvey presented his latest briefing note, 'A new model for safety alarm operator response time requirements' on behalf of the Explosive Atmospheres Special Interest Group.

There has also been an increased focus on the promotion of the RFSE qualification and on how the CPD development is demonstrated, all of which will continue in 2024. For those interested in learning more about the qualification, please do not hesitate to contact us via the InstMC website www.instmc.org/signs/functional_safety.

We have started working towards organising a standalone FS SIG event and are now in the process of exploring partnership with external event organisers. This will be in

addition to an increased collaboration with high profile industry events, professional organisations and other InstMC Local Sections, so please keep an eye out for communications from the InstMC around the matter.

Another point of interest for 2024 is the development of a Functional Safety mentorship scheme through InstMC membership. We set the wheels in motion for the development of the scheme in 2023 and will be looking to firm up the program later this year. We believe this would be a great opportunity to raise the profile, not only of the FS SIG, but of the InstMC as well, and that it would provide an immense benefit to more junior members or those just embarking on the journey of functional safety by providing access to a breadth of knowledge in the field.

The FS SIG welcomes your interest as we plan to attract increased participation in our activities from a wide range of industry sectors in 2024.

Tudor Balan,
Chair, Functional Safety SIG

NATIONAL SKILLS METROLOGY ALLIANCE (NMSA)

After a huge amount of work and effort from a wide range of individuals, organisations and partner groups, we have now finalised the National Metrology Skills Alliance competency framework.

This industry-led new standard provides a detailed and comprehensive framework that will provide the foundations needed to standardise metrology skills in the UK and internationally.

Currently completed are the Core standard and associate guidance documents, as well as two subject specific annexes, covering Manufacturing Metrology and Flow. The working groups have already started to work on additional annexes and have plans for several more.



So far, the final documents have only been shared with those who have contributed to the project, but they will be publicly launched at the beginning of February, and then available from the InstMC website.

Now that the Core standard is complete, members of the Skills Alliance are turning their attention to the development of a recognised professional qualification for Metrologists, based on the 3 levels contained within the standard. These will be competency based and assessed in a similar manner to the Science and Engineering Council. The qualification will allow metrologists to prove their skills, which will be of great benefit to individuals and will also give confidence to industry, especially in safety critical areas, to know their staff can prove a defined level of skills and competence.

STANDARDS



The Standards SIG focuses on standardising existing and novel technology systems and elements used within the 'Measurement and Control' world. We achieve this with the support of active members who represent their organisations, InstMC and in an individual capacity at various national and international standards-making bodies e.g. BSI and IEC.

In 2023, three S-SIG all-members meetings were held, welcoming new members and including a guest appearance by InstMC president Ms Sheila Smith, thanking SIG members for their contributions. Our members shared relevant updates on standards from their various technical committees' volunteering work. We also highlighted the recent changes made by the UK NSB BSI e.g. adding the 'London Declaration' to the meeting's agenda and active management of their membership.

One of the major achievements led and accomplished by InstMC S-SIG members has been that the revised standard BS6379 (Code of practice for instrumentation in process control systems: installation design and practice) draft is now out for public comments and will soon be

published. S-SIG was also featured in the June edition of Precision highlighting 'UK's Standardisation Needs, New Projects' presented at the IEC TC Automation Forum, London.

It will also give people a basis for career development and allow them to plan their learning and identify gaps and areas for improvement. Our hope is that it will enable both the InstMC and other organisations to develop structured training programmes and skills pathways for metrologists who want to work towards the top levels of the qualification. Having an accepted professional standard and qualification for metrologists will not only highlight the hugely important role that good quality and robust measurement plays in science and engineering, but will help promote metrology as a valid career choice.

Phil Bamforth,
Chair, NMSA SIG

The year ended with celebrating two of our members who received prestigious awards for their service to the Institute and the international community.

We held our first steering committee meeting of 2024 in January discussing the pathway ahead to grow the success of S-SIG. We are moving forward with centralising our data onto SharePoint as part of our continued improvement approach. This will enable stronger relations and connections with our internal and external engineering communities.

We are looking forward to collaborating and building on the success of S-SIG at the next all-members' meeting on 13th March. We have a lot to deliver and we always welcome new ideas. To join us, contact SIG Chair navdeep.mehay@instmc.org.

Navdeep Mehay,
Chair, Standards SIG

JOINING A SPECIAL INTEREST GROUP

If you are an InstMC member and would like to join a SIG, login to your membership account through the InstMC website and select 'Manage My Profile'. Tick the box of any SIG you wish to join.

InstMC Special Interest Groups are also open to non-members. To join, visit www.instmc.org/signs/default.aspx, select the appropriate SIG page and message the email contact.

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)
- 15% discount on advertising across InstMC publications and platforms
- Appear in the regular Precision magazine feature 'CCS Showcase' to highlight your company
- 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.



WELCOME TO NEW CCS MEMBERS

The InstMC Companion Company Scheme has been running since 1992, enabling companies to raise their profile amongst our membership of 3,000 professional engineers in the measurement, automation and control sectors.

CCS members have the opportunity to network with other businesses, InstMC accredited universities and individual members, at local and regional level, through Local Sections and Special Interest Groups.

We are delighted to introduce to you, our newest CCS Members!

Endress+Hauser

Endress+Hauser Ltd is a global leader in measurement instrumentation, services and solutions for industrial process engineering. We provide process solutions for flow, level, pressure, analytics, temperature, recording and digital communications, optimizing processes in terms of economic efficiency, safety & environmental impact. Our customers come from various industries, including chemical, food & beverage, life sciences, power & energy, mining, minerals & metals, oil & gas and water & wastewater.

Tel: +44 (0)161 286 5000

Website: www.uk.endress.com

OBD Instrumentation Ltd

Calibration, repair, failure investigation, commissioning, and consulting; OBD Instrumentation offer a range of services whether that be on-site or in our workshop. We carry out calibration/verification of: Flow, Pressure, Temperature, Level and Analytical devices and repair instrumentation from a variety of manufacturers.

In addition, we conduct on-site services including: Commissioning, Industrial Network Support, Consulting, Repair, Calibration and much, much more.

Website: www.OBDInstrumentation.co.uk

Qrometric Industrial and scientific metrology

Qrometric is a UK metrology company specialising in product and system innovation. Our objective is to deliver products and services that solve specific project challenges or meet needs not ideally resolved by existing technology or thinking.

Our application knowledge and technical expertise is based on a combined experience of more than 60 years in metrology, instrumentation, fundamental research and product development. This experience underpins everything we do, and we share this with our customers and suppliers.

Tel: +44 (0)20 7099 5807

Website: www.qrometric.com

CAPULA

With a focus on operational technology and digital transformation, Capula has been a leader in advanced system integration for decades; optimising energy efficiency, intelligent asset management and delivering operational performance for asset- and energy-intensive clients.

Delivering critical technical solutions that range across automation control, panel build, cyber security, digitalisation and industrial operational technology (OT) programmes, we can ensure the integrity, safety and security of complex solutions across the industrial landscape responding to the challenges you face today and will face in the future.

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DET-TRONICS

Det-Tronics has been providing proven flame detection, gas detection and hazard mitigation systems for high-risk processes and critical industrial operations worldwide since 1973. The company designs, manufactures and commissions certified SIL 2-capable flame and gas detection solutions. Det-Tronics products carry performance and safety certifications from globally recognized third-party testing agencies and approval bodies.

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Website: www.det-tronics.com

LOCAL SECTION NEWS

NORTH EAST

On 8th November 2023, Teesside Instrument Engineers & InstMC North East Local Section held its 36th Annual Instrument, Control and Electrical Exhibition at Middlesbrough College STEM Centre.

19 exhibitors from control, instrumentation and electrical suppliers along with local education, training and other related organisations were present.

The Exhibition attracted some 215 visitors from local industries, education, service providers and managers, engineers and technicians representing various companies located in the North East.



CUMBRIA

Professional Registration Presentation to Students

On 9th November 2023, the Cumbria Local Section led a session on the road to professional registration to the latest apprentice intake at the GEN2 training facility in Workington. With over 50 students in attendance, as well as representatives from six other institutes, a presentation was given to the students about their

route to becoming a professionally recognised engineer. The event was organised by Graham Whittaker, lecturer at the facility and the session was opened by David Jones, Head of Operational Technology Group at Sellafield Ltd and member of the InstMC Cumbria Local Section. After David's brief presentation explaining

the role the institutes will take in the student's careers, they were given the opportunity to talk to the individual institute representatives to get more specific information about each institute. They fed back that they found it very informative and a number are registering to join the InstMC!



Thermometry in harsh environments and on surfaces

Tuesday 19th March 2024

16:30 – 18:30 GMT

3M Buckley Innovation Centre, Firth Street, Huddersfield HD1 3BD (and online)

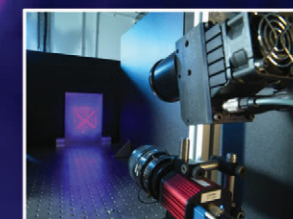
www.npl.co.uk/events/mmn-events-2024

Join us for a seminar with practitioners at the cutting edge of industrial temperature measurement science

Covering the latest developments in thermometry for harsh environments: the redefined kelvin, driftless thermometry, thermographic phosphors for surface thermometry, self-validating thermocouples, and practical Johnson noise thermometry

- Introduction to new techniques in driftless thermometry – Jonathan Pearce (NPL)
- The redefined kelvin and practical consequences – Graham Machin (NPL)
- Traceable phosphor thermometry for surface temperature measurement – Aldo Mendieta (NPL)
- Self-validating thermocouples: INSEVA – Phill Williams (CCPI Europe)
- Practical Johnson noise thermometry – Paul Bramley (Metrosol)

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NETWORK





MEASUREMENT QUALITY MATTERS. ASK TREVOR

Modern Management Systems explained – Do I need one? I am not a lab and maybe I don't make any calibrations, tests or measurements.

In previous issues Trevor has concentrated on "labs", that is organisations making measurements, but the same principles apply to all organisations doing anything!

Most people have heard of ISO 9001 and firms use it, especially if they are supplying something to a bigger firm who make that a requirement. It can be applied to almost any activity and can give confidence in consistency of output.

This month, Trevor explains what a modern management system might

look like. Without getting into details of ISO 9001, or the ISO 17000 series, he gives you some pointers to how you might organise yourselves to achieve the main requirements common to all such systems and the benefit that would bring.

What is a management system?

Everyone has one, whether it is documented or not. It is how you go about your business. Maybe you are a small organisation, perhaps with a strong boss, even an autocratic one who simply tells everyone what to do and watches closely. That is a management system, so is one held by a huge firm with loads and loads of often old or misleading overlapping documents that you know contain the requirements, but you can't see the wood for the trees, as one might say. Most organisations lie somewhere between these two extremes.

Let's consider a generic example, it does not matter what you make, sell or service. You will have customer (or your own) requirements, you will have people, resources,

environments, inputs and outputs. The aim of the management system is to ensure requirements are met and outputs are suitable. For consistency, efficiency and profitability, you want to do this well and have an easy and relaxed life, maybe. You don't want complaints, bad outputs, re-working and reputational damage.

A documented management system

This is the solution but keep it simple. A modern simple system defines the aims of the organisation and describes in general terms how you go about achieving your aims. That is the top tier, often a "quality policy statement" at the start of a "manual". These days it may not be paper documentation but could be a set of hyperlinked webpages for example. Computer controlled arrangements have many benefits, particularly in "document control" (keeping it secure, up to date and accessible by the people that need any information.

So, the policy describes what you aim to achieve, and the rest of the

system is that required to achieve those aims in your particular circumstances.

Consider the diagram to the right:

The policy statement in the centre orange circle is the starting point. Here you simply define what you aim to do and give pointers to where more may be found about the various things you do. If you intend to comply with a particular Standard, like ISO 17025 if you were a lab for example, you would mandate that here. This is often just a single page showing commitment.

The blue circles show the things you have or do that need to be controlled: This is all about who does what, with what, where and when! Depending on your business there may be very little to document on some of these points, but some may be important, difficult and requiring extensive documentation and implementation. Everything needs documenting only to the extent needed for consistency.

People: This involves the job requirements, training and authorisation for all people that could affect the outcomes of your business.

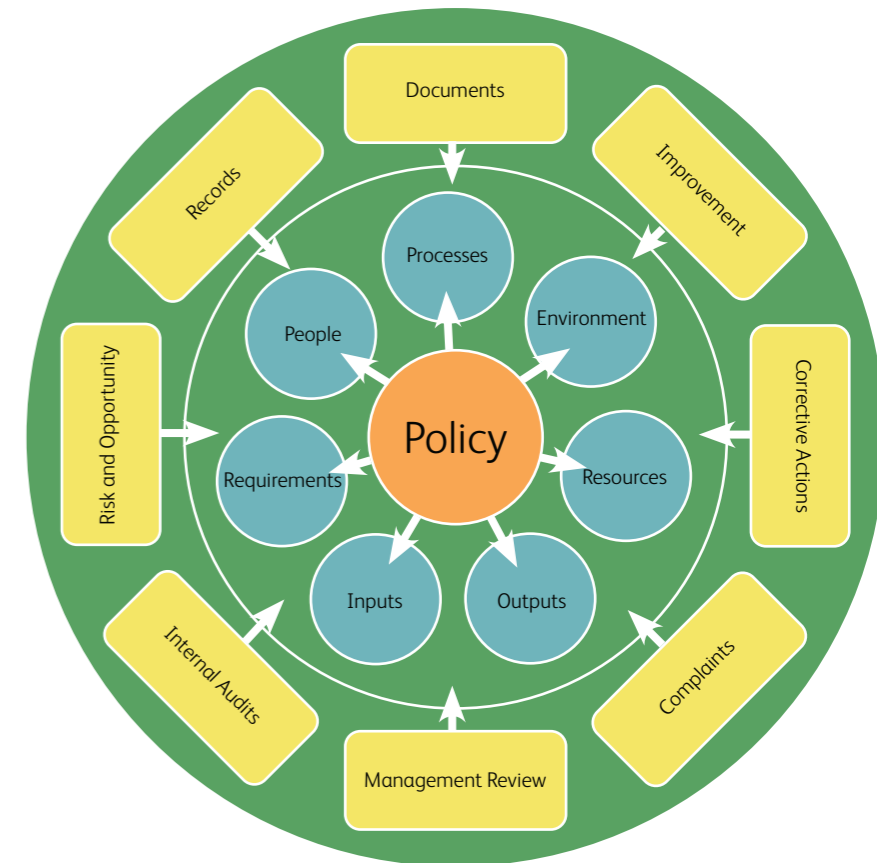
Processes: Instructions, guidance and information about how to do the work. The people will have been trained and authorised to follow these. They should be documented only to the extent necessary for consistency.

Environment: Needs to be suitable and not a threat to the quality of the activities. May require controls.

Resources: What you need to have to do your work. This may be equipment, contractors, space, money. It has to be adequate for consistent outputs.

Outputs: The finished work. It needs to meet customer and/or your own requirements and be clearly prescribed, known and controlled.

Inputs: The things you need to achieve the outcomes. This may be a mixture of external resources,



customer supplied items or data, according to, what it is you do - known and controlled.

Requirements: This may be those in a documented Standard, customer requirements, regulator or legal requirements. To be known, understood and complied with.

Now, to achieve the above, consistently and to be able to demonstrate that you do, there are so called "management system features" which vary a little between the different standards but may be described generically as shown in the yellow boxes. These features hold the whole system together and serve to provide confidence in compliance with requirements in a demonstrable way that meets at least the intent of standards like ISO 9001.

Documents: The instructions, requirements, specifications that you need to do your work. These need to be identified and controlled such that the correct processes are followed. These may be changed in a controlled way over time. All versions, even when superseded, should be kept long enough to

repeat the work or to audit them or to fulfil contractual requirements.

Records: These are the evidence of what has been done. They are recorded at the time and cannot be changed. If records are found to be incorrect, they may be corrected in a visible and traceable manner. Records should be kept long enough to audit them and to meet contractual requirements.

Risk and Opportunity: This is a feature introduced into modern management systems so that an organisation may determine for itself where risks exist and where opportunities may be taken in the depth and breadth of meeting requirements. Modern standards specify outcomes, rather than tell you how to do something. This means that in your system important things will be a big deal, and things that don't matter need little attention. The regime for collecting and processing risk and opportunity should touch all the people and all the processes involved.

Internal Audits: A programme of examining your own conformity

with your system. No-one should audit their own work and the programme should cover everything over a period of time. Each audit is a sampling exercise and shall be scheduled in advance. Typically, this has an annual cycle and takes a few hours each month.

Management Review: This is where the senior staff receive details of the organisation's activities and determine future actions. It will include review of the internal audits, complaints, customer feedback, growth or shrinkage of business and more. Typically annually, but more frequent when there are a lot of changes occurring.

Complaints: Nowadays defined as any expression of dissatisfaction from any source. Not all complaints will be valid but you need a system for handling them.

Corrective Actions: This system will process the outcome of complaints, assessments, internal audits and anything you yourselves find wrong in your business. A good system identifies required actions, assigns responsibility for completion, follows up, comparing with risk and opportunity data and ensures any changes have only a positive effect.

Improvement: Modern standards require a process to continuously try to improve your management system and hence your outcomes. The study of complaints, risk and opportunity data and audit results help inform how best to strive to improve. This should feature also in the management review.

In conclusion

Remember that this is not about generating a load of documentation just for other people to view. It is for you and facilitates the high quality of your work. We find that many organisations already have most of the documentation needed, but it is often unstructured, duplicated, or with gaps. The idea is that you could recruit a suitably qualified person who could then use your system and get the same results as existing

staff. Many of the features in the circles and boxes will not require a lot of work. It will depend very much on what you are doing. The more complex the task the greater detail should be expected to achieve consistency. If you have a good effective system, the "management system" items in the boxes serve to protect the activities and features shown in the blue circles.

If you are a couple of people doing one thing then I would expect just a few pages in total for the whole document system plus, of course, your records of what has been done, both for the work and for the maintenance of the management system. If you are much larger, multinational or multidisciplinary with many staff, doing many different things then of course your system will be large and require sometimes dedicated staff to operate it.

These days, with the ability to use computers to serve a single source of information (avoiding issues concerning updating and validity) with different people able and authorised to operate different parts (giving people access only to that which they need for their work) and enter information accordingly, we see some very impressive slick operations from both small and large organisations.

There are huge benefits from having a simple effective management system along the lines described above. Done well, reworking, complaints and inefficiencies are minimised while staff satisfaction benefits from the sense of involvement in the internal audits and contributing to the risk and opportunity regime. It should follow that long term viability and profitability are maximised.

Remember that this is not about generating a load of documentation just for other people to view. It is for you and facilitates the high quality of your work.

Trevor Thompson retired from The United Kingdom Accreditation Service after many years assessment and accreditation experience. He offers help on management system issues, measurement, testing and calibration as www.bestmeasurement.com operating in the UK, Europe and beyond. You may email him at questions@bestmeasurement.com and he is happy to answer readers' questions. Any interesting topics or requests may be covered in future issues of Precision. If you would like more information or have questions about anything covered this time, or in previous issues, please contact him.

SPOTLIGHT ON STAFF:

Q&A with InstMC Staff Member
Heather Suarez,
Registration & Accreditation Officer

How long have you been with InstMC?

I started at InstMC the last week of November 2023. It has really flown by! I've enjoyed learning how InstMC works, getting to know the team and the members.

What is your background?

I studied Educational Studies and Humanities, then went to teach English in Mexico for a year. Since then, I've worked in membership organisations for most of my career across many different positions; from operations management to sales and marketing, but most recently I was in financial services working with a variety of working groups to raise standards in their sector primarily through Guidance, conferences and webinars which also had accreditation and membership arms. As one of just two employees I had the opportunity to be involved in a bit of everything! I also had my own Virtual Assistant business for around 5 years which was great fun working with a variety of sole traders all in very different sectors.

What is your role at InstMC?

I'm an Accreditation and Registration Officer by job title, which covers Membership, supporting committees, facilitating Accreditation visits and Professional Registration.

Can you describe a typical day in the office?

I'm not sure there's such thing as a typical day! I always start my days with membership; working through queries, checking applications etc. then move on to anything pressing accreditation-related. I will answer member phone calls, plan ahead for future accreditation visits, follow up on things I'm waiting on, attend meetings – and before I know it my day will be over! The unpredictability and variety is what makes the role so interesting.

What do you bring to the team?

I'm incredibly passionate about what I do and bring with me a huge drive to help make things the best they can be. I see things in terms of the whole picture and enjoy problem-solving.

What do you like best about working for the InstMC?

I love working at InstMC because it's unusual to find somewhere where everyone cares so much. The team is amazing! I also love how friendly the members are and the enthusiasm they have for the sector.

What do you do to unwind, once your working day is over?

Once my working day is over, the chaos of family life resumes! When I do get a chance to unwind I like to get creative. I paint, draw, listen to music or read.

Can you tell us a fun fact about yourself?

I was once asked to perform at Glastonbury festival...in the circus tent! I was in a group that performed aerial silks and flying trapeze.



I also had my own Virtual Assistant business for around 5 years which was great fun working with a variety of sole traders all in very different sectors.



Awards Night 2024

SAVE THE DATE

Thursday 4th July

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



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President
Sheila Smith



Honorary Secretary
Billy Milligan



Honorary Treasurer
Stewart Macfarlane



Chief Executive
Steff Smith
+44 (0)20 7387 4949
steff.smith@instmc.org



Marketing Executive
Ernest Kyei
+44 (0)20 7387 4949 Ext 4
ernest.kyei@instmc.org



**Director of Membership
& Registration**
Leila Atherton
+44 (0)20 7387 4949 Ext 3
membership@instmc.org



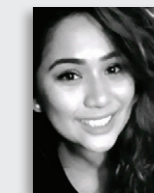
**Marketing &
Communications
Manager**
Jane Seery
+44 (0) 20 7387 4949
jane.seery@instmc.org



**Registration &
Accreditation Officer**
Jessica Currie
+44 (0)20 7387 4949
jessica.currie@instmc.org



Project Manager
Caroline Trabasas
+44 (0)20 7387 4949
caroline.trabasas@instmc.org

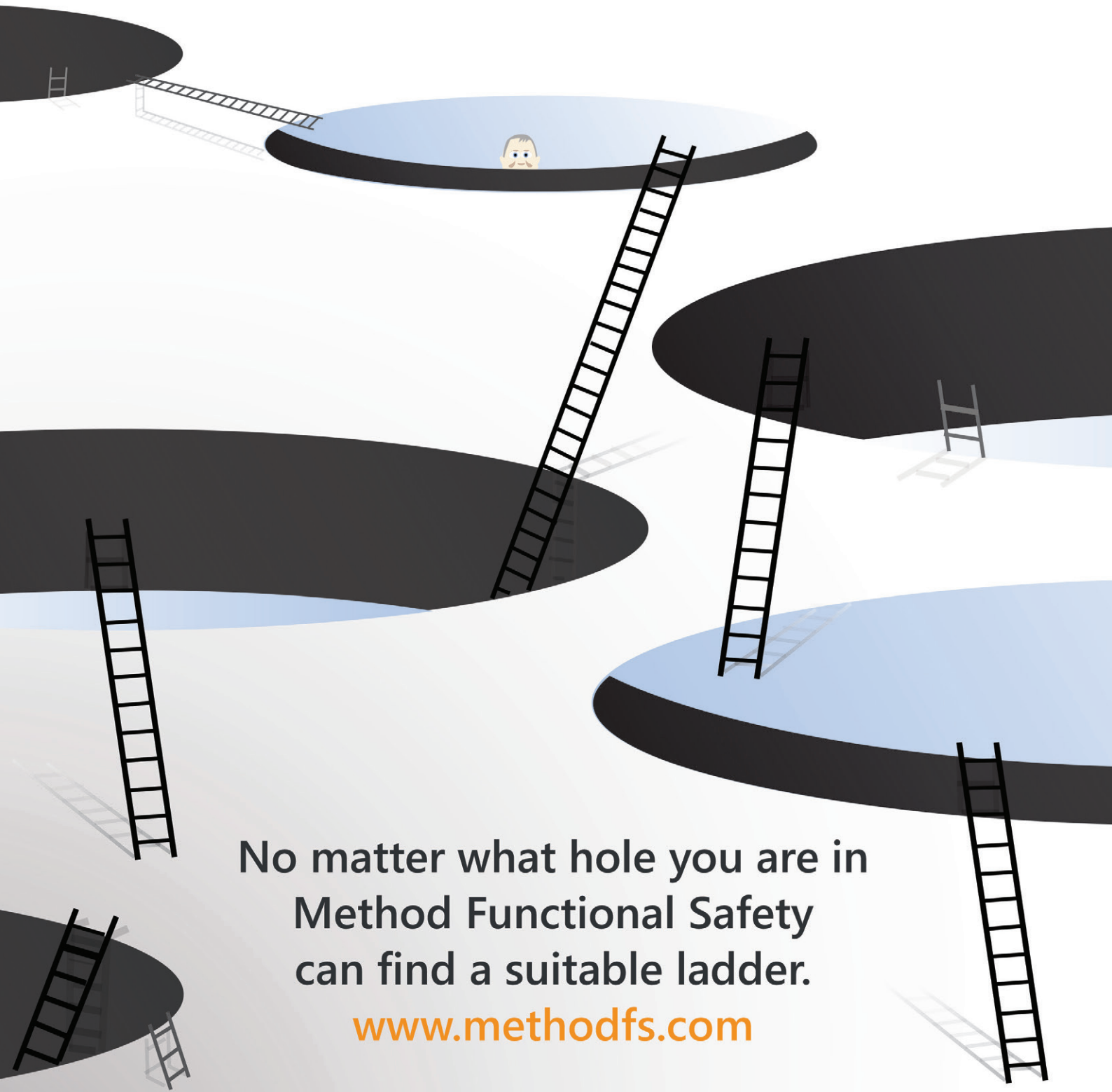


**Registration &
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Heather Suarez
+44 (0)20 7387 4949
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