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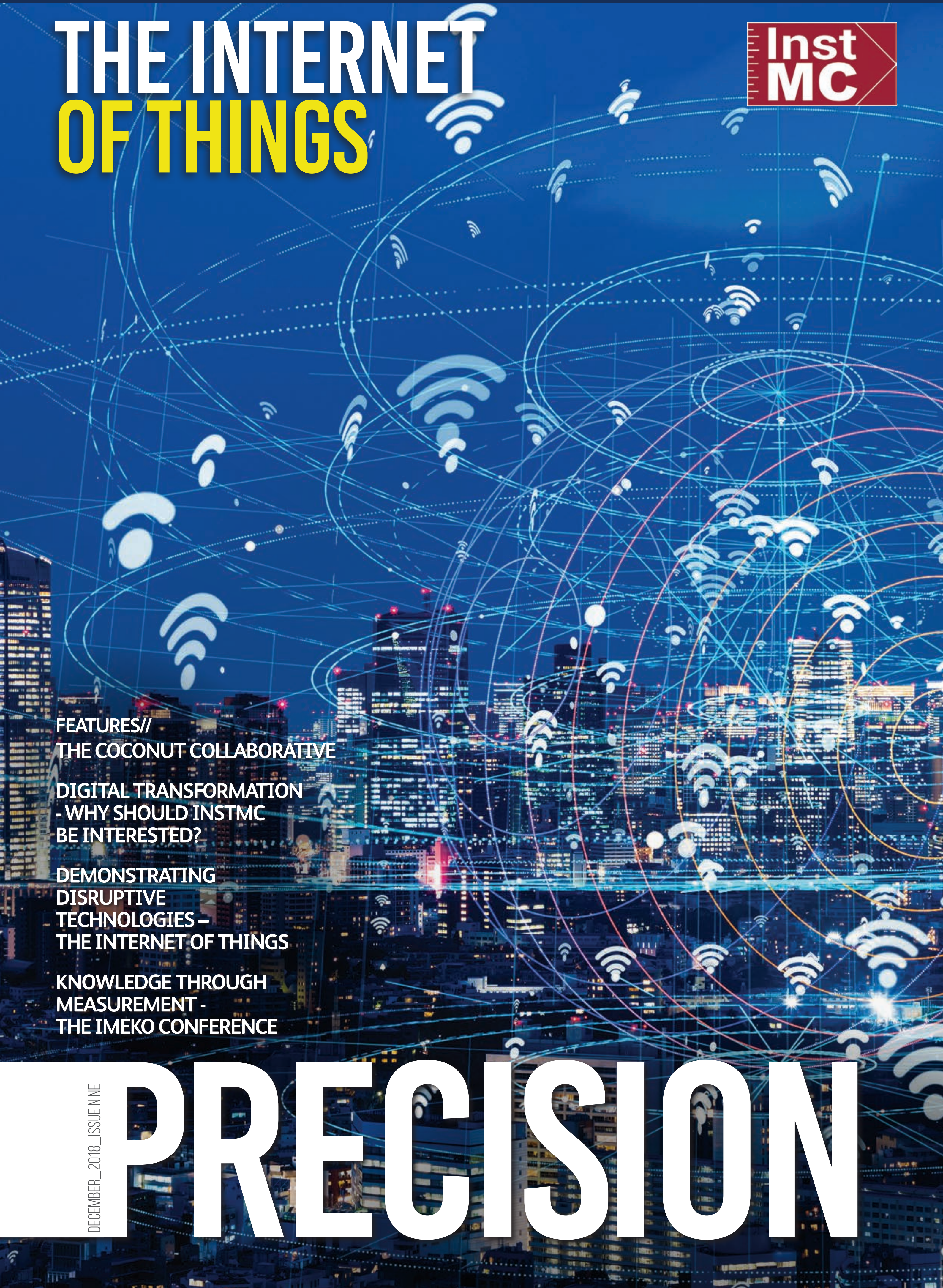

THE INTERNET OF THINGS

InstMC

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DECEMBER_2018_ISSUE NINE

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CHANGE AND CONTINUITY

For the engineers and scientists in our sector 2018 has been significant in many ways, with most of the important events for some reason happening in the tail end of the year.

Undoubtedly the most important scientific decision was the vote by the General Conference on Weights and Measures in Paris on November 16th to change the fundamental definitions of the SI system of units, taking effect in May 2019. From that date, metrologists will define all the seven base units of measurement in terms of fundamental constants rather than physical artefacts. Some commentators claim this is the most important change in measurement since the introduction of the metric system.

Totally removed from this, the most important non-scientific decision of the year for our British and European members was the November vote by the 27 member states to approve the UK's departure from the European Union, marking a milestone in a process which will undoubtedly affect us all, not least in our professional lives.

The knock-on effects on professional registration and mutual recognition of qualifications remain unclear.

For us as an Institute, hosting the September international measurement congress IMEKO in Belfast represented the largest conference we have ever handled, and we were proud of the result: a pleasing number and quality of scientific papers, two Nobel Prize winners giving keynote talks and a very positive set of feedback reports. You can read more details of the congress in the article within this edition. IMEKO was also where we launched the Festival of Measurement in front of 80 local A level Physics students. It lasts 23 million seconds reaching its climax on May 20th next year – international metrology day, when the SI changes. We have already held two public lectures at the Royal Institution in London, and we are planning to launch our schools competition early in the New Year with a wide range of other events planned.

Looking internally, this year has seen the start of new Special Interest Groups in specific technology sectors to complement others that were already running: we now have nine with healthy memberships and plans for a range of activities from conferences to training programmes. We have also started to revamp our Companion Company Scheme, agreeing a number of new benefits for member companies including a regular forum for networking - the first of which took place in November. During 2019 we will be rolling out the upgraded scheme which we are confident will attract more companies to join the current membership of just under 100.

Amidst these various new initiatives and external disturbances, the regular work of the Institute has continued locally, nationally and around the world. New engineers have qualified for professional registration; universities and companies have had their courses accredited and approved; regional training courses, exhibitions and lectures have been organised by our local sections and the Institute has contributed to the development of science and engineering through its participation in an eclectic range of public events, policy discussions and technical consultations. All of this is only possible because of our dedicated staff team and our truly committed army of member volunteers around the UK and internationally who give freely of their time. We manage to punch above our weight because we work well together, and it is a pleasure to thank all those who have contributed to the growth in our numbers, activities and influence during the year.

Patrick Finlay PhD CEng
Chief Executive Officer

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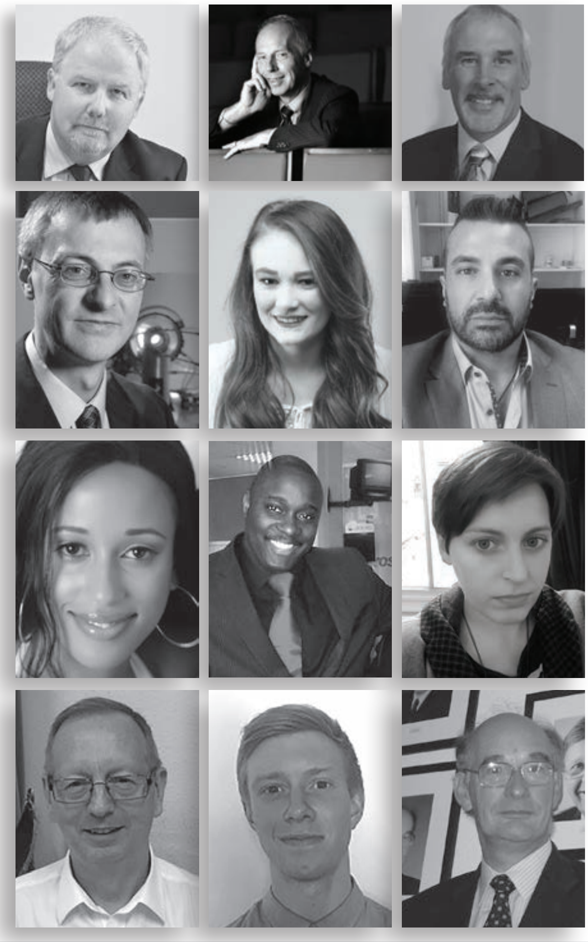

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Developing rapid and robust screening approaches to support food quality

THE COCONUT COLLABORATIVE

The Coconut Collaborative Ltd (CCL) manufactures Coconut Yogurt for the UK and a wide international market. Based on its innovative products and strong market presence it has become the market leading coconut brand in the UK.

Quality checks are required to ensure CCL maintains the high quality of product expected by its growing consumer base. The unwanted use of a barrel of coconut cream tainted by rancidity in the manufacture of coconut cream renders it unsuitable for sale and consumption. This leads to complete batches of coconut yogurt being rejected. Checks for rancidity are currently performed manually, with batches of coconut cream being tasted ahead of their use in production. With the growth of the business, this is becoming increasingly impractical but there are currently no automated methods available to test for rancidity.

Through the Analysis for Innovators (A4I) partnership, CCL had access to innovative and advanced measurement and analytical technologies at both the National Measurement Laboratory (NML) and the Science and Technology Facilities Council (STFC) to develop assess the feasibility of developing a rapid and robust screening approach to detect rancidity in coconut cream.

Supply specialists, engineers and scientists from CCL, the NML and STFC assessed the feasibility of using multispectral imaging (MSI) and Raman spectroscopy to detect traces of rancid coconut cream ahead of its use in the production of coconut yogurt.

> The A4I project collaboration has been incredibly valuable to the Coconut Collaborative Ltd. It has enabled us to work in a time efficient way with world class institutions and scientists to develop and prove a principle for solving a very unique but real rancidity measurement problem. We are impressed with the encouraging results.

Multispectral imaging (MSI) methods showed the sensitivity and repeatability to screen for and detect rancid coconut cream, performing a non-destructive test in no more than 20 seconds. MSI has also been shown to have the potential to be used as a quantitative screening approach to determine the level of rancidity in a sample of coconut cream.

These encouraging results have demonstrated proof of principle for using MSI as the basis for an enhanced level of quality control and screening in CCL's manufacturing plants. This screening approach will help avoid annual costs in excess of £500k through reduced production and material charges. With further optimisation, MSI could also be used as a predictive tool upstream in the sample production process prior to the onset of full rancidity, making further efficiency and cost savings for the industry in general.

In addition, the method has been "future proofed" so that it can also be extended to understand variations in coconut cream consistency between batches, suppliers and even geographic origin, as well as screening for the presence of other undesirable materials which could affect the quality of coconut cream.

The A4I programme is run by the UK National Measurement System laboratories, the Science and Technology Facilities Council and Innovate UK. It provides companies with access to state-of-the-art measurement and analytical technologies to solve existing analysis and measurement problems that are a barrier to competitiveness or productivity.

Funded by the Department for Business, Energy & Industrial Strategy (BEIS). For further details: measurement@lgcgroup.com

DEMONSTRATING DISRUPTIVE TECHNOLOGIES – THE INTERNET OF THINGS

Working on industrial digitisation within the manufacturing measurement group, Aaron Whittam, Research Scientist at the National Physical Laboratory, discusses the benefits of looking carefully at technology demonstrators before embarking on installation.

Disruptive technologies require, by their very nature, a great deal of care to install within any process, in order to make the most of their new capability and mitigate side-effects. Many of the side-effects are unimaginable until after installation begins. The risk of change can be very high, especially in already high-risk environments and for smaller companies.

The Internet of Things (IoT) is a term used to describe a network of physical devices embedded with electronics, software, sensor(s) and some form of network connectivity. The goal of this approach is that data from devices can be transmitted to centralised databases for remote visualisation, decision making or triggering events. The use of such technology in industry has coined the term the "Industrial Internet of Things" (IIoT), and falls under the umbrella of some of the most disruptive technologies which are paving the way for the Fourth Industrial Revolution (4IR), along with others such as virtual/augmented reality and artificial intelligence (AI) and machine learning.

Uptake of IoT devices

The main uptake of IoT devices to date has been within consumer products, using low cost sensors. However the rise in products coming to market has been dramatic and growth within this area is forecast to continue increasing rapidly over the coming years.

This growth in low cost internet enabled sensors comes at a time where the cost of storage is decreasing, cloud computing availability is increasing and developments in machine learning techniques are making major steps forward. These conditions are soon going to enable attractive digital solutions for small to medium enterprise (SME) manufacturing companies looking to improve, or start to introduce, remote monitoring, quality control, predictive maintenance or supply chain management systems. This is evident by a number of larger manufacturers already starting to adopt more expensive off-the-shelf systems which are not yet affordable to many smaller businesses.

However, with these new opportunities come new challenges. In discussions with SMEs, it is clear that:

- Many companies simply do not feel ready to adopt, nor do they not see the potential benefit of the digitisation of their business at the shop floor level.

- Many of the low cost sensors being advertised lack traceability to national standards and therefore give poor confidence in the data created.
- There is often the requirement for large numbers of sensors to be used within a system, making the calibration of every sensor economically difficult to justify.
- Lack of synchronised timestamping of data from different systems hinders the ability to effectively analyse data chronologically.

To enable UK industry to reap the benefits of Industrial Digitisation, the National Physical Laboratory (NPL) is bringing together expertise from a number of different sectors to address these issues.

Digital demonstrators

NPL has begun to create a range of digital demonstrators to show industry how IIoT can be implemented in practical systems and how the data collected can be used to inform decision making. The expectation is that seeing these demonstrators in operation will help smaller businesses assess the impact of the new digital technologies on their own processes and be able to explore the benefits and potential drawbacks of a variety of options. This reduces the associated risk, and means that implementation does not have to be costly or difficult.

The first demonstrator is a small scale mock-up of a jet engine which has been retrofitted with sensors and remote control capability. This set-up shows how traceable sensor systems can be unobtrusively retrofitted to existing equipment. The embedded technology allows the user to start collecting data, store it locally or securely transfer it to the cloud, and perform subsequent visualisation of the data. The aim of this demonstrator is to show that having sufficient relevant data for a piece of equipment can provide valuable information regarding both the operating characteristics and how it may be drifting over time. Such quality information can lead to an ability to predict where conditions will exceed warning limits and allow for pre-emptive corrective action to be taken – keeping equipment within operating specification for longer.

Another demonstrator has been set up on a co-ordinate measuring machine (CMM). The system is being used to capture ambient environmental and on-machine conditions of both the CMM and the part being measured. The data collected is pushed wirelessly to the cloud, and is paired with the CMM measurement data including the part identification details. This additional data allows users to investigate the correlation between the measurement output and the conditions at the time of measurement. For example, continuous monitoring of the local and ambient environment can immediately alert a user where measurements are being taken outside of acceptable operating conditions, i.e. as a part is too hot, or vibrations are too high. The simultaneous data collection also enables more accurate quantification of the effect of CMM conditions, leading to the ability to correct for these variations from 'gold standard' values, and thereby increasing the potential range of conditions that the CMM could be confidently operated under.

Additional demonstrators are planned, to delve further into data analytics and AI for process control and predictive maintenance. The intention is to locate them around UK for easy access for smaller businesses, and enable them to assess the impact of the technologies on their own systems before embarking on installation.

Time synchronisation

As a last note – one major issue with pairing data from multiple sources is a lack of time synchronisation between systems. Differences in timestamps from machine to machine lead to serious inaccuracy when attempting to fuse large datasets for combined analysis. By creating a traceable and accurate local time hub, utilising GPS common-view, timestamping can be unified over an entire factory. The local time hub references back to the highly accurate NPL atomic clock system, known as UTC(NPL), via GPS and can provide an accuracy of <1 μs of UTC(NPL), as well as having traceability to national standards. Having common timestamping of data across entire factories will be essential to allow for accurate analytics and predictions of systems.

Visit www.npl.co.uk/regional-hubs/npl-huddersfield or email huddersfield_lab@npl.co.uk for more information.

DIGITAL TRANSFORMATION – WHY SHOULD INSTMC BE INTERESTED?

InstMC is in the process of forming a Digital Transformation Special Interest Group (DT SIG) with its first meeting set for 4th December (when is the issue published?).

Maurice Wilkins,
Chair of DT Special Interest Group

As DT is so diverse, this first meeting will establish which aspects InstMC should address and what deliverables the SIG will provide to our members.

But, what is digital transformation?

Over the past several years, there has been increasing reference to the Internet of Things (IoT) and its industrial counterpart, the Industrial Internet of Things (IIoT), Industrie 4.0, Smart Manufacturing, 4th Industrial Revolution (4IR) and so on. All of these fall under the umbrella of digital transformation.

As the term implies, digital transformation uses digital technology through interoperable systems, modelling and simulation, intelligent automation and networked sensors to analyse data and disseminate information throughout the entire manufacturing lifecycle. This allows companies to manage manufacturing operations proactively with informed and timely decision-making. But more than that, DT enables new business models and encourages innovative approaches. From an InstMC perspective, sensors and actuators are the eyes, ears and hands of digital transformation, while automation and data analysis are the brains.

Recent information from manufacturers shows that they are all at a different point in their DT journey, but all are doing something; from locally driven projects, aimed at solving specific issues to full blown centrally driven DT groups and projects driving corporate strategies.

> Inexpensive, portable and smart sensors will fundamentally change the way companies approach operations.

Innovative Technology

The process industries tend to be very conservative but even they are using innovative technologies to improve profitability and availability, to replace the knowledge of retiring experts and to maintain safe and sustainable facilities.

In recent editions of Precision we have seen drones and robots in various industrial applications and these are continuing to grow. Drones and robots are being used for surveillance and inspections in areas which have traditionally been dangerous for humans without extensive safety measures being taken. For instance, inside tanks and vessels, at the top of flare stacks and columns and also for surveillance in remote locations. Artificial intelligence (AI) applications are helping with the analysis of process data for the prediction of impending maintenance issues or process incidents. Artificial reality (AR) and virtual reality (VR) applications, along with ever more realistic simulations are giving process operators immersive training experiences in much the same way that airline pilots have been trained for some years now. Augmented reality is also helping operators to 'see' inside the process while conducting routine inspections.

Inexpensive, portable and smart sensors will fundamentally change the way companies approach operations. Manufacturers will be able to get a better picture of process operations under all conditions. We may even see 'measurement as a service' where manufacturers license sensors from suppliers for the duration of a process improvement exercise for instance. In addition, the ability to print sensors and even embed them into process equipment will enable the integration of a greater variety of variables with a higher accuracy and lower cost.

5G will take wireless into another dimension. With better security, accuracy, battery life, range and latency we could see wireless closed loop control for non-critical processes. Intelligent device to device communication will also become a reality.

Cloud and edge applications will enable us to move operators away from the process for all but the most essential tasks and give management a more accurate view of operations than they have previously had. Edge devices will also enable us to run advanced control and optimisation applications closer to the process.

Industry Needs and Drivers

Digital transformation is impacting industries across the board from oil and gas to pharmaceuticals with some more dramatic than others. But few industries have looked to digital transformation for dramatic improvement more than oil and gas. Ten to fifteen years ago there were few mentions of data analytics, drones, robots and so on in the upstream oil and gas industry. But today, driven by the need to optimise operations due to the price of crude oil and the push for improved process safety, we are seeing advanced applications for well management of offshore and onshore oil rigs based on information provided by data analytics. In fact, data analysts and scientists are now amongst the most sought-after functions in the recruitment industry. Added to that, self-managed robots are being used for routine maintenance and calibration, while drones are being used for inspections.

In the midstream industry drones are being used to monitor pipelines. There is also a move to put intelligent 'pigs' into pipelines, but the issue with these is location services, as GPS doesn't often work in underground pipes. The chemical and downstream oil and gas industries have deployed advanced control and distributed control systems for many years now, with very good results, but only a fraction of the data they produce is used for process improvement. These companies are now using data analytics to dive deeper into that mass of data. But even in these industries, big changes may be coming. ExxonMobil has been at the forefront of change in the automation industry with the introduction of the Open Process Automation Forum (OPAF) at the end of 2016. They are pushing the automation industry to develop a truly open control system, where hardware and software from multiple suppliers come together as one control system, with in-built security. However, the issue here may then become – who manages the system? Will this change the role of the suppliers and system integrators?

Digital transformation has changed the power industry. The integration of renewables into the power grid has been enabled by the ability to monitor and control diverse operations with digital technologies.

Even the pharmaceutical industry has been impacted. Driven by the lack of new 'blockbuster' drugs, it is also turning to digital transformation for new directions. Data driven analytics research and development programs are being used to increase the pipeline and dramatic improvements have been made in process efficiency and agility. They are also forging better links with customers to understand how the drugs are performing and what improvements can be made. This is against a backdrop of patients becoming more engaged in their own treatment, a drive for personalised care and more online engagement between patients and physicians.

The Role of Standards

Another of InstMC's key roles is in the development and support of standards, through BSI, IEC and others such as ISA, SPE and so on.

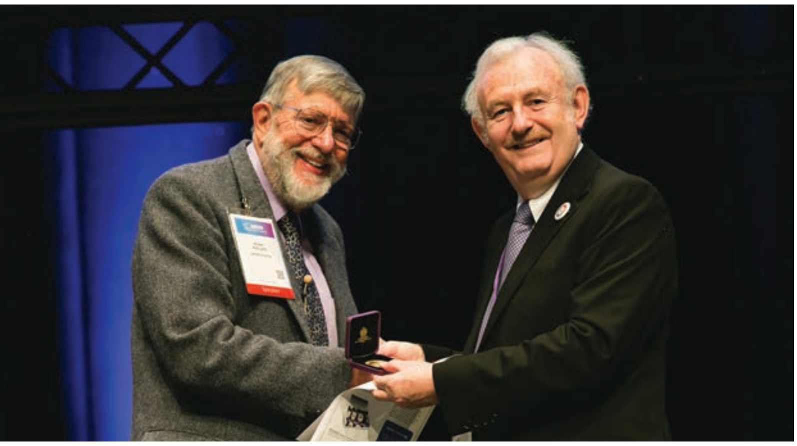
In order to support these new smart manufacturing technologies and activities, new standards or changes to existing standards will be needed. International efforts are underway to address this through both IEC and ISO, with joint working groups and committees being formed to look at 'smart manufacturing' communications, cyber security, architecture, reference models, data exchange protocols and others. Recognizing this, IEC has recently formed a new smart manufacturing committee (Syc SM) to bring all of these working groups and committees under one banner. This new committee had its first plenary meeting in Frankfurt in November.

The Future

As we have seen above, digital transformation will have a big impact on every aspect of our lives in the coming years and it will change the nature of jobs and their location. The evolving technologies will make people safer, more informed and more productive. As with past technological changes, it will probably also open new doors that we hadn't even anticipated.

> Inexpensive, portable and smart sensors will fundamentally change the way companies approach operations. Manufacturers will be able to get a better picture of process operations under all conditions.

KNOWLEDGE THROUGH MEASUREMENT: THE IMEKO CONFERENCE

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SECURING KNOWLEDGE THROUGH MEASUREMENT

Peter Thompson, CEO, National Physical Laboratory shares his thoughts from the recent IMEKO conference.

"Knowledge through measurement", the topic of this year's IMEKO conference, reminds me of the wise words of Lord Kelvin:

"When you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge of it is a meagre and unsatisfactory kind"

In 1854, the Belfast-born Lord Kelvin (then known as William Thomson) proposed that a unit of measuring temperature should be defined in terms of an interval between absolute zero (minus 273.15 degrees Celsius) and a single fixed point.

This was an idea far ahead of its time; we were only just beginning to grapple with the need for a consistent approach to measurement. This was decades before the International Metre Commission was tasked with outlining measurements that could allow for amounts to be compared across states for trading, and a prototype of a kilogram and a metre created. In fact, it took 16 years for these artefacts to be made and agreed upon.

Kelvin's proposal for a clear unit for temperature took longer still. A century later, in 1954, the kelvin was formally adopted as the unit for thermodynamic temperature, alongside the adoption of the ampere for electrical current, and the Candela for luminous intensity; forming what we now know as the International System of Units or Système Internationale d'Unités (SI). Since the 19th Century, a great deal has changed in science, and a great deal has changed with the SI to support this. Perhaps most importantly, we have moved away from involving artefacts in the definitions of the SI units. There was once a time when there was a block of metal which was 'the metre', from which all measures of length were calibrated. If this artefact changed, the metre itself would change – and it did – fluctuations in temperature, pressure and contamination were all capable of causing 'the metre' to change.

Thankfully, we no longer use an artefact to define the metre. Now, it is defined as the length of the path travelled by light in a vacuum in 1/299 792 458 of a second. To a general audience this may look more intimidating, but this robust definition offers reduced uncertainty and greatly simplified calibration practices.

The metre artefact has been replaced by a definition that relies on the speed of light, a natural constant. Our understanding of this value will improve, and redefining an SI unit in this way provides a solid base for using this unit in the future.

Today technology is the most sophisticated it has ever been. Measurement plays a crucial role to ensuring that it functions as intended and can be developed in a timely manner.

It might surprise you to learn that our definition of mass is still currently reliant on a lump of platinum-iridium alloy, situated at the Bureau International des Poids et Mesures (BIPM) in France. All mass measurements are still traceable back to this one artefact, the International Prototype Kilogram (IPK)!

This is set to change. This November, at the General Conference on Weights and Measurement, a redefinition of the SI units was accepted. This makes it an extremely important time in measurement (no pun intended). The proposal incorporates a long-held ambition to move all of the definitions of the base SI units (kilogram, second, mole, ampere, kelvin, metreand the candela) to be based upon natural fundamental constants, and the realisation of these standards by universally replicable experiments – a long-term aspiration for the community.

This is a truly international endeavour. For example, scientists at NRC in Canada and at NIST in the US have made the most accurate measurement of the Planck constant on which the new kilogram definition will be based. They used a method called the Kibble balance experiment which was developed at NPL some 40 years ago by Dr Ian Robinson and the late Dr Brian Kibble. Ian is now working on a smaller version of the Kibble balance to enable better dissemination of mass realisations to support NMIs, calibration companies and industry worldwide.

Finally, the kilogram, like the metre before it, will be free from its physical artefact-based definition.

Q&A

Dr Julian Braybrook

This month's interviewee is UK Government Chemist Dr Julian Braybrook, Director of Science for the National Measurement Laboratory at LGC, and Visiting Professor at Loughborough University.

What was the root of your interest in science?

My science teachers at school (maths, physics, chemistry and biology); in their own way they each brought the subjects to life and made them accessible and fun, especially during my 'A Levels'. However, it was probably during my PhD studies that I really came to appreciate 'the application of science' and first realised the role and value that science at the boundaries of these science subjects, but particularly chemistry and biology for myself, was going to play in my life and that of society more generally.

What does the Government Chemist do?

The Government Chemist role was created in 1909, to ensure the Laboratory of the Government Chemist could work independently of the Inland Revenue department (which provided staff to the Laboratory) and the Board of Customs and Excise (which controlled it).

Nowadays, the Government Chemist is appointed by the UK Government Department for Business, Energy and Industrial Strategy (BEIS) and oversees the statutory function of Referee Analyst (and that as Authorised Analyst) defined in/under various Acts and Regulations. The individual resolves disputes over analytical measurements predominantly, but not exclusively, in relation to food regulatory enforcement. It is fundamental to providing an independent voice for sound analytical measurement science and preventing miscarriages of justice. This independent technical right of appeal for businesses strengthens consumer protection and often avoids the need for recourse to the courts.

Under the associated Government Chemist Programme, we routinely settle approximately 10-20 referee food cases annually out of court, saving significant amounts of money each year; indeed the savings pay for the costs associated with the Government Chemist function several times over! Many of the analytical disputes referred to us are familiar - mycotoxin contaminants, food authenticity, genetically modified food and choking hazards - but each year brings something new.

The Government Chemist also has a role promoting analytical science and technology, providing advice to Government relating to chemical measurement for sound standards - and policy-making, and for regulation-setting.

What is your vision for the Government Chemist role by 2023?

Looking to the future, the Government Chemist has to be ever better prepared – to stay ahead of emerging scientific technologies, to address unmet regulatory need through the sound adoption of such technologies, and to recognise the increasing role for point-of-test screening technologies (before confirmatory laboratory-based techniques).

The broadly similar analytical nature of some referee cases being received is being off-set by an increasing interpretative challenge for others. Set this alongside the requirement for an ever more global perspective means being able to deal with further complexity and challenge in a similar smart and timely manner.

Additionally, the value of the work of the Government Chemist is nothing if it is not made ever more widely available; maximising awareness and impact of the work (beyond the direct court cost savings) therefore becomes ever more significant. Part of this also involves expanding the advisory component of the role around the more traditional chemical measurement focus, to account for the inter-disciplinary nature of science today and my more bioscience background.

What should the UK government do to address the shortage of UK scientists with the right skills for industry?

The Government options for schooling post-Y9/10 and for Apprenticeships has given more decision-making power to industry itself to specify and, importantly, be involved more closely in assuring training that provides the skill sets they will need.

However, there remain areas, such as analytical measurement science, which have not perhaps been receiving as much attention as is proving necessary - for as many years as I can remember, there have been increasing concerns expressed in many quarters about the threat posed by declining skills in analytical measurement science in the UK. The Community for Analytical Measurement Science (CAMS) initiative I am currently supporting is one example of several plans to help address this, bringing together academia, industry and other like-minded commercial entities, with the necessary public sector organisations, to ensure our future measurement scientists are as equipped as possible to help meet the analytical challenges facing their future sectors.

What do you do in your free time to relax?

When I find the time, then walking in the Lakes comes high on a more irregular list of activities, but some experimental cooking at a weekend offers more frequent opportunity!

Given one wish what would that be?

My wish would be for my children to grow up in a world where they are free to fully express themselves and maximise their opportunity to make their impact, whatever form that may take – although they each appear to have a science focus interwoven into their genes!

Looking to the future, the Government Chemist has to be ever better prepared – to stay ahead of emerging scientific technologies, to address unmet regulatory need through the sound adoption of such technologies, and to recognise the increasing role for point-of-test screening technologies (before confirmatory laboratory-based techniques).

ASK THE EXPERTS

I see the stated accuracy of instruments quoted as a percentage. But what is it a percentage of?

**Yours sincerely,
Angry of Mayfair.**

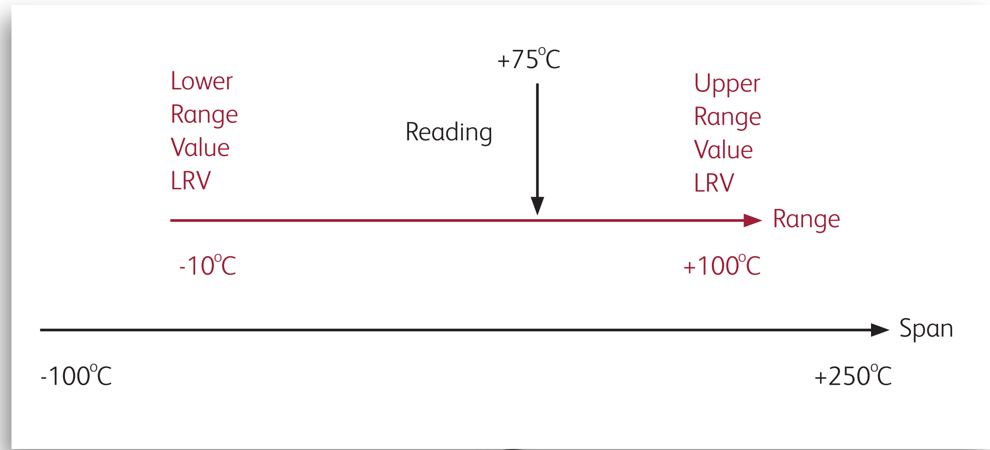
Tom S Nobes of Central North-West Local Section replies:

It is one of three things; % of Range, Span or Reading. There are three parameters that are often quoted:

- % error of span
- % error of range (often called % Full Scale Deflection, FSD)
- % error of reading(often called % Measured Value, MV)

The errors are often simply quoted as a % with no explanation of the parameter. It has been known for some manufacturers to 'cherry pick' the parameter, quoting some as % of range and some as % of span, etc. Their objective is to find the smallest possible number they can quote in the sales brochure. Text below defines what we often actually achieve on plant.

Let's ensure we understand the differences:



We bought a resistance thermometer based temperature smart transmitter which can be set to measure anywhere between -100'C and +250'C. Our usual reading is around +75'C. Therefore:

- +10 to +100'C (or sometimes simply 90'C) is the Range. The +10'C is called the Lower Range Value (LRV), the +100'C is called the Upper Range Value (URV). These are the figures we actually want to measure between.
- -100'C to +250'C is the Span. These are the extreme limits the smart transmitter could work between. We can set any LRV and URV between -100'C and +250'C and the transmitter would work within the manufacturers specified accuracy.
- +75'C is the Reading. The actual temperature of part of our plant.
- (for completeness Span/Range i.e. (-100 to +250) / (+10 to +100) = 3.88 is the Turndown)

It's essential to know what terms your manufacturer is using for what values, as EU, Japanese and USA manufacturers have different conventions on this (or regrettably no convention at all). Range and Span are very often intermixed.

Using our example, our selected temperature transmitter manufacturer's brochure states an accuracy of +-2% - but 2% of what?

This could be:

- 2 x (+10 - +100) / 100% = +-1.8'C error of Range.

or

- 2 x (-100+250) / 100% = +-7.0'C error of Span.

or

- 2 x (75) / 100% =+-1.5'C error of Reading

Manufacturers usually never quote % of Reading as they cannot possibly know what our likely readings will be. However; the importance of the difference between Error of Range and Error of Span is obvious.

To finish, an ISO Standard was to be published detailing such terms, but I don't think it ever was. Local and national conventions can be found on the internet.

regards,
Tom S Nobes. **C.Eng. F.InstMC**

Do you have a question for the our experts? Please send them to publications@instmc.org

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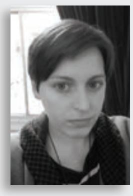

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