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

HOW DO YOU CREATE AN INCLUSIVE ENGINEERING GRADUATE PIPELINE?

NATIONAL METROLOGY SKILLS ALLIANCE

SAFE DIGITIZATION DOWN TO THE FIELD LEVEL

ELECTRICAL SMART GRID RESILIENCE CONCERNS FOR NET ZERO BRITAIN

TACKLING REAL WORLD PROBLEMS TO ENHANCE ENGINEERING STUDENTS EMPLOYABILITY

JUNE 2022 ISSUE 24

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ENGINEERING COUNCIL CONGRATULATES 2,040 NEW REGISTRANTS

In the first quarter of 2022, over 2,000 engineers and technicians became professionally registered with the Engineering Council, following a successful assessment of their engineering competence and commitment.

Professional registration is an internationally recognised mark of quality, as it is a standard set by the engineering profession.

Congratulations to each and every one of the 2,040 new registrants so far this year!

Unlike a purely academic qualification, registration demonstrates a person's competence (gained through practical experience) as well as their knowledge and understanding. The engineers and technicians who achieve professional registration are skilled professionals who have chosen to have their expertise independently verified. Registrants are able to use post-nominal letters after their names to show they hold one of these legally protected titles, demonstrating their professional status:

- Chartered Engineer (CEng)
- Incorporated Engineer (IEng)
- Engineering Technician (EngTech)
- Information and Communications Technology Technician (ICTTech)

In the first quarter of 2022:

- 1,262 people achieved CEng
- 247 people achieved IEng
- 479 people achieved EngTech
- 52 people achieved ICTTech

Engineering Council CEO Alasdair Coates BEng (Hons) MSc CEng FICE MCIHT CMIOSH said:

"We understand what a huge achievement professional registration represents – both professionally and personally. Congratulations to every single person who has achieved this milestone so far this year!

"Every registrant has chosen to have their competence independently assessed. As a condition of maintaining registration, registrants commit to maintaining and enhancing that competence, as well as to working in an ethical and sustainable way. This means society, employers and clients can have confidence in registrants as engineering professionals."

To verify an engineer or technician's Engineering Council registration, use the online tool RegCheck: https://www.engc.org.uk/regcheck

The Engineering Council licenses 39 Professional Engineering Institutions (PEIs), including the Institute of Measurement and Control, to assess individuals for professional registration. This is open to any competent practising engineer or technician, with different levels and pathways to registration available.

For your next steps to becoming professionally registered, visit https://www.instmc.org/Membership-Registration/Professional-Registration

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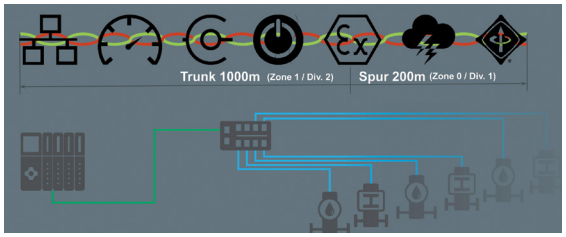

Ethernet-APL brings the benefits of digital communication to harsh environments of the process industry at field level.

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NATIONAL METROLOGY SKILLS ALLIANCE

BY CHARLOTTE BLAKE, TREVOR TOMAN, PHIL BAMFORTH, STEFF SMITH

Following a Midlands Centre for Data-Driven Metrology (MCDDM) training seminar in 2021, the team from MCDDM set out on an ambitious goal: to develop and enact a standard training pathway for Metrology in the manufacturing industry.

Led by Trevor Toman (Coventry University), Charlotte Blake (University of Nottingham), Phil Bamforth (Rolls-Royce) and Steff Smith (Institute of Measurement and Control), the group launched the initiative through a workshop discussing training and education needs for Metrology experts. Discussions during this workshop identified key areas of need in manufacturing industry:

- Standardised skill sets to validate hiring practises for expert metrology roles
- Clear pathways to competency for those entering into and progressing through careers in metrology
- Awareness of metrology practices for managers, design engineers and other non-metrologists to better understand the value of metrology in the manufacturing process chain.

In addition, a focus on "competency not certificates" was highlighted as a priority area, to ensure that real-world skills and knowledge are valued within the framework. The importance of practical skills and application of theoretical teaching was strongly emphasised by hiring managers present in the workshop.

Further investigation by the InstMC found that in the framework for engineering chartership, the words "measurement" and "metrology" do not appear in the document. From these discussions and discoveries, it was agreed that a group of cross-industry representatives would work together to develop a standard framework for training in Metrology. The National Metrology Skills Alliance (NMSA) has been formed from companies from across the UK manufacturing industry, including Rolls-Royce, Reliance Precision, National Physical Laboratory, SuirFlo, Jaguar Land Rover, and many more.

This year, the project has accelerated at pace and now a core steering group has been formed. This group, now formalised as a Special Interest Group within the InstMC, is made up of representatives from large industrial organisations and manufacturing SMEs alike. Their goals for the framework, including plans for writing and delivery timelines for the standard were outlined in March. Three working groups of key manufacturing disciplines – Flow Metrology, Force Metrology and Dimensional Metrology – alongside a working group for a core framework underpinning all disciplines and the key capabilities required for this career path.

NATIONAL METROLOGY SKILLS ALLIANCE FRAMEWORK

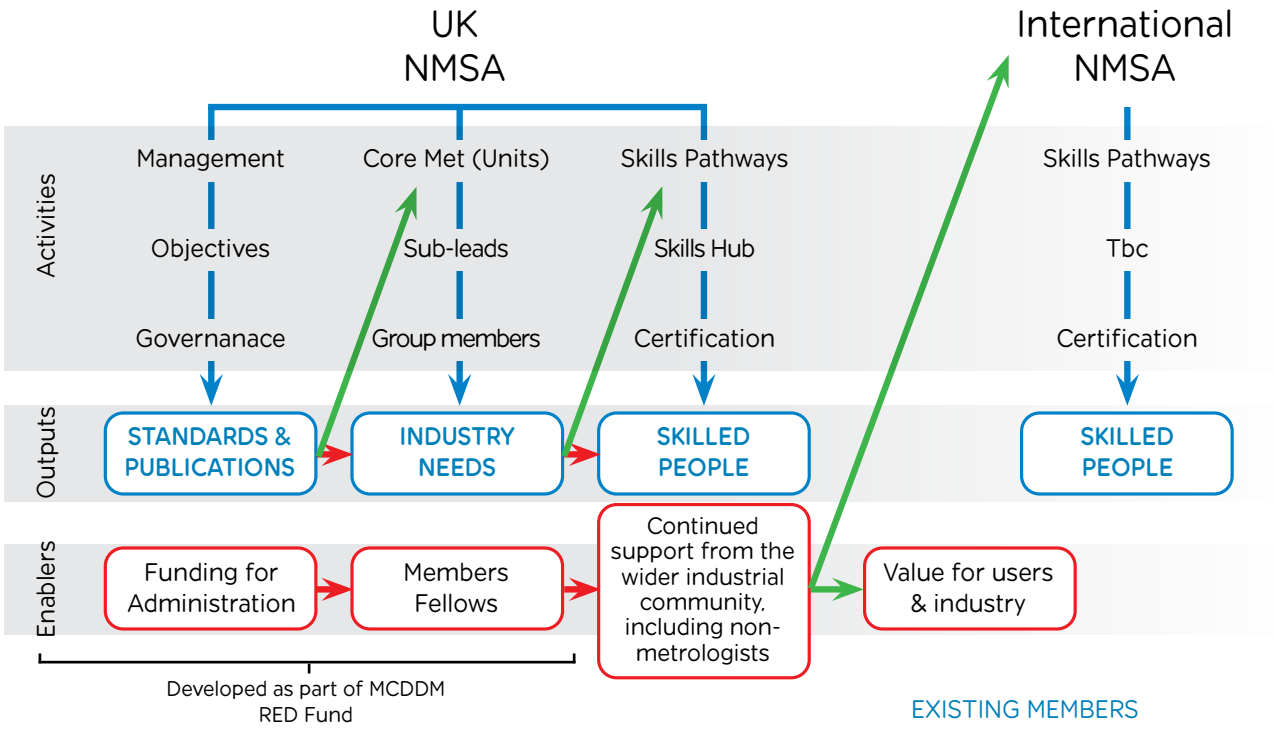


Diagram outlining the structure of stakeholders and deliverables involved in and expected to contribute to the development of the standard Metrology training framework under development. Whilst the current project is UK-focused, the group are planning to expand internationally in the future as appropriate.

EXISTING MEMBERS

CU - CO-lead
RR - Co-lead
MCDDM
NPL
NEL
BTMA
UKAS
UN
Inst. MC

The first draft of competency frameworks is expected to be ready for delivery by June 2022. In this draft, the initial fields of Flow, Force and Dimensional Metrology will be trialled with a view to expanding to all other fields of Metrology in future iterations. The initial group of topics have been chosen for relevance to the manufacturing industry at large, in addition to the primary pull of users interested in the framework proposal; however, this list is not exhaustive and recommendations of additional areas for consideration are welcomed.

The group are now seeking organisations willing to volunteer their time for testing of the framework once complete. These organisations will be asked to stress-test the standard against their existing training schedule and hiring practices for metrologists in the company. If you are interested in offering your time to this endeavour, please contact Dr Charlotte Blake at charlotte.blake1@nottingham.ac.uk in the first instance.

At Reliance Precision, skills and competence play a leading role in the success of our business, none more so in the verification of product conformance. The subject of metrology plays the pivotal role in ensuring measurement processes are defined and fit for purpose – this means the competency of people working in the subject is vital. We wanted to be involved in the project to ensure we as a business can contribute our knowledge of metrology so that the standard reflects how we approach metrology training – and what the important subjects are. We hope the standard helps with recruitment, internal training and evidencing our capability to our customers for the subject of metrology.

David Torr,
Head of Metrology, Reliance Precision Ltd

Engineers of all disciplines are required to "measure" and use aspects of "metrology" whether Electrical, Mechanical, Chemical, Digital etc. Currently there are adequate Standards to enable successful assessments of Engineers to award the appropriate Professional Qualifications. There is a body of Engineers who have the necessity to utilise detailed measurement knowledge from multiple disciplines, typically Flow Measurement Engineers, when adequate assessment proves difficult. A subject qualification covering "metrology" could be utilised to assist in the assessment process and give a Professional Qualification status.

Gordon Fish,
Director,
SuirFlo Ltd

HOW DO YOU CREATE AN INCLUSIVE ENGINEERING GRADUATE PIPELINE?

BY ANNE NORTCLIFFE, FOUNDING HEAD OF SCHOOL OF ENGINEERING, TECHNOLOGY AND DESIGN, CANTERBURY CHRIST CHURCH UNIVERSITY

STEM Diversity Problem

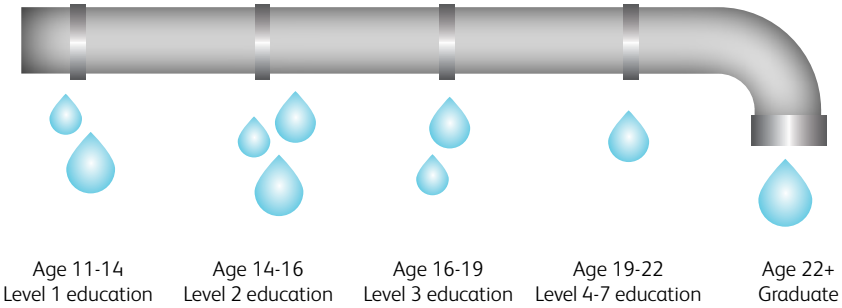
UK's industry is facing 173,000 STEM skills shortfall[1].Increasingly these roles demand higher and degree skills to support industry 4/5[2], typically in 2020 approximately 117,000 STEM students graduated[3]. However, the challenge is further up the STEM pipeline, students in the UK are limited by geography to access to prerequisite STEM education[4], for example school students in the West of South Yorkshire have access to STEM A-level education as opposed to those in East of South Yorkshire who do not.

Only 14% of Black Asian Minority Ethnic (BAME) students secured graduate employment, compared to over 70% of their white counterparts[5]. Placement attainment gap is similar between BAME and White engineering students[6]. BAME and female graduates are typically employed in non-engineering roles, as well as female engineers being paid less than their male peers[7]. Only a third of employers have taken positive action to address inclusiveness[8].

In conclusion, in the UK everyone on the STEM pipeline (see Figure 1) needs to take ownership to address the inclusive and diversity leaks:

- Schools should ensure that students have access to the right STEM education and advice
- Higher Education (HE) should support Schools to ensure an inclusive and diverse STEM pipeline into HE
- HE should recruit, nurture and retain students to graduation into industry
- Industry should reflect on how inclusive their recruitment processes are
- Industry should evaluate the day-to-day operations and practices support inclusive and diverse workforce.

Figure 1: STEM leaky pipeline



Addressing Leaky Pipeline

In Kent and Medway, historically the access to HE engineering has been limited. Aspiring engineering and technology students have had to leave the area to study, and feedback from regional employers implies that the students don't typically return to the region. To address the regional engineering skills gap, the Office for Students and South East Local Enterprise Partnership, Charity Donations have invested £14.8M in the creation of the Kent and Medway Engineering, Development Growth Enterprise Hub (EDGE Hub) at Canterbury Christ Church University (CCCU). Kent and Medway EDGE Hub vision is to create an inclusive 'industry-ready engineering and technology graduate' pipeline to the region, national and enterprises to support economic growth.

The new School of Engineering, Technology and Design at Canterbury Christ Church University (CCCU) has been designed to be truly inclusive, and to recruit and retain students for the STEM pipeline (see Figure 2). The approach has adopted lessons learnt from industry and education on how to address STEM pipeline leaks through:

- Student recruitment activities
  - o Schools and Colleges outreach activities
  - o Student marketing activities
- Higher Education Facilities and Resources
  - o Human resources inclusive and diverse team
  - o Estates Facilities and equipment
- Industrial engagement and learning opportunities
  - o Commercial awareness learning
  - o Employer Inclusive Engagement
- Higher Education Curriculum
  - o Curriculum content
  - o Learning and teaching facilitation

Student Recruitment Activities

Schools and Colleges Outreach

In 2021, the ratio of male to female students studying Maths A-level was 2:1, and 4:1 for Physics A-level and Further Maths A-level. In fact, only 2 % of female A-level students study Further Maths A-level. Consequently, a very small pool of potential applicants fulfil the typical STEM A-level pre-requisites (Maths, Further Maths, and Physics) for engineering and technology degrees. Engineering needs to learn from Allied Health and Life Sciences degree subjects (no-longer requiring A' level Maths), whose "pipeline" is four times greater than engineering[9]. At CCCU the entry requirements are 3 A-levels or more or equivalent (including an A-level or equivalent in Maths, Physics, Applied Science or Engineering) for engineering courses. The curriculum is designed to develop students requiring mathematical and engineering science learning throughout the degree course.

The real key is inclusive outreach activities in schools[10], which has a positive impact on the short, mid and long-term unbiased pipeline to STEM. The ASPIRE Programmes demonstrated that meaningful STEM outreach learning activities at each key stage of national curriculum leads to students progressing to a STEM career[11].

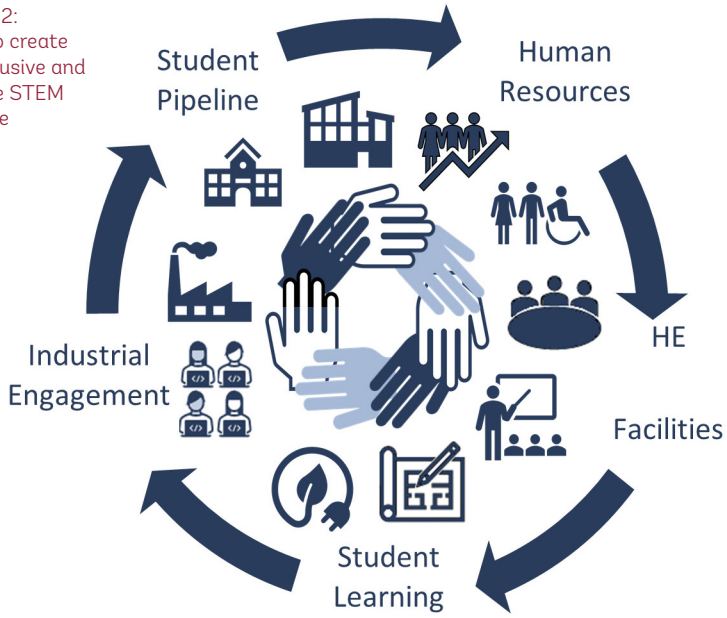
In 2021, there were 79,473 fewer A-level students than in 2017. The Covid-19 pandemic has widened the education attainment gap between high and low social economic students[12]. However, in Kent and Medway in real student numbers terms more students studied STEM A-levels than in 2017[13]. The real success story is the female uptake of A-level Computer Science (5-fold increase) and Physics (1.8-fold increase) positive impact on the STEM pipeline.

Student Marketing

Student marketing materials, resources and activities all need to be inclusive and without bias. The School of Engineering, Technology and Design at CCCU has adopted lessons learnt from inclusive recruitment processes used by industry[14]. Marketing materials are gender decoded to prevent perpetuating gender bias[15], the key being to feminise wording in course advertisement materials. Visual stills and reels reflect an inclusive and diverse engineering and technology community, as female[16] and BAME[17] students seek-out affirmation of 'people like me'.

The current student population at the new School of Engineering, Technology and Design at CCCU is 16 % female, 36 % students from low social economic household, 21 % declared disabled and 23 % describe themselves as BAME. The School is working towards 30-35 % widening participation of lower socio-economic, females and BAME students by 2024/25.

Figure 2: How to create an inclusive and diverse STEM pipeline



Higher Education Facilities and Resources

Human Resource Activities

Female role models matter to female students to inspire achievement and progression[18]. Equally, visibility of BAME staff promotes BAME student engagement and provides the opportunity for authentic conversations between students and staff on how to address and overcome employment challenges[19].

Leaders' influence is key to inclusive and diverse staff recruitment in reducing unconscious bias[20] and should aim to;

- produce inclusive recruitment adverts[15], promoting flexible working and returning to work career opportunities.
- educate the recruitment team on gender/cultural applicant complexities and unconscious bias[20]
- address short-listing biases[20-21]
- provide good practice inclusive applicant assessment job related exercises and interview practice (gender balanced panel and batch interviews)[22]

Currently the new School of Engineering, Technology and Design at CCCU, the learning and teaching team (academics, PhD Scholars, University Instructors and technicians) is 41 % female and 49 % BAME.

Higher Education Facilities

The school's new facilities are in the new Verena Holmes Building, which has been researched and designed to be inclusive[23]. Verena Holmes was a local trailblazing woman who was the first female member of the

Institution of Mechanical Engineers (IMechE) in 1924. She had a full-time career as a professional mechanical engineer, innovator and engineering entrepreneur of inclusive engineering products. The school has procured inclusive equipment, CE Kite Marked[24], inclusive PPE[25] to support a sense of belonging for all students and staff. This has extended to the classroom furniture through the use of round and reuleaux tables in the active learning spaces to promote inclusive and successful student collaborations[26-27].

Industrial engagement and learning opportunities

Commercial awareness learning

In keeping with Verena Holmes spirit of creating inclusive and entrepreneurial engineering graduates, the school has adopted the Conceive, Design, Implement and Operate (CDIO) engineering education practice developed by Massachusetts Institute of Technology (MIT)[28] (see Figure 3). The commercial CDIO group projects are typically sourced from industry and embedded into the foundation to final year curriculum.

Creating flexible internship

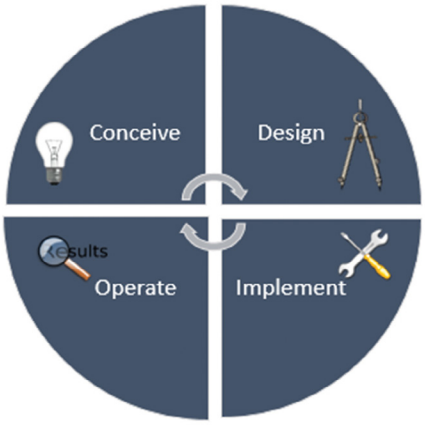


Figure 3: CDIO engineering education pedagogy approach

opportunities (one day a week/ sandwich/summer/vacation) with industry and open to all students at any academic level is a more inclusive solution. Flexible internship accommodates mature students and students with caring responsibilities and still has the potential have a positive impact on student grades and long-term graduate employment prospects as traditional sandwich placement[29].

Employer Inclusive Engagement

The industry and academic collaborations through CDIO/ Research/IP/Consultancy projects and student placements have the potential to promote[30] and cross-fertilise inclusive engineering working practices[31].

"Working with CCCU was a fantastic experience. The university gave us access to the skills and knowledge of their students and academics, which added real commercial value to our projects and aided in our product development. Our [local first year] intern was exceptional and his eagerness to learn and apply his skillset made the project a great success." - Jack Sherrin, Managing Director at Aptus Outdoor Limited

Higher Education Curriculum

Curriculum content

The engineering courses at CCCU embrace spiral curriculum and the multi-disciplinary nature of engineering subjects; materials, manufacture, design, engineering science, maths, engineering dynamics, electromechanical, instrumentation and control to derive inclusive solutions[32]. Adopting inclusive, decolonised curriculum, with a world-centric view, language and culture[33], promotes academic reflective practice continuous improvement and critical analytical skills of students.

Learning and teaching facilitation

The industry sourced CDIO projects facilitate student learning in a social context[32] and in engineering inclusive solutions to problems[34]. Active learning sessions develop students' ability to work collaboratively in teams, a key skill for an engineering career. The TARGIT Toolkit has been adopted as a useful resource that enables engineering educators to facilitate good gender inclusive teamworking practices.[30]

Conclusion

Schools, colleges, higher education and industry need to work collaboratively to address the leaks in the STEM pipeline. One party needs to take ownership and leadership to initiate the collaboration. In the South East, Canterbury Christ Church University has acted as the regional kingpin in steering and leading regional education and industry collaboration. The collaboration has the potential to create a resilient inclusive engineering workforce to address regional, national and international economic growth and capable of solving problems for all of society. To learn more, colleagues from industry and academia are welcome to get in touch with School of Engineering, Technology and Design at CCCU.

Working with CCCU was a fantastic experience. The university gave us access to the skills and knowledge of their students and academics, which added real commercial value to our projects and aided in our product development.

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ELECTRICAL SMART GRID RESILIENCE CONCERNS FOR NET ZERO BRITAIN

BY PETER NORMAN, IENG, MINSTMC, MIET

The launch of BS 7671:2018+A2: 2022 on 28 March 2022 was announced by the IET as the standard serves as their Wiring Regulations 18th Edition, covering UK Requirements for Electrical Installations aimed mostly at preventing harm from electric shock and electrical fires.

BS 7671:2018+A1:2020 was previously mentioned in Precision Issue #16, June 2020 in relation to EV charging safety at home.

A significant new feature of Amendment 2 (A2) is a new Chapter 82 covering the complex subject of 'prosumer electrical installations' (PEI) within the low-voltage system context. The new noun 'prosumer' was created in October 2018 within the new IEC 60364-8-2 international standard to help advance the decentralisation of electricity generation.

The PEI concept has been developed to take advantage of renewable sources of energy and enhance the needs of the end-user. By utilising active energy management, the end-user should be able to permanently monitor and control their own electricity consumption and production.

The key device for making a prosumer's complex and changeable supply/demand system work is the smart meter which uses Zigbee Alliance technology for wireless communications - a standard built on top of IEEE 802.15.4 for low cost and low energy consumption.

The new Chapter 82 of BS 7671 outlines key PEI aspects including: energy efficiency measures; the interface with the smart grid; the management of electricity consumption; the management of renewable sources of electricity; and, energy storage.

In brief, there are three defined types of PEI: 1. Individual 2. Collective with individual or common generation and storage 3. Shared. PEIs will also have three different operating modes: 1. Direct-feeding mode (from the grid) 2. Reverse-feeding mode (to the grid); 3. Island mode (disconnected from the grid for home generation and storage).

All this clever electrical engineering sounds brilliant, but The Engineer magazine reported on 4 March that: 'Analysis of data from smart meters has found that renewable energy fed into the main power grid could destabilise the system and potentially cause power failures.' That conclusion was derived from a study by mathematicians at Nottingham University using data from smart meters to discover that power grid resilience varies during the course of a day when tracking grid composition changes over time. Household power generation is a key element for the integration of 'renewables' which includes the Feed-in Tariff (FiT). The most notable 'spanner in the works' is created by the one million plus, small-scale domestic, solar PV (Photo-voltaic) systems installed in the UK. These are intermittent, low output, small-scale electricity generators that provide unpredictable power inputs to the main grid system as households alternate between the roles of consumers and producers varying according to meteorological conditions, as well as daily and seasonal power requirements changes. The UK data analysis work was published in detail in Science Advances magazine of 4 March 2022 (Vol.8; Issue 9).

It should be noted that the power distribution system management will be the responsibility of the UK's regional Distribution System Operators (DSO) – a role transition for the Distribution Network Operators (DNO).

Q&A

Charlotte Blake

Sharing her thoughts on the past, present and future of engineering is General Manager at the Midlands Centre for Data Driven Metrology (MCDDM), **Charlotte Blake**.

What was the root of your interest in Engineering?

Initially, I pursued a degree in Human Physiology and began my research career working towards potential cancer therapies. During my undergraduate studies though, I was really interested in biomedical engineering and particularly in applying novel engineering technologies like additive manufacturing to the medical world. I was fortunate to be accepted to study a PhD at the University of Nottingham specifically looking at bespoke surgical implant development using laser powder bed fusion. This project combined my love of engineering and technology development with my background in human physiology and pathology and really ignited my passion for manufacturing technologies. After working in additive manufacturing research across a number of applications and sectors, I transitioned into managing a Metrology team in 2020. Although starting a new role and a new field through Covid-19 lockdowns presented its own challenge, I've had a really rewarding time adapting to this new subject area and leading the progression of research and teaching across three respected university sites.

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

The next ten years of technology development is sure to be hugely exciting for engineering across sectors and application areas. There are massive challenges to be met for society as a whole, and engineering will lead the way in solving many of these issues. Achieving Net Zero will require the combined effort of technologists in improving electrification and hydrogen-enabling instruments. On a wider scale, the lessons of the past two years are sure to have impacts on our workforce and the way we collaborate between businesses and internationally into the future. How engineering organisations adapt to and make use of these changes will hugely impact their outputs as well as the teams they hire and maintain.

At the rate of technology development we've seen for the past three decades, it isn't hard to believe that none of us can possibly predict what engineering will look like in ten years' time. Those in education now will enter the workforce in jobs we can't imagine existing today. Automation and artificial intelligence are sure to impact the landscape of engineering as a career and an industrial sector – this is not to say that humans will be replaced, but that our role in manufacturing particularly is likely to look very different in the near future!

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

As it stands there is an excellent effort across early- and mid-stage education to encourage STEM skills and careers. It is admirable to see and be involved in so many outreach programs at primary and secondary schools, including presentations on career paths, coding skills and practical hands-on workshops with engineering equipment. However, we shouldn't discount the skills and knowledge of those already in the workforce who are willing to retrain or develop new skills to enter engineering careers.

Standard pathways to competency in engineering disciplines, such as those found for Non-Destructive Testing (ISO9712), the framework currently under development for

Metrologists by the MCDDM team, and Engineering Chartership, can aid this transition between career paths when workers are keen to join engineering careers at later stages. Acknowledgement of translational and soft skills which are applicable to engineering careers, even if developed through a different early career path, can go a long way to encouraging skilled personnel to join engineering disciplines later in their working life. Join this with offering appropriate, funded CPD in technical and manual skills, and a new source of employees is uncovered – people who are ready and able to work in the immediate term, rather than waiting for the end of their education before starting their careers. Encouraging employers, and providing funding where necessary, to adopt these standards and provide this professional development, would be a huge step the government could take towards addressing our shortage of engineers.

What do you do in your free time to relax?

At home I love to bake – thankfully I have a great group of taste-testers in the office, who are more than happy to trial any new inventions I come up with. I don't think I'll be challenging the repeated success of the Catapult centres on Bake Off anytime soon, but I do enjoy what I can! Outside of this I spend a fair amount of time in the gym, and when the weather is good (so, rarely!) I love to run. I completed my first marathon in 2016 and have plans to continue with more races in the future now we can get out and about more often.

Given one wish what would that be?

I would wish for more interdisciplinary collaboration in all research fields, but especially in engineering R&D. The progress which can be made by humans is limited only by our imagination, and combining the ideas and experience of those with a different world view to our own will accelerate that progress further. Areas of cross-collaboration between designers, managers, biologists, artists, and manufacturing technologists will unlock new concepts and improve our outputs for all of society.

That, and maybe a unicorn.

TACKLING REAL WORLD PROBLEMS TO ENHANCE ENGINEERING STUDENTS' EMPLOYABILITY

BY JOSHUA HAWORTH,
YR 2 COMPUTER SCIENCE,
UNIVERSITY OF SHEFFIELD

At the beginning of the 2021/22 second semester at the University of Sheffield, students from across the Faculty of Engineering worked on a real-world project. In our particular group, this was to design a biomimetic (i.e. inspired by nature) solution to reduce energy waste in UK housing and address the challenge of achieving net zero targets.

Working together with other students from the departments of Civil and Structural Engineering, Mechanical Engineering and Computer Science, we spent a week between Semester 1 exams and the start of the second semester, tackling this issue through virtual collaboration via the BlackBoard VLE Group Room facility. In this way we were able to meet virtually, assign tasks, share Google Slide presentations, review mutual progress, present daily updates to our hub facilitator, pull our respective tasks together into a technical bid to design the biomimetic home and then pitch our design ideas to the university staff overseeing the project.

Scoping the project and assigning tasks

My role in the team was to design the Smart Home System, address accessibility and costs associated with the Smart Home App, consider the financial feasibility and calculate profit projections across a suitable time frame, and develop an appropriate cybersecurity policy. Other members of the team worked on the technical building design and construction, the project timeline from conception to completion, costings for land purchase, building materials and construction (including the estimated costs for the dynamic photovoltaic envelopes), and an overarching risk assessment together with proposed strategies to mitigate any risk. Matters of inclusivity (including building accessibility) and the overall sustainability of the project, together with the development of a sustainability policy addressing reduction of waste during construction, maximising use of clean renewable energy, were also included.

Our proposed solution

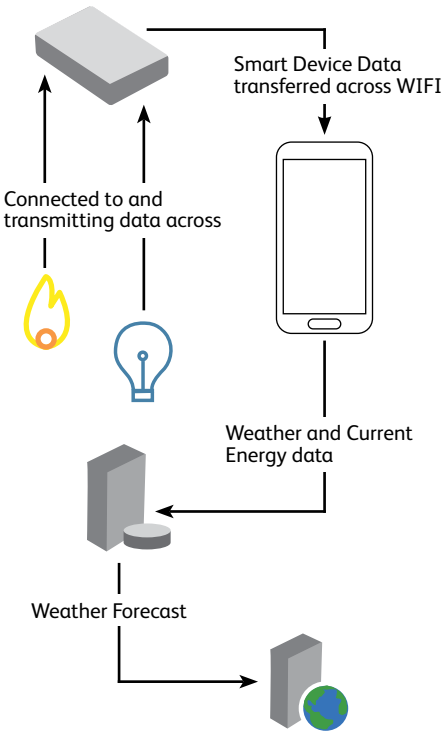
The overall solution to the design brief was to combine the technical aspects of a smart home with dynamic photovoltaic modules, a technology inspired by heliotropism - plants' motion towards the direction of the sun, to produce a more energy efficient and cost-effective method of construction directed towards the building of sustainable apartment blocks in a northern post-industrial city.

The Smart Home System

The main idea behind the use of smart technology in our solution came from methods animals use in nature to help reduce energy use/loss (e.g. hibernation) which we thought could help to cut down energy waste in UK homes. The smart radiator thermostats and the smart lighting of the building design will require internet connection in order to transfer data to either a smartphone or web application. The information provided by the smart devices (thermostats and lighting), as well as the weather forecast retrieved from multiple websites using a simple web scraping program, are stored on a cloud server. This data can then be used to adapt room/building conditions to keep in line with the user's set preferences, otherwise the settings will be adjusted to fit with a standard level of comfort (heating set to 21°C and 150-300 lux, depending on seasonal and temporal factors). The smartphone version of this process is illustrated in Fig 1.

User preferences are stored in the cloud database and can be used to adjust the default settings for comfort. To help improve accessibility, local in-house manual adjustment of settings is available in addition to the smartphone and web application options.

Figure 1: Data flow for the smart home system (smartphone version)



Cybersecurity Policy

The cyber security policy outlines the guidelines and provisions for protecting the security of user data and smart home infrastructure.

This policy applies to all employees, contractors and users of the system.

Policy around handling and storing confidential information:

- All employees handling data will be given training on how to avoid data breaches and the correct procedures for storing and handling data (including financial and customer data).
- Guidelines will be provided to customers regarding what information will ever be/not be asked for when requiring support with the system.
- All customer (and sensitive information) will be stored in a database for no longer than needed and will be encrypted to keep up with GDPR policy.

Policy in regard to the usage of customer data:

- Customer information will only be used for improving our own systems (with consent from the user) in regard to finding optimal temperatures and lighting levels for the default settings.
- Customer data will only be given to third parties if absolutely necessary and the user concerned will be notified, or permission will be asked for depending on what the situation allows.

Policy and guidelines around protecting personal/business devices:

- Passwords should be changed regularly (around every 2-3 months) to uphold security confidence
- In case of a data breach, passwords should be changed immediately.
- Only add people to a user network if the user has confirmed through two factor authentication (users can add people on their own).

What we gained from the experience

The rationale behind the project was to engage students in a real-world problem, embracing issues of sustainability and net zero challenges within engineering, and to enhance our knowledge and skills for future employment under the banner of 'Engineering - You're Hired!'

Skills development opportunities afforded by the project included remote inter-disciplinary team working with both UK and international colleagues, planning and problem solving, research and data analysis, working to tight deadlines, effective oral and written communication and presentation skills, policy development and report writing.

Working on this project and collaborating with other engineers from across the faculty provided me with essential experience to bolster the content of my CV, as well as a rich source of material for discussion in subsequent internship interviews for my forthcoming 'Year in Industry'.

As a vehicle for enhancing student employability, this experience has been invaluable.

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For the purposes of this project, I was part of a group of five 2nd year engineering students, and we were tasked and supervised by staff from the Faculty of Engineering at the University of Sheffield.

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2022

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SAFE DIGITIZATION DOWN TO THE FIELD LEVEL

ETHERNET-APL AS AN ENABLER FOR ENHANCED PLANT EFFICIENCY

BY STEFAN DITTING, PRODUCT MANAGER AT HIMA

Ethernet-APL brings the benefits of digital communication to harsh environments of the process industry at the field level.

The universal use of Ethernet-APL makes it possible to consolidate an infrastructure for safety-related and non-safety-related communication. Even so, complete separation is preserved and maximum availability and safety are ensured. The digitization through the use of Ethernet-APL ensures full information transparency from a sensor to the cloud. This information is available for evaluation across all automation levels throughout the entire plant lifecycle. This article describes the features, benefits, and challenges of the new technology and draws comparisons to preceding ones.

The time-to-market aspect is crucial to the success of a plant operator. For new plants, the focus is on the planning, engineering, and construction phases. For existing plants, however, the primary concern is efficient change management, as plants today must be able to respond flexibly to market demands. Moreover, maintenance and repair account for a significant proportion of the costs of operating a plant, and can frequently exceed the acquisition costs. This is why it is important to consider all the components and their interaction in the entire lifecycle of operating a process plant for cost effectiveness.

Striving for more flexibility is as old as automation itself. A major step in this direction was the decentralization through remote I/O. Here, data of various I/O types can be converged or distributed on site. The connection to higher-order levels for processing is established via digital networks. This approach has improved over the years, resulting in remote I/O concepts e.g. for operating functions, safe automation, flexibly configurable I/O and for accessing the Ex-Zone. Unfortunately, these concepts are often oversized and they merely exchange process values at the field level.

HART takes a different approach. The communication protocol exploits the existing analog signals and additionally communicates modulated data to the devices directly connected to the field level. This approach, however, still has

drawbacks such as the reduced accuracy of the analog values, a still considerable wiring effort and missing properties for functional safety.

A good combination of the two concepts, with a fully digital communication with a direct network connection of the sensors and actuators to the field level, would therefore be the ideal solution. Ethernet-APL is designed precisely for this purpose and enables end-to-end digital communication down to the field level of process automation.

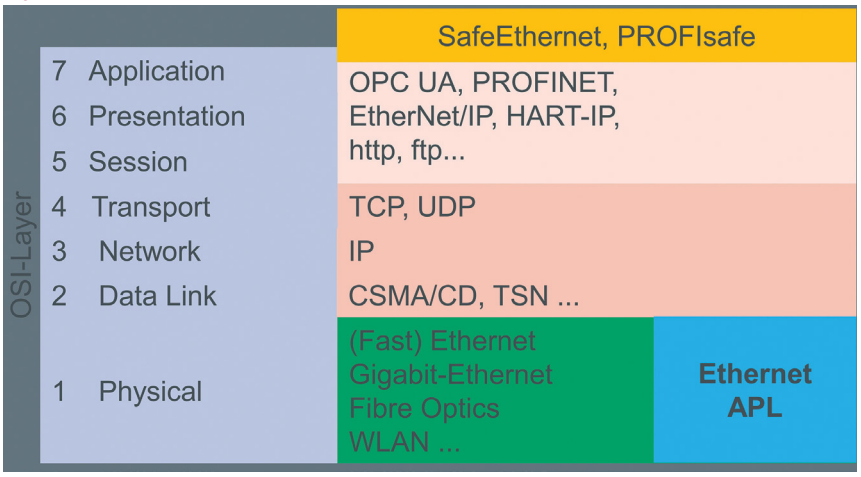
The tasks of Ethernet-APL

Modern communication systems are structured in several layers (Figure 1: ISO/OSI 7-layer model). Each layer provides different capabilities and can be replaced by other technologies operating on the same layer.

The lowest layer is the so-called "physical layer". APL stands for "Advanced Physical Layer" and, like "Fast Ethernet", "WLAN" or "fiber optics", it describes the physical transmission of data. Each of these connections is designed for a specific area of application. Ethernet-APL combines some very important features for process automation such as:

- 2-wire connection with reverse polarity protection (SPE, Single Pair Ethernet)
- 10 Mbit/s per connection, making the fieldbus solutions more than 300 times faster than existing ones
- Full duplex switched Ethernet, enabling existing topologies like "star" or "ring"
- Distances up to 1000 meters with full preservation of data quality
- Point-to-point connections, enabling simple network design and network maintenance
- Data and power transmission on the same line
- Communication in explosion-protected areas (up to Ex-Zone 0 Div.1)

Figure 1



- Robust design for industrial environments
- Standardized and thus future-proof

The ISO/OSI layer interchangeability allows for easy conversion from Fast Ethernet to Ethernet-APL. Pepperl + Fuchs, for example, proves the point with an Ethernet-APL switch that is used as a media converter from Fast Ethernet to Ethernet-APL.

With respect to the physical layer, it makes no difference which higher-order layers are involved in the communication and which data is exchanged. Well-known higher-order layers are IP and TCP/UDP. These higher-order protocols are also interchangeable if they are on the same layer. It is only in the application layer that data is given meaning. A protocol of a higher layer widely used in automation is Modbus, which can use TCP or UDP as well as Fast Ethernet or Ethernet-APL. Modbus is a simple example. For universal automation solutions, however, more modern and universal protocols with a wider range of applications are more interesting.

An example of a widely used, well proven and open industrial protocol is PROFINET. In addition to many other benefits, it also provides PROFIsafe, an open protocol for functional safety that establishes a "black channel" between a host and a device, ensuring detection of potential errors in intermediate communication layers. Consequently, thanks to the interchangeability of the underlying layers, PROFINET and PROFIsafe can be transmitted via both Fast Ethernet and Ethernet-APL.

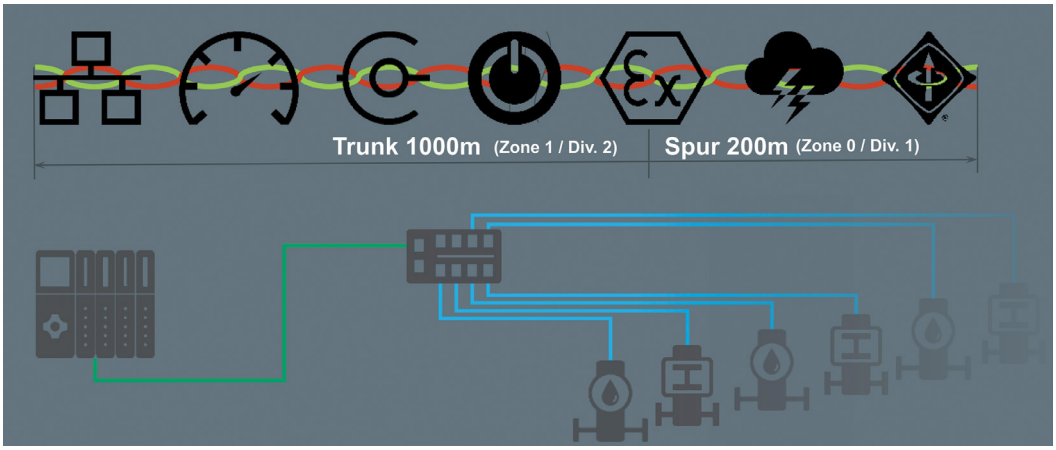
Technologically, Ethernet-APL is stepping up to replace existing 4…20 mA solutions as well as remote I/O. This is a major promise and requires manufacturers and users to rethink their applications. As with all technology or paradigm shifts, digitization should not be an end in itself. It should create true added value in real plants.

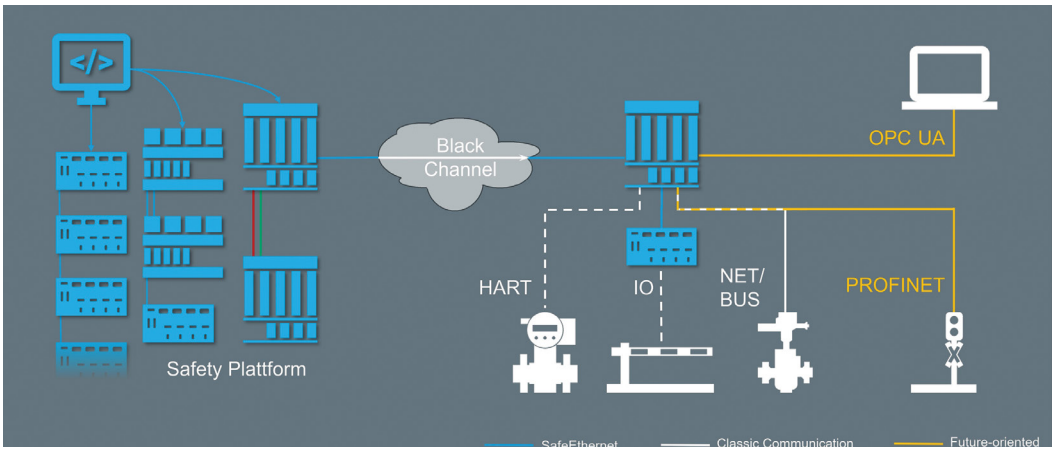
Test setup at BASF

BASF in Ludwigshafen has set up a fully functional network with Ethernet-APL components to gain practical experience and insights. The test setup also includes a prototype with Ethernet-APL, PROFINET and PROFIsafe. This is the first fully functional SIL 3 communication via Ethernet-APL worldwide. The concrete connection must be viewed on two levels:

The physical connection is implemented via Fast Ethernet from the HIMA safety-related controller to the Ethernet-APL switch from Pepperl + Fuchs. This is done in the usual way using an Ethernet cable with RJ45 connectors. From there, it continues with Ethernet-APL. The connection is carried out with a 2-wire cable, which is terminated on both sides with screw terminals. The sensor from Endress + Hauser can then be supplied with power and data.

The logical connection of how





the data is exchanged and which significance it has, occurs via PROFINET and PROFIsafe. In this case, the HIMA safety-related controller exchanges data in digital quality directly with the Endress + Hauser sensor via PROFINET and PROFIsafe. This ensures that the data is transmitted from the sensor to the processing unit correctly, unaltered, and with maximum accuracy.

Comparison to existing technologies

The following sections describe the individual benefits of combining Ethernet-APL with PROFINET and PROFIsafe as compared to previous technologies (4…20 mA, HART, remote I/O, fieldbuses):

4…20 mA wiring

The 4…20 mA interface is currently dominant in process automation, primarily for the transmission of safety-relevant data. With regard to the connection technology, Ethernet-APL has the advantage over 4…20 mA technology in that a connection can be established very easily over almost any distance into the field using a single cable. Where increased availability is required, a ring can be used. As such, the wiring effort with Ethernet-APL is significantly lower than with 4…20 mA. Furthermore, there is no need for a marshaling level and, for systems in Ex-Zones, an Ethernet-APL switch replaces Ex isolators, thus saving additional space and cost within the control cabinet.

4…20 mA accuracy

One downside of a 4…20 mA interface is that signals from the sensor to the safety-related controller must be repeatedly converted between analog and digital, which means that the transmitted analog value is prone to interference. This inaccuracy cannot be compensated for by a high-resolution analog-to-digital conversion within the controller. For this reason, safety margins must be planned.

However, modern transmitters process the internally available data in digital form anyway. With digital communication, the data can be made available unaltered and with higher accuracy. Safety margins can thus be reduced and the plant can be operated closer to its limit. Depending on the process, this can result, for example, in increased output, lower power consumption, or better quality of the goods to be produced.

4…20 mA information content

The information content of 4…20 mA is rather low and the value must always be interpreted in the processing unit. Furthermore, the valid range for process values is between 4 mA and 20 mA. As a result, a value above 20 mA is not a valid process value and indicates an error state. In turn, this means that either a process value or an error will be displayed.

With digital transmission, multiple values such as process value and health status of the field device can be transmitted. If the field device detects the need for maintenance, this can be communicated in the digital data record. The plant can continue to operate until preventive maintenance is performed, thus ensuring increased plant availability.

4…20 mA with HART

HART modulates digital data onto the analog signal, allowing for additional information such as the health status of a field device to be transmitted in addition to the process value. This transmission via HART is very slow, does not provide

much data, and affects the accuracy of the process value. Neither can the additional data be used for safety-related applications.

Conversely, with a digital connection with Ethernet-APL and PROFINET, large amounts of data can be made available very quickly. With PROFIsafe, the information can be used directly for safety engineering. For example, in the case of differential pressure measurements, even additional process values (both pressures) can be evaluated from a safety viewpoint. Even the units of the measured values can be transmitted, making it unnecessary to interpret the data in the safety-related controller because this information is directly provided from the field.

Central configuration and start-up are possible with both the HART and the Ethernet-APL/PROFINET solution. Thanks to its faster transmission capability, Ethernet-APL offers much more extensive options.

Remote I/O with or without flexible I/O

Compared to the 4…20 mA solution, remote I/O with or without flexible I/O have the advantage of less wiring and thus usually are more flexible with easier planning. In the end, however, they only move the I/O into the field and are still 4…20 mA interfaces. Therefore, the lower information content and the inaccuracy of the process values (almost) correspond to the direct 4…20 mA solution. Depending on the design, the hardware overhead and space requirements are also significantly lower with Ethernet-APL than with remote I/O.

Fieldbus systems

Fieldbus systems such as PROFIBUS represent a first approach to establishing digital communication at the field level. For the most part, serial connections are used here. Fieldbus has the drawback of being very slow (factor 300) and quite error-prone compared to Ethernet-APL (nothing is more annoying than a forgotten terminating resistor).

Ethernet-APL: Future capability and challenges

Modern approaches to process automation benefit from the use of Ethernet-APL to extend high-performance networks down to the field level. Concepts such as NOA (Namur Open Architecture), MTP (Modular Type Packages), modern AMS (Asset Management System) or even visionary approaches such as ‘control in the field’ can only unfold their potential if performance and information content from the field increase significantly.

Of course, new technologies bring new challenges. For minimum complexity and maximum cost efficiency, all field devices in a plant must be consistently integrated via Ethernet-APL. Consequently, the entire sensor and actuator portfolio should be available at the field level for operation and safety functions.

Connecting a single digital input or output does not yet make sense from an economic point of view. In this respect, remote I/O do have their merits. They can be integrated in the same network, even if other protocols are used on higher layers. The principle should be: networking where possible, wiring where necessary!

The security aspect should also be considered from the outset. Ethernet-APL is merely a “physical layer”, so the security concepts developed both in the standard (IEC 62443) and by user organizations (e.g., PI) can be applied.

Added value with Ethernet-APL

Ethernet-APL qualifies for both new (greenfield) and existing plants (brownfield). The benefits described earlier in this paper relate to technical characteristics. Depending on the application, however, these benefits can be extended even further.

Our experience at HIMA shows that requirements may vary from one plant to the next. Different field devices are suitable for different applications. The openness of the interfaces combined with the resulting compatibility and interoperability make it possible to use the best field devices in their respective class (best-of-breed). The definition of “best” varies from plant to plant. For example, “best” for one plant may be high accuracy, while for another, high speed, and for yet another plant, low costs.

The openness of Ethernet-APL combined with PROFINET/PROFIsafe also improves the spare parts situation, as alternative devices or successor products can be used more smoothly. The data already in digital form can be perfectly forwarded to higher layers via OPC UA.

HIMA Approach: Independent Open Integration

The flexible HIMA Safety Platform offers a complete portfolio of solutions that meet the highest functional safety and availability requirements. It enables both centralized and highly efficient decentralized solutions. In decentralized solutions, safety-related communication between the safety controllers and to the remote I/O occurs via HIMA’s proprietary SafeEthernet protocol.

The safety-related systems support all common communication options, including OPC UA and PROFINET. This means that the safety platform can be flexibly combined with the leading DCS systems. Ethernet-APL is now the first to enable the efficient, digital connection of safe field devices. HIMA calls this concept ‘Independent Open Integration’ - enabling plant operators to implement their individualized solutions. Ethernet-APL now offers even more options for communications down to the field level.

Conclusion

Ethernet-APL provides an excellent digital highway down to the field level to implement customized solutions with best-of-breed products for end-to-end safety.

For further details contact Nicole Pringal, HIMA Paul Hildebrandt GmbH, n.pringal@hima.com or www.hima.com

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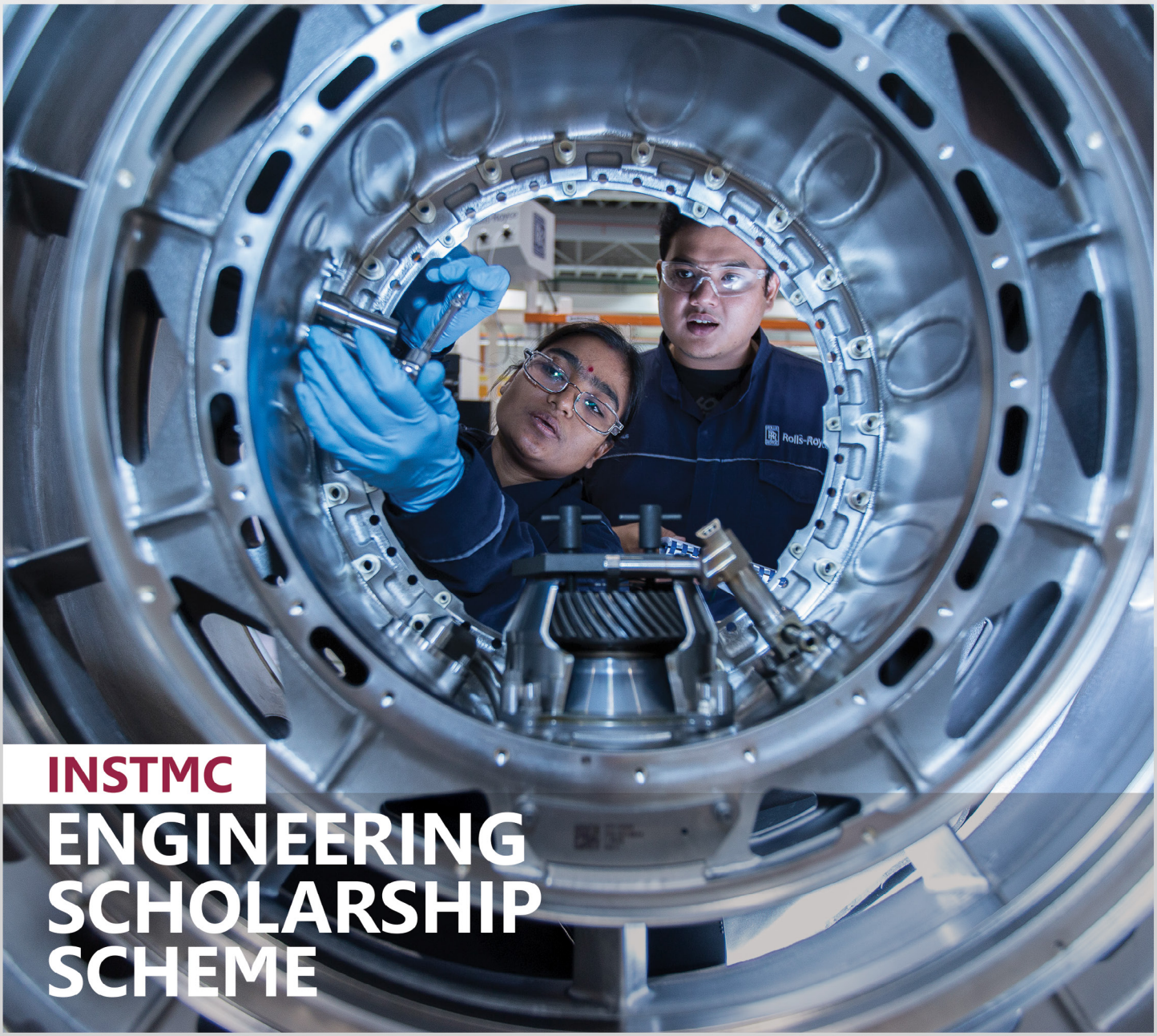

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Originally planned to commence in summer 2022, the scheme was placed on hold due to the ongoing Covid-19 pandemic. We are now ready to relaunch the scheme and are keen to hear from companies interested in taking part.

How the scheme will work

InstMC will manage the process on behalf of sponsor companies, shortlisting the best candidates from undergraduates studying for an accredited MEng or BEng degree at one of our partner universities. Students chosen will be on track for a 2:1 or higher and be studying an approved course at an accredited University. The InstMC will perform a pre sift of the applications, ensuring each candidate matches any company specific requirements and provide a shortlist to invite for interview. Each student placement will run for 8 weeks commencing Summer 2023.

Sponsoring companies would be expected to fund a bursary and pay an agreed minimum salary to the student during the placement. A management fee from sponsoring companies would be payable to the InstMC and used to cover the cost of promoting the scheme and managing the selection process. If you wished to make an offer of a placement to a student, the InstMC would also manage this process for you, including the administration of paying the bursary to the successful student.

Benefits to sponsor companies

- Gain access to the widest pool of dedicated students who are studying Measurement, Control, Instrumentation or Automation
- Recruit from a pool of top-quality students for your summer interns
- Significantly reduce graduate recruitment and administrative costs and burden
- Raise awareness of your company with students, universities and schools
- Recruit scholars who are ready for the workplace with the right personal skills and mindset
- Improve the number of undergraduates who become full-time graduate engineers.

Benefits to students

- A unique scheme enabling students to connect to companies with a focus on metrology
- Develops their professional skills and provides employability training
- Structured placement provides invaluable training in the workplace
- Annual bursary plus the opportunity to network and build professional relationships.

For full details on fees, application process and dates, view the Scholarship Scheme 2023 Terms & Conditions.

If you are interested in participating as a sponsor company, please email jane.seery@instmc.org

LOCAL SECTION NEWS

NORTH EAST

Annual Dinner & Reunion 2022

On Thursday 10th March 2022, the North East Local Section, InstMC Annual Dinner & Reunion was held at Jury's Inn, Middlesbrough.

Having missed a year because of Covid restrictions, 16 Companies invited 132 representatives and guests whom alongside 23 InstMC guests, enjoyed an excellent meal and interesting thought-provoking words from our Top Table guests.

Following the formalities, we were entertained by comedian Jed Stone who, as usual, kept the audience amused.

The raffle of donated monies and prizes from companies, guests and members raised £1000 which will be donated to "Recovering Connections", a local Middlesbrough charity whose aim is to "inspire, motivate, empower and support all those affected by substance misuse, to sustain long term recovery and lasting positive change". The handover of the donation took place at the North East Section AGM in April.

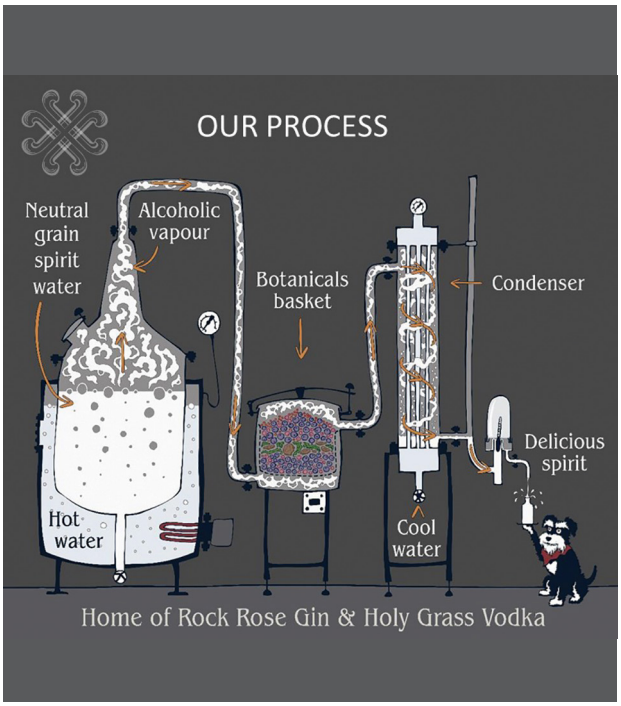
Although numbers were down on previous years the evening was considered a success and encouraged by this response, and the fact that companies have already asked to book their tables for 2023, the organising team will strive to improve on this performance next year.

John Noon
North East Local Section

NORTH OF SCOTLAND

Webinar: Rock Rose Gin

On 16th March 2022, North of Scotland hosted an online webinar presented by the founder of Rock Rose Gin. Martin Murray is a Chartered Chemical Engineer who previously worked in the oil and gas industry before starting up his own distillery in Dunnet Bay, located in the most north-eastern tip of Scotland. Having worked for companies such as Astra Zeneca, Scottish Water, Conoco and BP, Martin returned to Heriot Watt University (where he originally graduated) to do a MSc in Brewing & Distilling. Utilising uniquely designed copper pot stills and a botanical vapour basket, Martin produces small batches of his Rock Rose Gin. It is a vapour infused gin using 18 botanicals, some of which are foraged locally, and a wheat-based spirit. Each bottle is then hand-filled, individually wax sealed and signed off before it leaves the distillery. Martin distributes Rock Rose Gin to more than 25 countries internationally, including a national deal in the USA.



NORTH EAST

Presentation of Cheque to Recovery Connections

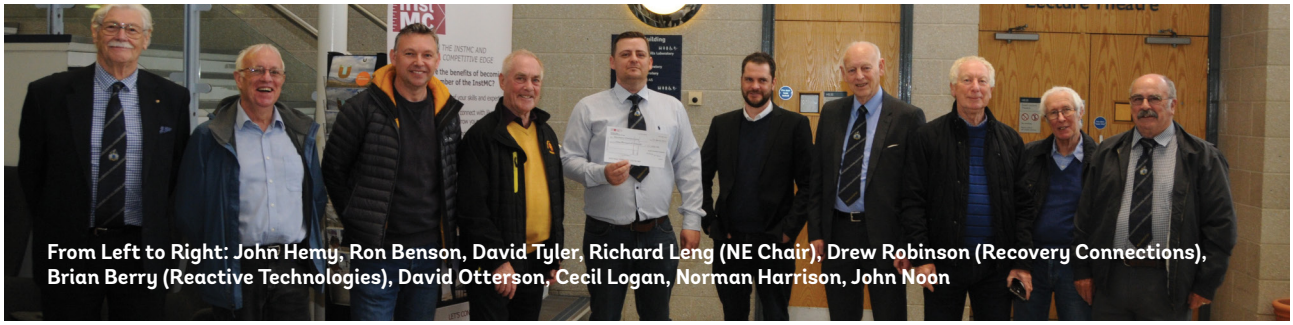
North East Section supporting local charities work

At a ceremony held at Teesside University in April, a cheque for £1000 was presented to the Middlesbrough based charity, Recovery Connections.

The money was raised at the local sections' annual dinner and will help fund a community garden project in Middlesbrough. In the words of Recovery Connections CEO, Dot Smith "The garden will be a place of solace, connection and joy for members of our community and their families".

Recovery Connections provides practical support to a wide range of people with addiction, long term unemployment and other issues.

The cheque was presented to Mr Drew Robinson of Recovery Connections.



From Left to Right: John Hemy, Ron Benson, David Tyler, Richard Leng (NE Chair), Drew Robinson (Recovery Connections), Brian Berry (Reactive Technologies), David Otterson, Cecil Logan, Norman Harrison, John Noon

WESSEX

Webinar: 'Cyber Security – A Process Industry Perspective'

Presented by Cevn Vibert, Vice Chair of Wessex Local Section and Chair of InstMC Cyber SIG with an introduction by Graham Dunkley, Wessex Local Section Chair, and Andy Hudson, Professional Development Officer. This online event on 16th March 2022, attracted more than 60 attendees both national and international.

Multiple attacks and outages on industrial systems around the globe are being reported by the media on a regular basis. Security threats are increasing as evidenced by reports both from global news and from the National Cyber Competent Authority NCSC.

All Industries need to improve their Cyber, Physical and Operational Security and Resilience to counter this ever-developing threat.

Significant improvements are required across industry in the areas of governance, risk assessment, incident response and security monitoring.

There is some resistance to the implementation of enhanced security protocols from industry. Ultimately change will be driven either by regulation, or as a result of high consequence security breaches. Put bluntly, companies and people will act either before or after they experience a cyber-attack.

Cevn presented a wide perspective of threats, past, present and future as well as current trends in the market. The need for a culture of security analogous to the culture of safety is essential.

The ability for risk management and business resilience understanding across all sectors of an organisation is essential.

It is not all gloom and doom, the industry is improving, but needs to improve more and at an increased pace. The bad-guys don't stop getting better so more must be done and faster.

Shields Up!

Questions

Q: Where can we learn more about improving cyber in our businesses. A: The National Cyber Security Centre website https://www.ncsc.gov.uk/ and web searches as easy starters.

Q: What do you think about current threat levels. A: NCSC publishes current threat levels to organisations. NCSC has not seen evidence of specific threat to UK but threats globally are increasing due to the war in Ukraine. Collateral damage is always a threat. Both UK and US have issued warnings for resilience.

If you missed the event, head to the InstMC YouTube channel where you can view the full video. https://youtu.be/oHxGWKaUTWc

LOCAL SECTION NEWS

CENTRAL NORTHWEST

The local section has been busy over the winter, planning an exciting programme of events for 2022.

General news

At the section AGM held in February, we renewed the team for another year. You can view the full team list on the local section page of the InstMC website. https://www.instmc.org/sections/north_west

We are actively seeking new people to join the committee so please get in touch. In March, at the first committee meeting after the AGM, we appointed Chris O'Hara (ENI UK Limited) as Technical Secretary and Samantha Gower (GPEC) as Social Secretary, we thank them both for volunteering to support the work of the section and look forward to working together.

Technical Talks

The 2022 technical talk programme started as normal in February with sessions planned throughout the year, excluding August and December. The sessions are listed on the InstMC website (just June and October to be listed as these sessions are being finalised at the time of writing). The sessions are remaining exclusively online during 2022 and we are reviewing a hybrid approach for 2023. They are scheduled as 'Lunch and Learn' style sessions at 12 noon, UK time, usually on a Wednesday. The sessions are open to all members, irrespective of location, and are hosted on MS Teams (booked through Eventbrite). The topics are aimed to show different aspects of measurement, control and automation throughout the year.

In February we hosted a very interesting session on 'What if not everyone thinks and acts like you' where Andy Guile (Independent Business Coach 'askandyguile') shared with us the different personality types and how each type interacts with one another. The session was thought provoking and certainly opened my eyes to how I interact with others both personally and professionally. It wasn't a traditional technical talk but feedback from attendees was very positive. If you missed the session, you can view the recording on the InstMC YouTube channel https://www.youtube.com/channel/UCM-SCCcAMxM7LfMzVgGCq0A. Andy has shared that he would be available for follow up discussions if anyone wishes to contact him.

In March, we had a last-minute change to the programme. I was scheduled to share a session on Machinery Safety Standards changes following recent issues of new standards / advance developments of others. Unfortunately I was taken down with a non-COVID related illness which resulted in a complete loss of my voice, which my family was most pleased with! This session will be rescheduled for later in the year.

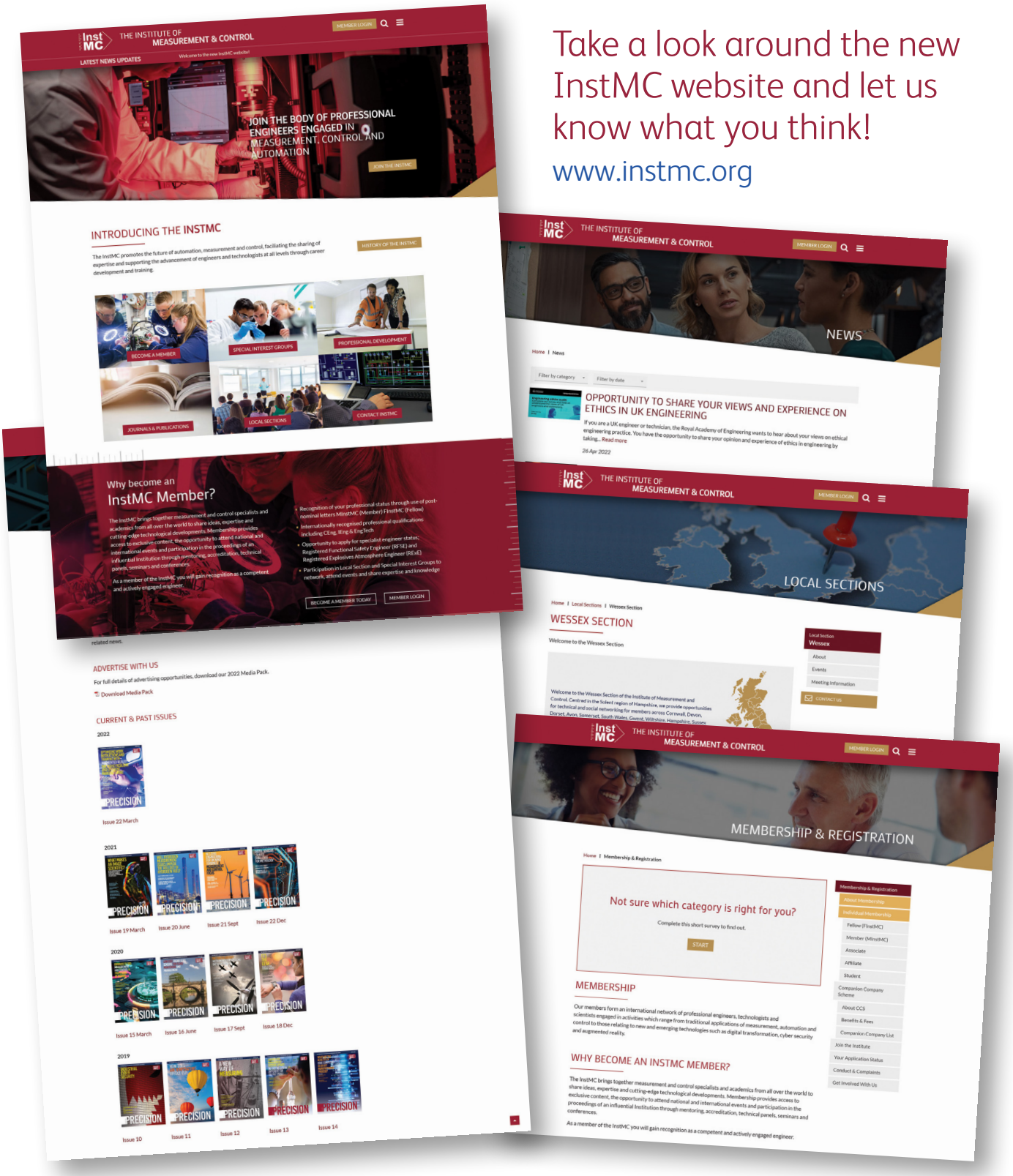
The event was replaced with an interactive session led by Harvey Dearden (HTS Engineering Group) on 'LOPA considerations - demand rate, occupancy, probability of ignition, mitigation etc.' and was well attended. Feedback confirmed that the attendees found the session really useful, and they particularly enjoyed the interactive nature of the session. Thanks to Harvey for stepping in at the last minute! The session was recorded and will be on the YouTube channel by the time you're reading this article. I'm sure that Harvey would be available for a chat should you have any specific issues with LOPA, alternatively you can search out Harvey's latest version of his book 'Functional Safety In Practice' which is in its fourth edition and out now.

In April, we heard from Alexander Dixon (ITI) who shared a presentation on 'Using real time data to improve reliability and efficiency'. The session explored the benefit of understanding the data that your operating facility provides. Then using different matrices on the 'normal' versus your 'current' data personnel can focus efforts on values / equipment which is operating outside of the normal boundaries. By understanding this data, it can lead to review of the causes which can be applied to similar equipment across the facility in advance of any failures, thus improving overall reliability. The talk was recorded and will be on the YouTube channel by the time you're reading this. Alexander's contact details are available on the video should you wish to contact him with any of your concern areas.

ADVANCE NOTICE – In November we have HSE presenting a session on regulator interpretation of requirements in Electrical, Control and Instrumentation. They have asked the members what topics they would like to cover so we have setup a survey to gather this information. Please look at the event here https://www.instmc.org/events/282/central_northwest_ask_the_hse_inspector and follow the link to complete the survey. We need to provide the list to the presenters by 30th June 2022.

Dave Green,
Local Section Chair, CNW

WELCOME TO THE NEW INSTMC WEBSITE



Take a look around the new InstMC website and let us know what you think!

www.instmc.org

COMPANION COMPANY SCHEME (CCS) SHOWCASE

There are opportunities to network with other businesses, InstMC accredited universities and with individual members, at local and regional level, through Local Sections and Special Interest Groups. We currently have 81 CCS members and are pleased to introduce some of them to you here.

Engineering Safety Consultants Ltd

Engineering Safety Consultants Ltd (ESC), an ERM Group Company, is a global engineering consultancy that provides functional safety management services and advanced safety advisory services that enable owners, designers and operators in manufacturing, chemical, renewables, utilities, oil and gas and petrochemical industries to plan and manage their assets and projects safely and successfully.

The Consultants are multi-disciplined professionals who have extensive global experience in the full safety-lifecycle. The ESC team has over 100+ combined years of technical safety expertise and sit as members of international expert working groups for the key international Functional Safety Standards IEC 61508 and IEC 61511; providing leading edge insights into developments in this domain.

ESC has also developed ProSET®, a process safety evaluation software that allows the user to complete HAZOP, LOPA, SIL Verification and SRS activities part of the Functional Safety Lifecycle, as required by international standards.

Tel: +44 (0) 20 3206 5200
Website: www.esc.uk.net

HIMA Paul Hildebrandt GmbH

The HIMA Group is the world's leading independent specialist in solutions for safety-critical applications. With more than 40,000 installed systems and TÜV-certified hardware and software, HIMA qualifies as the leading technology

company in this sector.

For over 45 years the world's largest oil, gas, chemical, pharmaceutical and energy-producing companies have relied on HIMA products, services and consulting to provide uninterrupted plant operations and protection for people and the environment. HIMA solutions are also leading the way to increased safety and profitability in the rail industry, logistics and machine operations.

An independent family-owned company, HIMA operates from over 50 locations worldwide and has a workforce of approximately 800 employees. Since 2017, HIMA has had a direct presence in the UK and provide both local Sales and Service support.

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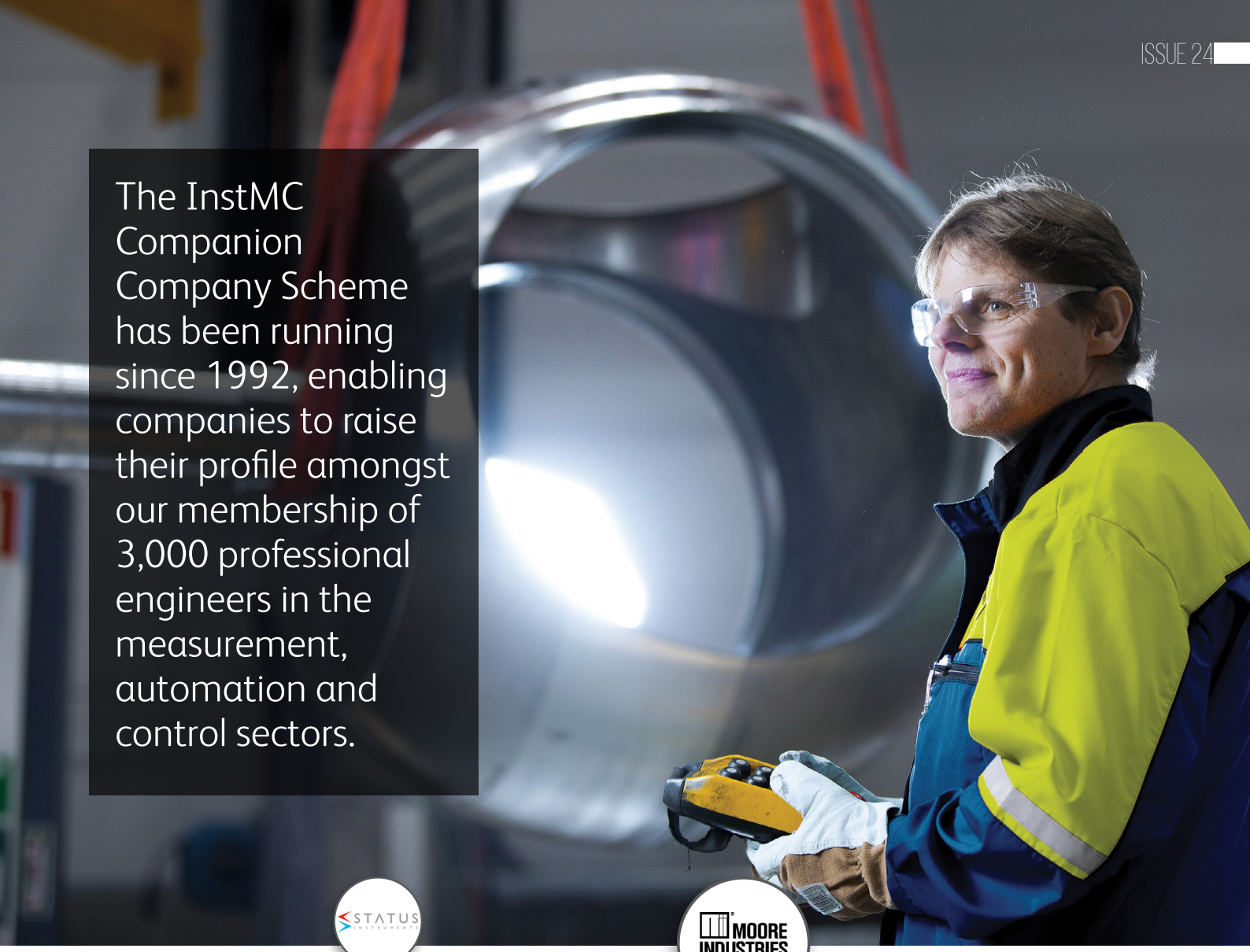

The InstMC Companion Company Scheme has been running since 1992, enabling companies to raise their profile amongst our membership of 3,000 professional engineers in the measurement, automation and control sectors.

Status Instruments Ltd

Manufacturer and supplier of process instrumentation since 1982, celebrating 40 years in business during 2022. Specialising but not limited to temperature, pressure, humidity and signal conditioning instrumentation.

Tel: +44 (0)1684 296818
Website: www.status.co.uk

Moore Industries International Inc

Since 1968, Moore Industries has been proudly serving process manufacturing businesses and fortune 500 companies in chemical; petrochemical; utilities; petroleum extraction, refining; pulp and paper; food and beverage; mining and metal refining; pharmaceuticals; and biotechnology industries.

Today, Moore Industries is an award-winning company that makes rugged and reliable products including alarms, HART interface devices, temperature sensing and transmitting products, signal conditioners and isolators, and a rapidly expanding line of IEC 61508-certified Functional Safety devices. A world leader in the design and manufacture of interface instruments for industrial process control, system integration, and factory automation, the company's primary focus is to provide only the highest quality process industry products and services.

Our sales and support offices located in countries around the world including United Kingdom, Belgium and the Netherlands, provide exceptional service and solutions with an extensive network of knowledgeable applications engineers well equipped to help meet our customer's needs.

Tel: +44 (0)1293 514488
Website: www.miinet.com

REFRACTOMETRIC CONCENTRATION MEASUREMENT IS PROVIDING A ROBUST AND COST-EFFECTIVE ALTERNATIVE TO THE POTENTIAL RISKS OF RADIOMETRY

The online concentration analysis of liquid media is one of the most crucial considerations for accurate process and quality control within the harsh realities of the chemical industrial environment.

Monitoring, recording and controlling the concentration of dissolved solids in production lines, the process refractometer measures the refractive index continuously and in real time, accurately establishing the concentration, mass ratio, density or dissolved solids contents of binary or quasi-binary liquids.

Users in industries such as chemical, textile, automotive and semiconductor are switching from radiometric measurement to refractometric technology for a more reliable, less hazardous and continuous solution for which no regular tests are required by law. Measurement is rapid and quantitation is extremely accurate.

FLEXIM recently worked with a major German chemical manufacturer looking for a suitably reliable and stable, long term alternative to the risks, high cost and administrative and organisational requirements of radiometric density and concentration meters for the continuous concentration measurement of highly corrosive hydrochloric acid. As well as the demands of regular documented maintenance, these meters are also expensive to dispose of at the end of their life cycle.

Producing chlorinated aromatics, amongst other things at its Höchst site, the chemical manufacturer's so-called side-chain plant specialises in the chlorination of the side chain of aromatic compounds, which is carried out by UV catalysts.

> For hydrochloric acid there is an almost direct correlation between concentration and refractive index.

Compliance with the specified concentration must be ensured at all times.

Chlorination and hydrolysis both produce hydrogen chloride gas. Pure high-quality hydrochloric acid is produced by precipitation with water, following the burning at very high temperatures of the organic exhaust gas components. This is why it is essential to continuously measure this concentration, ensuring that it is at 30% when fed into the industrial park's integrated network.

Measurement of refraction is a well-established laboratory method for defining density and concentration.

For hydrochloric acid there is an almost direct correlation between concentration and refractive index. Refractometers like those used by FLEXIM, combine the high accuracy of refraction measurement with unerring process reliability. Measuring using a patented transmitted-light method, the sensor head directly measures the refraction of light, unlike laboratory refractometers that measure indirectly via the critical angle of total reflection.

For more information on the refractometric measurement process and how it rises to the challenges of everyday industrial life, contact Simon Millington www.flexim.co.uk | sales@flexim.co.uk | +44 (0)1606 781 420

ACCREDITATION CORNER ASK TREVOR

In this issue, Trevor explains some of the terms encountered in measurement work

It is always necessary these days to ascribe a Measurement Uncertainty (MU) to any measured value during any test or calibration. Without the MU, one can have no confidence in the suitability of the result. For example, if one had an uncertainty of 2% but the specification of the product was 1%, the confidence one could have in any pass/fail statement would be very low and the work virtually useless.

Let's look at a few suitable approaches that have been used in the past and would lead you toward calculating the MU as you gain experience in these sorts of considerations.

Measurement Uncertainty (MU) is a figure used to describe the doubt about the result of your measurement and arises from several sources including the calibration of your reference device, the environment, your competence and other factors all added up in a special way. Special because arithmetic addition would be pessimistic as not all the components would be likely to act in the same direction at the same time. Some beginners find it hard to get this measurement uncertainty thinking into their heads, so I shall now describe a few simpler concepts as an introduction to the subject.

Test Accuracy Ratio (TAR) is worthy of consideration. Years ago, this was sometimes used instead of Measurement Uncertainty, particularly in the USA. In its simplest form one would use a reference instrument that has a calibration certificate from someone else that shows an accuracy figure (actually ideally a MU) and compares that figure with the specification of the item you are testing or calibrating. The measuring equipment being four times better than the required specification (a ratio of 4:1) or more usually results in an acceptable situation in general engineering measurements, assuming that the equipment is used correctly and is suitable. Those are big limitations but often a good starting point for choosing suitable measuring equipment. Many labs will be off to a fine start if they choose reference equipment four times "better" than the specification they are working to. In some disciplines this simply cannot be achieved. Conversely in some high-risk work customers may require even 10:1.

Test Uncertainty Ratio (TUR) should not be confused with TAR. It is similar, but a refinement, and requires a knowledge of your measurement uncertainty. This is primarily used to assess risk and determine the suitability of your equipment and process to make pass/fail statements at a required confidence level.

Limit of Detection (LoD) is a term often used in analytical chemistry to describe the sensitivity of the measurement. It is the lowest amount of a substance that can be detected. In more general science it can be taken to be the smallest increase from zero that results in a change in the measuring equipment response. Measurements at the LoD may not be meaningful as the MU may be too high or the TUR too low.

Limit of Quantification (LoQ) is similar but should refer to the ability to make a meaningful quantification of the measurement, in other words, a valid measurement. In more general science it may be useful to consider this to be the smallest change in a stimulus that results in a meaningful change in a measured reading. This could occur tending to zero, as with LoD, but could also apply to a change anywhere within a range of measurements. This effect may not necessarily be linear. One should concentrate on the LoQ at the points one wants to make measurements in practice.

If when starting out with some testing or calibration you consider the above terms and the relevance they have to your work, you should be able to choose suitable measuring instruments by careful study of the manufacturer's data. For many people, the measuring equipment is the main and first input into their uncertainty budget. In a future issue we shall consider how to add to this with repeatability, bias, and the other real-life components of a realistic uncertainty statement.

After many years at the United Kingdom Accreditation Service, Trevor Thompson is now partly retired and offers training and consultancy services in Metrology and Accreditation for the UK, Europe and beyond at www.bestmeasurement.com.

If you have any questions for Trevor on any aspect of accreditation, please email him at questions@bestmeasurement.com

THE MAGAZINE OF THE INSTITUTE OF MEASUREMENT AND CONTROL

2022

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Inserts are accepted into Precision magazine and must go to the entire UK circulation.

CIRCULATION BREAKDOWN:

2519 UK Engineers / 500 Overseas Engineers
85 Companion Company Members

The Institute of Measurement and Control is committed to promoting the professional excellence and standing of engineers and technologists at all levels in the automation, instrumentation, control and related industries.

Our aims are to serve the public by advancing the science and practice of measurement and control technologies and their various applications, to foster the exchange of views and the communication of knowledge and ideas in theseactivities, and to promote the professional development and qualification of our members.

In 2017 the InstMC launched Precision, a new coffee-table style quarterly magazine, presenting technical articles related to measurement, control and automation. The journal is circulated to our 3000+ members and shines a spotlight on current topics, developing technology, opinion pieces and member-related news. It is also aimed at anyone interested in the various uses of measurement and control.

Precision is a positioning and marketing tool for the InstMC and speaks to a wider audience on the use of measurement and control in the world today.

PRECISION MAGAZINE

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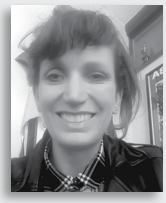

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