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

ONWARDS TO 100: MEASUREMENT AND CONTROL A PROFESSION OF CHANGE

FEATURES//

NEW NEL FACILITY TO ENHANCE CONFIDENCE IN PERFORMANCE OF MULTIPHASE FLOW MEASUREMENT

TRANSITION TO HYDROGEN

ELECTRICAL MATTERS AT HOME FOR NEW TECHNOLOGIES PART 1

PRECISION

MARCH 2020_ISSUE FIFTEEN

INSTMC WELCOMES NEW PRESIDENT MARTIN BELSHAW

As an Institute member for over 20 years, most recently serving as Vice President and member of the Board of Trustees, I am delighted to be stepping into the role of President of the InstMC.

I first started attending meetings at Gower Street more than a decade ago, as stand-in for the then Chair when, following in the footsteps of the engineering greats of decades before, you had to sign a leather-bound book. It was all a bit of a mystery, but I never imagined that I would find myself in the position of Chair, writing this today. So, if there is one piece of advice I can direct to younger members, just because something seems impossible doesn't mean that it is! I am also pleased to welcome Ian Craig as the new Honorary Treasurer, replacing Colin Howard, and Billy Milligan as Honorary Secretary replacing Graeme Philp. I would like to thank Colin, Graeme and outgoing President, Graham Machin, for all their hard work on behalf of the Institute.

Over the years there have been trials and tribulations within the InstMC, and none more so than the last 18 months which have been challenging, particularly with the decision to sell the Gower Street headquarters. However, the team saw a solution, a light at the end of a very bendy tunnel that was not a train coming the other way! We acted, adapted and survived, and today continue to progress with a new model, some new faces and lots of new challenges.

Some of these challenges are those faced by all membership driven organisations and the changes we now have to make in order to survive include; development of alternative revenue streams, improved member engagement, adapting to emerging technologies and making the output of SIGs more transparent and visible to the wider membership. Some of these goals came out of the recent strategy meeting in October last year and will feed into the business plan along with new ideas such as an InstMC consultancy service. Others are a bit more tenuous, such as collaboration with the Society of Petroleum Engineers (SPE) and the Royal Academy of Engineering (RAE) who recently announced spending £22m on emerging technologies, such as agri-controls, which would be in our interest to be part of. Some of these are doable now, some of these doable later but all doable sooner or later!

Looking ahead to events and activities this year, I have been invited to open CHAIN Bristol in March – an event aimed at inspiring and engaging young engineers at the start of their careers. As part of the Engineering Policy Group Scotland, will address the future of Scottish satellites through the Scotland in Space initiative and, along with fellow industry colleagues, I will be attending the President's Reception at the RAE. Later in October we will be celebrating the membership's talent and achievements with the InstMC Awards Night and of course, all our Local Sections continue to provide a variety of lectures, visits, social events and activities. I look forward to working with all of you and here's to a successful 2020 for the InstMC!

Martin Belshaw
CENG MINSTMC
Current President

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The magazine of the Institute of Measurement and Control

Published by: Institute of Measurement and Control
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T: +44 (0) 20 7387 4949
www.instmc.org
www.facebook.com/instmc
www.linkedin.com/groups/117672

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Design, print & mail fulfilment by HMCA Services Ltd
Tel: 01423 866985 Email: enquieries@hmca.co.uk

Cover price, where sold, £15

NEW NEL FACILITY TO ENHANCE CONFIDENCE IN PERFORMANCE OF MULTIPHASE FLOW MEASUREMENT

Figure 1: UK Designated Institute for Flow and Density Measurement Campus, East Kilbride, Scotland. Bottom left of picture; Reynolds Building, home of the Advanced Multiphase Facility.

In the oil and gas industry, the move towards production optimisation and remote, deep-water production has led to a growing market for multiphase meters.

Capable of measuring unprocessed streams, these meters remove the need for expensive processing equipment to separate and measure the different oil, gas and water streams and have therefore made it possible to recover hydrocarbons from previously uneconomic fields.

As the demands for greater meter accuracy to support fiscal taxation reporting and allocation measurement have increased, the technology behind these meters has become increasingly sophisticated. Multiphase meters have long been recognised as a key enabler for subsea engineering. However, the lack of suitable test facilities has proved a major barrier to their widespread use, despite their sophistication and the claims of the meter manufacturers.

Efficient operation requires an understanding of the effect of higher operating pressures over the full range of multiphase flow regimes a meter will encounter. Existing facilities across the world have struggled to meet the conditions required to replicate these real-world environments, leading to many multiphase meters being used outside their qualified operating envelope.

To address this gap in facility capability, National Engineering Laboratory (NEL) recently launched the Advanced Multiphase Facility, designed to serve the £50-billion-per-annum global subsea sector.

NEL operates the UK's National Standards for flow and density measurement and is part of the UK's National Measurement System (NMS). Funded through the Department for Business, Energy and Industrial Strategy, the NMS supports the metrology needs of UK industry and academia through a network of world leading experts, laboratories and measurement infrastructure.

The new Advanced Multiphase Facility can test at pressures up to 140 bar with flow rates much higher than comparable facilities elsewhere in the world[1]. It will be a great addition to the UK's National Flow Measurement Standards for the next 25 years, replacing the original multiphase flow National Standard built in 1993.

With a footprint of 1,600 m² and a full production scale separator weighing 270 tonnes, it is the only facility in the world capable of evaluating multiphase and wet-gas flow meters over a wide operational envelope. In addition, 2D, three-phase, x-ray tomography and sensors can deliver high definition images of complex flows to help visualise and understand the multiphase fluid behaviour and its impact on measurement.[2]

To support current and future flow measurement challenges, it is expected that services will include flow meter performance review under wellhead conditions; addressing flow regime and modelling challenges; evaluation of metrology performance in multiphase and wet-gas conditions; and the development of flow imagery to study flow profiles and patterns from low to high pressure. A series of Joint Industry Research Projects have also been launched to support the industry in driving forward this technology.

Following the opening of the Advanced Multiphase Facility in October 2019, Dr Brian Millington, Managing Director of NEL highlighted its potential to "increase the viability of well exploitation by helping operators to more accurately measure multiphase flows and better understand the performance of production operations in these challenging but potentially profitable environments."

Scotland's enterprise agency, Scottish Enterprise supported the development of the Advanced Multiphase Facility with £4.9 million of research and development funding. In addition, National Engineering Laboratory's parent company, TÜV SÜD AG, also invested £11.1 million.

Figure 2: The 33 metre-long, full production scale separator of the Advanced Multiphase Facility

Flow Rates	
Oil	0.2 – 550 m³/hr (0.5 % Uncertainty) [30 – 83,026bpd]
Fresh water/Saline	0.2 – 550 m³/hr (0.5 % Uncertainty) [30 – 83,026bpd]
Gas	50 – 3,000 m³/hr (0.5 % Uncertainty) [0.45 - 358 MMscfd]
Operating Conditions	
Working Line Pressure	15 – 140 bar(g) [217 - 2,045psia]
Working Line Temperature	10 – 43 °C [50 – 109°F]
Horizontal and Width Test Section	>40m x 7m test section [131ft x 23ft]
Vertical Test Section	10m [33 ft]
GVF	0 – 100 %
Water Cut	0 – 100 %
Salinity Change	2 – 6 % [Sodium Chloride]
Meter Size	2" – 12"
Option	Integrated subsea choke available
High Accurate CGR or WGR	0 – 300 bbl/MMscf
Fluids	Nitrogen, mineral oil, water

Table 1: Advanced Multiphase Facility Technical Specification [3]

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Engineering Council

Engineering Council workshop programme 2020

The Engineering Council organises a regular programme of workshops, covering a broad range of topics relevant to institution staff and volunteers.

Workshops will be held at the Engineering Council offices in central London unless otherwise stated and usually begin at 10.30am. A sandwich lunch will be provided where the workshop runs over lunchtime. All workshops are free of charge.

The overall objectives of all Engineering Council workshops are to:

- Exchange good practice and ideas
- Maintain standards, continue to ensure consistency and transparency
- Encourage greater collaboration between Institutions
- Increase opportunities to network with peers and staff
- Ultimately contributing to increased institution membership and professional registration

Book your place: to attend any of our workshops, please email the contact shown.

Please note: in April 2020 Engineering Council will be moving offices from London EC2V 5HA to London EC3R 6EN. Joining instructions for each workshop, including directions, will be sent to attendees in good time before the event.

Date	Workshop title	Purpose	Audience	Contact
30 Mar	Annual statistics	• Review of Engineering Council annual registration statistics • Highlighting key trends in 2019 statistics and comparison with previous years • Considering demographic changes and their impact	PEI staff	marketing@engc.org.uk
18 May	Promoting professional registration	• Highlights from annual registration statistics and what these tell us about key trends in registration • Discussion of recruitment and retention trends, current practice and what has been most effective • Consider issues for different titles and routes	PEI Marketing and Membership staff	marketing@engc.org.uk
25 May	CPD reviewers' workshop	• Confirm CPD sampling requirements and guidance • Institution perspectives of CPD sampling • Review of example CPD submissions	Staff and volunteers at PEIs	licensing@engc.org.uk

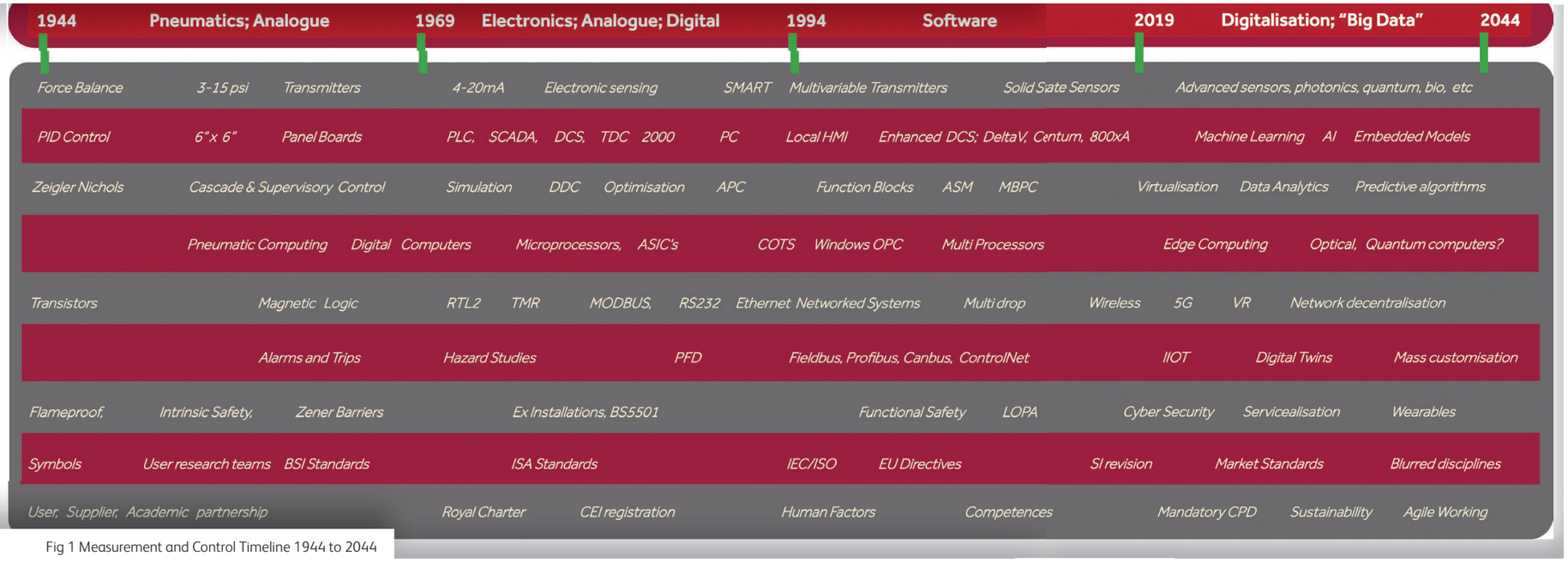


Fig 1 Measurement and Control Timeline 1944 to 2044

ONWARDS TO 100

MEASUREMENT AND CONTROL; A PROFESSION OF CHANGE

COLIN HOWARD BSC CENG HON FINSTMC CPHYS MINSTP, IMMEDIATE PAST HONORARY TREASURER, INSTMC

The 75th anniversary of the Institute of Measurement and Control in 2019 was marked by two papers in Precision (Issues 11 and 12[1]) reprinted from the Golden Anniversary of the Institute in 1994. This paper uses information from the rich history of the Institute to look forward to its centenary in 2044.

From a great many interesting aspects of our technologies, a few have been selected by the author in the timeline (Fig 1) as representative highlights in each of the three quarter centuries past and the one to come. Key features of each period are identified as: 1944-69 Pneumatics, analogue; 1969-94 Electronics, analogue, digital; 1994-2019 Software; and 2019-2044 Digitalisation and Big Data.

The last 75 years have been a period of continuous evolution in measurement, control and automation, punctuated by significant shifts in the technologies available. The pace of change particularly increased in the period 1969-94, with the transitions from pneumatic to electronic analogue systems and then to digital technologies. In the quarter century from 1994 to 2019 change centred much more on software, communications, security and application; adopting mainstream software offerings as the basis rather than wholly bespoke approaches.

All the topics listed for the 25 years to come are current aspirations, but not guaranteed to become reality. We take for granted the technologies now available, although five years ago we may have been circumspect about adopting them and ten years ago some may never have existed; expect this to continue.

For success, it is essential that there is a clear understanding of the problem to be solved and the contribution that the selected technologies can provide. Winning hearts and minds to develop clarity of thought and understanding in what is possible as well as relevant is a pre-requisite. Failure to live up to the hype leads to loss of confidence and progress is delayed, or in the worst case, terminated. Starting small with a standalone application with clear intent and understanding is a recipe for success.

The range of techniques, tools and equipment has vastly changed over 75 years, but the basic physics and science remain, and we should identify elements to be retained or revised. Orifice plate flowmeter technology is largely unchanged, but the sensing methods can now include process diagnostics, whilst coriolis flow metering, with its multivariable capabilities has become available largely through advances in electronics and computing.

Development of measurement technology and applications now available is expected to continue into the next quarter century aided by digitalisation; including the miniaturisation of sensors and the development of novel sensing approaches and capabilities, together with the expansion of measurements into new sectors.

The need for traditional non-microprocessor instrumentation will continue, particularly in the nuclear industry and similar applications where quantified reliability is required and software based systems are not considered to have sufficient integrity. Legacy issues everywhere will still need to be effectively managed.

Data has always been created across all aspects of business but, until recently, the capability to do something with that data was limited: 50% of the world's data total was created in 2019 but less than 0.5% has been analysed or used. With 5.5 million new items worldwide being connected to the internet each day the scope for digitalisation is vast.

The PID controller is still appropriate for the vast majority of process control loops, as is the Zeigler Nichols tuning methodology. Although modern controllers provide automatic tuning functions, the ability to use the Z-N approach can still prove beneficial. Advanced Process Control (APC) covers a wide range of techniques whether for specific niche applications or for the wider optimisation of the operation. Application of these existing techniques will expand into newer fields, but is there more control capability to come under the banner of Advanced Process Control, or have the core techniques now been developed?

The traditional Distributed Control System (DCS) functionality will become but a small part of the future measurement and control systems. They will be broadened and deepened by the extensive use of the data that can be assembled about the process and its operations from genuine smart sensors.

Simulation of systems, from testing control system designs through plant walk throughs and operator training simulators, has developed over the last 50 years to the point where it is now possible to model whole production facilities and generate

Developments in machine learning linked to virtual systems and geopositioning of instrumentation embedded into the plant models will aid fault finding and direct technicians to resolve issues. Permit to work and safety requirements will also be embedded in the virtual system; possibly the technician will be receiving instructions via a wearable device.

Measurement and control professionals, in designing new systems and applications should have in mind that the end user will expect to interface with the application at least as easily and intuitively as they do with their mobile phone. To have to repeatedly involve a support team to ensure the application functions will lead to certain failure.

Developments often have competing potential solutions to a need (remember Fieldbus) and where solutions are not mutually compatible lead to frustration in implementation. One similar emerging topic is edge versus cloud computing. It is vital to understand the pros and cons of each approach and to recognise where the real benefits will lie in an application, particularly in a real time environment. The ideal solution is that both coexist, contributing from their strengths to make the overall application even more successful. A cloud based control system may be too high a risk to take.

The acronym GIGO (Garbage In Garbage Out) continues to apply to anything involving computer and data systems. It is important to ensure that measurements are appropriate and sufficient, that assumptions are adequately specified and valid, and that the outcomes permitted are essential for any mathematical modelling, predictive algorithms, machine learning or artificial intelligence activity. Remove human oversight, validation and challenge of these new technologies, and unintended consequences can be expected.

Connection of individual instruments to the central control point is moving from individual cabled circuits to localisation through signal concentrators and genuine distributed control units with networked connections. Wireless technologies have matured over recent years, particularly for difficult to access measurements, but have not yet made significant inroads into the bulk of the cabled systems. The introduction of 5G technology has the potential for further technology shifts in how instruments and systems communicate.

In the early days of DCS's and computer applications the key security instruction was to not connect the system to a remote host, and certainly not to allow software changes to be made without close supervision. With the growth in integration of process and business level computing and the adoption of more commercially available software, the need for permanent communications to remote locations and the use of the internet became inevitable. Maintaining software in an updated status is vital, but if past experience has taught us anything, even required updates can go wrong. Ensuring suitability of updates is essential, but running unsupported or out-of-date systems is potentially an even larger security risk. Ensuring the essentials of cyber security like access controls and password protocols will remain fundamentals, but it will be interesting to see how new technologies avoid unnecessary complexities. Attention to cyber security will not go away and is likely to remain an important development theme in the next 25 years.

Developments in DCS capabilities significantly extended opportunities for data generation, in many areas more than was strictly always necessary. The plethora of alarms that could be generated for each measurement, if not correctly assigned, contributed to overload and confusion for the operator. Serious incidents resulted in the development of an industry led standard for alarm systems and many proprietary alarm management tools. Similar incidents must not be allowed to develop as a result of digitalisation and "big data".

Preparing a safety case report involves gathering acceptable equipment and human performance data. Much of the currently available information is based on theoretical estimates of component data: the application of digitalisation to generate real life, validated information from actual installations will bring significant benefits.

Volume 1 of the Institute's "Transactions" included a paper on the symbols to be used in P&I diagrams[2] ; many of which are still recognisable in today's standards as part of the internationally accepted approach to including measurement and control requirements as part of the basic plant design.

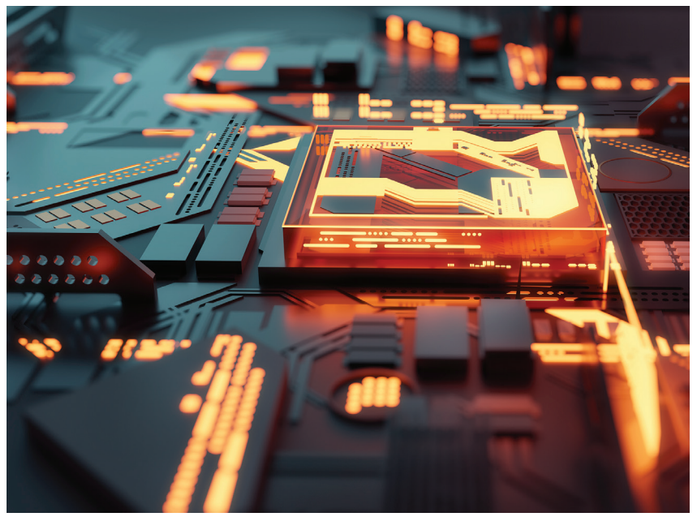
The availability of standards underpinning the technologies to record best practice and regulatory requirements has been a foundation. These have expanded in scope and content (and length) over the years through user and trade association involvement with BSI, ISA, HSE, ISO and IEC. EU Directives have also influenced standards requirements additionally in welfare, health and safety and environmental protection aspects. The gestation period for new or revised standards has steadily lengthened whilst at the same time the pace of technology change has increased. This has led to different approaches to develop standards based on market requirements. Much of the work of standard setting is by volunteers on committees, and their availability for the task is increasingly of concern. How to reinvigorate the process of standards setting requires attention in the coming years.

The composition of the governing body of the Society of Instrument Technology in 1945 had equal representation from the user, supplier, and education and research (academic) communities. This served very well in the formative years and, as a model to engender cooperation and promote developments, still has much to recommend.

The UK Government has included measurement, control and automation as a core part of what it calls the "ElecTech Sector" and has recently published "ElecTech Sector: a Roadmap for the UK[3]" setting out perceived investment needs in the sector over the next ten years covering many of the aspects in this paper. The recommendations from this work could re-enable partnerships between the suppliers, users, academics, and involve the Institute.

It is already clear that suppliers are moving away from being the providers of hardware and software, but are seeking to introduce a "servicealisation" approach to deliver a specified performance outcome, perhaps not dissimilar to the supply of aircraft engines "by the serviceable hour."

Measurement, Control and Automation are not silo activities, but for really successful implementation they require shared connections and competences. Other skills and knowledge, involving all aspects of IT (computing, communications, software) need to be blended with the fundamental measurement, control and automation skill sets, leading to a blurring of disciplines, and above all, agile working. The level of development involved in the "Digitalisation" future will provide ample opportunity to meet the mandatory CPD requirements for registrants that are being introduced by the Engineering Council in 2020.



Only a limited range of engineering professionals are subject to formal licencing in 2020, but increasing requirements to demonstrate competence in key roles together with changing approaches to regulation and how the public is protected from engineering failures may lead to more demands for formal licencing. Measurement and Control professionals are unlikely to be immune from these developments.

Conclusions

The measurement and control profession has risen to the challenges and contributed to many significant innovations, developments and productivity improvements over the last 75 years, but perhaps an even greater era of innovation, development and change awaits in the next 25 years. The overall strength and capability of the profession is greater than the basic sum of its parts. After all without good measurement there can be no effective control. New challenges and opportunities, some of which may not even be on the horizon as yet, will present themselves. This is for the current and upcoming generation of measurement and control professionals to grasp, measure, and take control.

Acknowledgements

The author thanks Graham Machin, Graeme Philp, Steve Brambley, Scott Pepper, and David Tipton for their assistance in the preparation of this paper; and his wife Elizabeth for her forbearance over his many years of involvement with the Institute.

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Q&A

Beverley Stanford

This month's interviewee is Beverley Stanford, now retired but formally Head of Major Projects, at WSP CEL Ltd in Coventry followed by several years as an independent Project and Value Management Consultant. She is Chair of InstMC's Professional Registration Committee and an Honorary Fellow.

> We are ever more conscious of our limited resources and the adverse effect of our actions on the environment and society in general.

What was the root of your interest in Engineering?

Put simply, the opportunity and the encouragement of my parents not to just to accept that things worked, but to find out why. At the beginning, this sometimes resulted in a pile of bits that couldn't be put back together, but I'd learnt something about the world around me and it made me want to learn more.

I grew up during a time when there were rapid advances in technology and I was absolutely fascinated by science fiction and was an avid watcher of factual science programmes on television. As a result, when the decision needed to be made about whether I chose physics or history at secondary school, it had to be physics,

In reality, it was quite late in my final year of a Science degree before I decided that I wanted a career in Engineering because, as I perceived it, there were no bounds as where that might take me.

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

The UK has a rich history in innovation and manufacturing built on a foundation of imagination, forward thinking and courage and commitment to turn ideas and theories into realities.

We are ever more conscious of our limited resources and the adverse effect of our actions on the environment and society in general. We need to harness those traditions together with the rapid changes in technology and the advent of the digital age to enable us to use resources more effectively. The likely consequence is a more "lean" approach, minimising waste and emissions leading to manufacturing methods which are more resource and energy efficient. We need a greater emphasis on the application of engineering and technology to make our transport and utility systems more efficient and capable of reacting to external influences more readily. I think we'll see engineering improving and giving better control of animal husbandry and crop growing resulting in better yields. It will also become the norm to provide remote monitoring of an individual's health condition from the comfort of their own home, enabling appropriate intervention and consequently reducing the number of potential emergencies. The opportunities are endless, only limited by our imagination and the will to make it happen, but one thing is certain: measurement control and automation will play a key role.

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

While the STEM initiative is to be applauded, there is unlikely to be a step change in the numbers attracted to a career in engineering until the discipline is better recognised within UK society as a valued and respected profession, with appropriate remuneration. There needs to be more opportunity for individuals to remain in a technical role rather than, as all too often happens, migrating into commercial, financial and project management.

A significant part of that recognition is for Government and society in general, to wake up to the concept that the engineering and the input of the engineers are fundamental to the wellbeing of our economy, safety, and a way of life which, unfortunately, too many take for granted.

There is no quick fix, and throwing money at the problem will not resolve it. Instead, it has to be attractive to enter the Engineering profession with Government commitment to a long term strategic plan, with multiple pathways, properly costed, with short term and long term goals and supported by employers to provide the facilities, educators and opportunities to deliver the appropriately trained engineering resources so badly needed. This must include a pathway which provides the opportunity to allow individuals who later in their working life want to retrain to give them access to engineering roles.

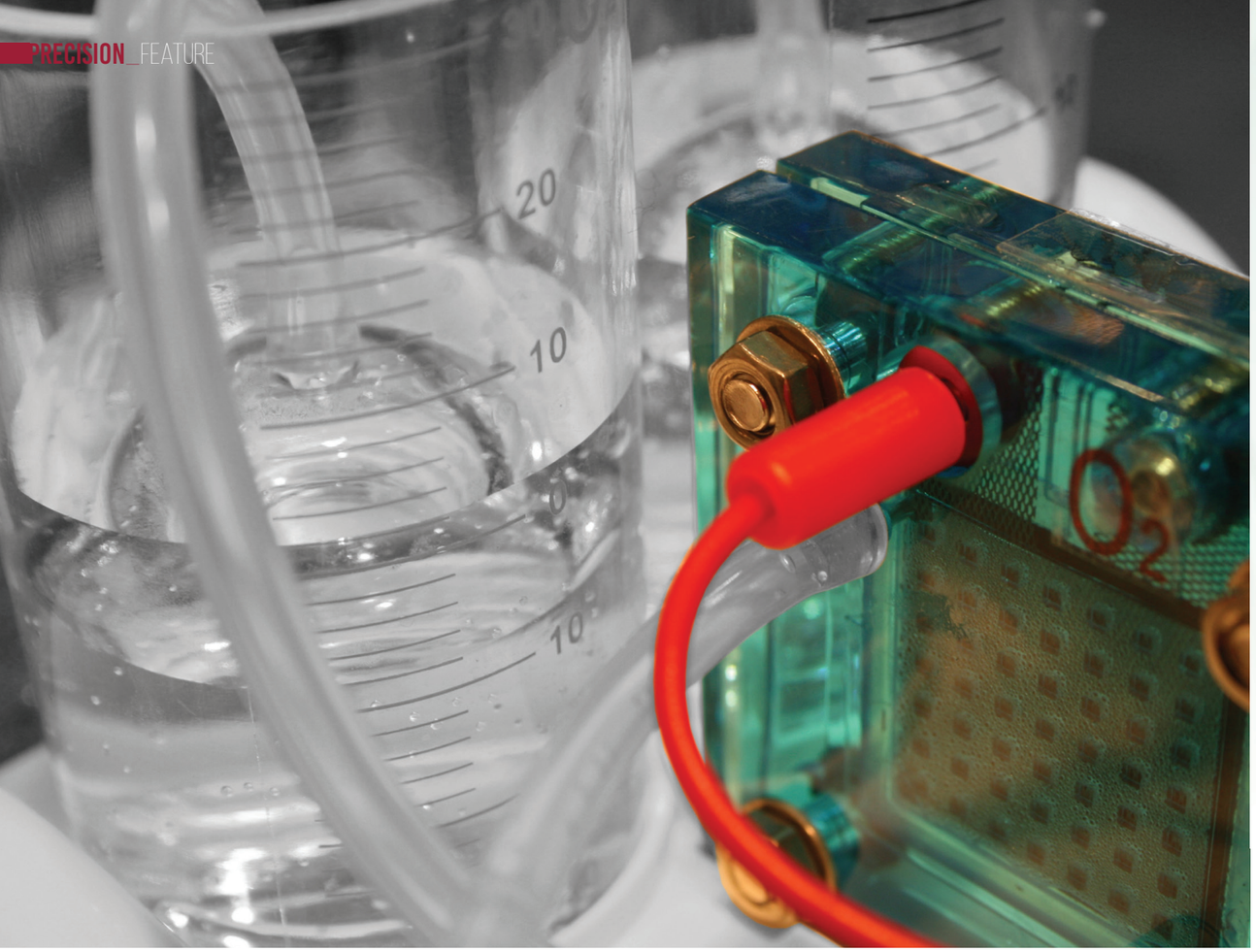
What do you do in your free time to relax?

I spend time with family and friends and I'm grateful that I can take holidays when I want now that I am retired. I play lawn and short mat bowls; I play duplicate bridge and I bake. The latter tends to be a little experimental but as there's never anything left, I assume the results are at least edible.

Given one wish what would that be?

One day, individuals in positions of influence will use their collective talents more constructively, and instead of wasting time and effort arguing for their own position and views, will work together for the betterment of us all.

> I think we'll see engineering improving and giving better control of animal husbandry and crop growing resulting in better yields.



TRANSITIONING TO HYDROGEN

MARTIN BELSHAW CENG MINSTMC

If we are to achieve our targets of net zero greenhouse gas emissions by 2050, then sometime in the middle of this decade our respective governments will have to make some difficult decisions with respect to decarbonisation and transition to a low-carbon economy, specifically the decarbonisation of the National Gas Network.

> "Green" gas already exists such as bio-methane harvested from food composters, sewage plants and landfill sites but the capacity is limited and will never replace or even significantly augment natural gas in the grand scheme.

One obvious solution would be the mandatory electrification of industry, businesses and homes across the entire country. A less obvious solution would be to replace natural gas with another gas, which is what transitioning to hydrogen aims to do.

Hydrogen is particularly attractive because it allows much of our existing gas infrastructure to be reused. It can be used by industry, businesses and homes alike, it can be produced in large volumes and compares well with other low carbon heat technologies. Hydrogen is, in effect, a good fit for a phased transition process. The current Scottish Energy Strategy already acknowledges hydrogen as one of two scenarios for future energy development. Scotland now leads the UK in examples of innovative hydrogen-based energy schemes.

Over the last 50 years, natural gas has gradually replaced solid fuel and today, more than 85% of domestic heating is gas based. Unfortunately, "gas" has also become a major component of the UK CO2 emissions and to compound this problem about a third of our electricity is also generated by gas.

Today, albeit in small steps, we're moving away from dependency on fossil fuel to low-carbon solutions such as nuclear and renewables. If these low-carbon solutions can also make hydrogen, then we have a way to move away from natural gas and reduce the CO2 emissions accordingly. However the gap is massive and the cost difference is significant.

"Green" gas already exists such as bio-methane harvested from food composters, sewage plants and landfill sites but the capacity is limited and will never replace or even significantly augment natural gas in the grand scheme.

Meantime, hydrogen is already being produced in large quantities for the chemical industry. The National Gas Network upgrade has been ongoing for decades (the yellow pipes), and is more or less complete, meaning within the next decade we will be hydrogen ready. Over the same period, UK North Sea gas will have declined significantly with the shortfall to be met by imports from elsewhere. So now is perhaps the time for change, a change not dissimilar from the switch from town gas to natural gas in the 1970s, and the discontinuation of propane on the Isle of Man more recently, although much bigger. The change will have to be done in phases, initially blending hydrogen with natural gas before finally switching to 100% sometime later, since this will involve the replacement of millions of devices.

The problem, as always, is one of production capacity - making hydrogen in sufficient quantity to replace natural gas. Three methods exist: electrolysis of water, steam reforming and partial oxidation. All are mature technologies, the issue is just one of scale.

In the UK there are about twenty projects already investigating hydrogen in one way or another, albeit on a micro scale, including blending trials, 100% trials, and feasibility/proof of concepts studies. Hydrogen better suits a phased changeover than all out electrification, for industry, domestic and automotive applications. It can use existing infrastructure, existing devices (to some extent, and new devices such as fuel cells (with some clean-up process) through a sequence of easy to implement options along the way. The biggest problem is educating people sufficiently to make the right decisions from the outset; rather like VHS vs Betamax or Minidisc vs CD, when the best technical solution did not necessarily win.

For the time being, hydrogen production is likely to be by electrolysis of water using electricity from low-carbon sources such as wind or solar until such time as the problem of carbon capture associated with gas reforming can be sorted. This will probably limit use to transport markets only. New technologies will be required to produce hydrogen in sufficient quantity and sufficiently quickly to meet the 2050 greenhouse gas emissions targets. Gas reforming and carbon capture appears particularly suited to the oil and gas sector, which has assets and infrastructure already in place and has tentatively been considered before.

Thus, hydrogen blending is probably the most likely short-term outcome as it is easier to achieve and more likely to be accepted long before 100% hydrogen becomes a reality, and 30% of users are unlikely to notice except for the price rise.

Industry should be looking now at the skill sets and people required to do this, and engaging with schools, colleges, universities and PEIs to do so in years to come. Tremendous opportunities exist for everyone.

Thus, hydrogen blending is probably the most likely short-term outcome as it is easier to achieve and more likely to be accepted long before 100% hydrogen becomes a reality, and 30% of users are unlikely to notice except for the price rise.

LOCAL SECTION NEWS

HERTS

WEAPONISED PDFS

Geraint Williams, Chief Information Security Officer of GRC International Group, the leading provider of IT governance, risk management and compliance solutions.

My talk focused on how the Portable Document Format (PDF), which was previously thought "safe", has been hijacked and turned into a weapon, maliciously attacking and infecting our machines.

It all developed from my experiences protecting the company I work for from cyber-attack. We could be subject to targeted advanced attacks at any moment, so I'm keen to understand what attackers are trying to achieve. Simple AV, whilst preventing many attacks, does not provide enough detail for my needs.

The majority of cyber-attacks start with a simple e-mail that contains a link to a malicious website or carries a malicious payload. Whilst most users are wary of office documents, as they know they can contain malicious payloads, few realise that PDF documents can be just as dangerous.

In the first part of my talk I looked at how the ubiquitous PDF, used throughout the business and commercial world, can be weaponised to carry out a variety of attacks. PDF started as a document standard that would allow sharing across multiple operating systems, but it has become so feature laden that it can be easily exploited, even by those without the uber skills of the elite attackers. Easily available toolkits can create documents that, when opened, allow attackers to gain control of the system. I explained the structure of the PDF document, showing how attackers can leverage features designed to make life easier for the everyday user to attack systems and, how they can create weaponised PDFs.

I went on to show how security researchers can examine a PDF to identify if and how it has been manipulated, so that they can reverse engineer the payload and discover the malicious intentions of the attacker. This allows them to generate signatures to be used to identify attacks in the future and develop tools to reverse the attack and cleanse machines from malware. I gave an example with a live weaponised document, showing how it can be reverse engineered, using readily available tools that any knowledgeable computer technician, engineer or scientist can deploy.

The talk wrapped up with a Q&A and a discussion on what can be done to prevent future attacks and the best course of action to follow, to protect oneself and businesses.

Herts Local Section held the Technical Lecture Weaponised PDFs at Eaton Electric Ltd in Luton on 29th January 2020.

> We could be subject to targeted advanced attacks at any moment, so I'm keen to understand what attackers are trying to achieve.

TEESSIDE

VISIT TO NIFCO

The new year started off well with a visit to NIFCO, manufacturers of automotive components, at Eaglecliffe on 23rd January.

Fourteen attended and we were all impressed by the complexity of production and the precision required to produce what appears at first glance to be just simple pieces of plastic; whether it is the plastic rivet that holds your car door panel in place or the spacer that separates the cell plates in a Nissan Electric Battery, or the plastic components for your car's air conditioning.

The dexterity of the robots that pick the moulded components from the injection moulding machine, then whilst holding the required parts gently drop the waste pieces into the recycling container, was impressive.

After being ground up and reused by the same machine the desired components are then gently placed on a conveyer for transfer out of the machine.

The components are examined by the operator to ensure everything is working as it should be, then samples are taken and put through stringent quality control tests to ensure the finished product meets the customer's requirements.

Mike Vowell, Hon Sec, Teesside

JEOFF SAMSON BSC

HON F INSTMC 1928 – 2020

Jeoff Samson was a member of the Inst MC for nearly 69 years, having joined on 1st February 1951. He served the Institute (and its forerunner the Society of Instrument Technology) in its formative years in a range of roles including as a Vice President, as President (1969 to 1971), and as Honorary Treasurer (2000 to 2005). Even during his last 18 months, Jeoff found the time to provide wise council to help the Institute through the process of preparing for the sale of 87 Gower Street.

Jeoff had received a scholarship to Clare College, Cambridge, where he achieved a first-class honours degree in Physics in 2 years, following military service in the Royal Signals (although, apparently, he never mastered Morse code).

Jeoff had a very successful and varied career in industry rising to senior manager and director positions in several well-known companies, including Fisher & Porter and Negretti & Zambra, at the time when the industry was transitioning from pneumatic to electronic and later microprocessor-based instruments. Later in his career he had senior roles in major companies including STC, GEC (Hotpoint) and Amstrad where he sparred with the likes of Lords Weinstock and Sugar.

Outside of work Jeoff had a wide range of interests as a car enthusiast and boater as well as a keen interest in art collection and classical music and also in his family life and work in his local community. Sport also figures highly in his list of interests, from being the Northern Command Heavyweight boxing champion during his period of National Service to his passion for Rugby Union, particularly as a regular visitor to Twickenham. He was also a connoisseur of fine wines and good dining.

Jeoff was a very generous and supportive person with an excellent sense of humour and a bottomless stock of jokes, particularly useful in lightening the mood after a difficult meeting. When necessary, he could also be very firm and to the point.

Jeoff was the envy of his generation with the ability to navigate new technology although he apparently never managed to leave the house with his mobile phone.

With Jeoff's passing both his family and the Institute, have lost a great man who leaves behind many abiding memories.

Colin Howard
Immediate Past Hon Treasurer

Graeme Philp
Immediate Past Hon Secretary

Jeoff was the envy of his generation with the ability to navigate new technology although he apparently never managed to leave the house with his mobile phone.

ASK THE EXPERTS

What are the challenges during plasma measurements and controls within Nuclear Fusion experiment machines?

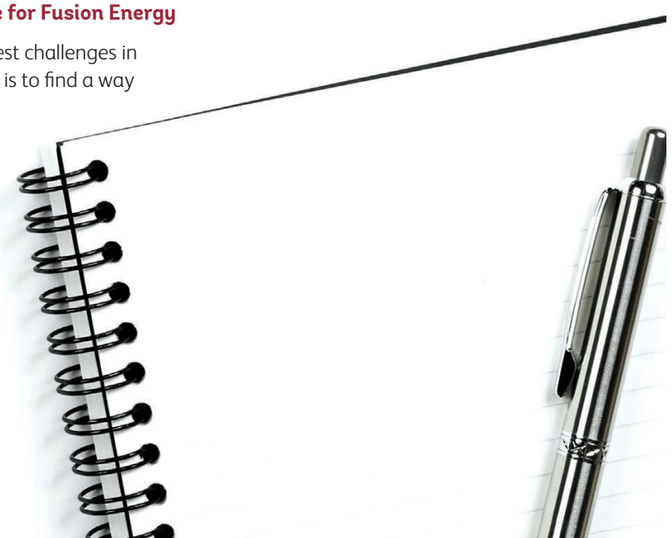
Navdeep Mehay, Machine Control and Protection Group Leader at MAST-U, MINSTMC

Background

Fusion Power is generated by harnessing the energy released by replicating the fusion processes that happen within stars like our Sun. The Sun uses hydrogen as a fuel and the core temperature is estimated to be 15 million°C, however the fusion rate for hydrogen is very slow, in order to generate power by the fusion within a machine on earth, we need to use a different fuel based on heavy hydrogen molecules called deuterium and tritium, which requires plasma temperatures in the region of 100 million°C. This is achieved in a fusion reactor or machine commonly known as a tokamak (Russian word токамак).

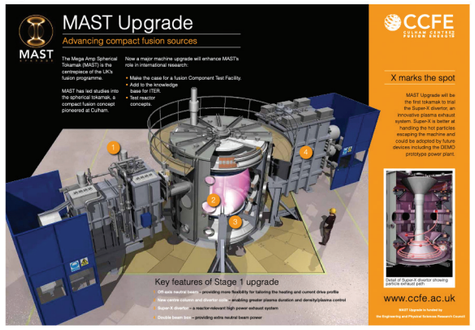
Culham Centre for Fusion Energy

One of the biggest challenges in fusion machines is to find a way to dissipate hot plasma exhaust without damaging the surface of the divertor. Science communities around the world are working towards overcoming such challenges and helping to convert theory into practice for efficient future power generation. The UK has its own "MAST-Upgrade" machine at Culham Science Centre which is going through commissioning following major upgrades to enable scientists to carry out experiments into how to handle this heat. However, machines like original MAST and JET at Culham Centre for Fusion Energy (CCFE) have already produced excellent results for the fusion community.



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

Figure 1: Mast-U upgrade plan



Plasma measurements

To measure the temperature within plasma we use scientific techniques like Thomson Scattering which, by observing spread of a scattered light wavelength, can measure speed of the particles and hence calculate temperature using their velocity distribution. The intensity of scattered light can also give us the information on the electron density. In addition, over 700 Langmuir probes at various locations will give us electron temperature, electron density, and electric potential of the plasma.

Engineering Challenges

Now let's talk about the real challenges to bring this science into reality. I hope no scientists are reading this!

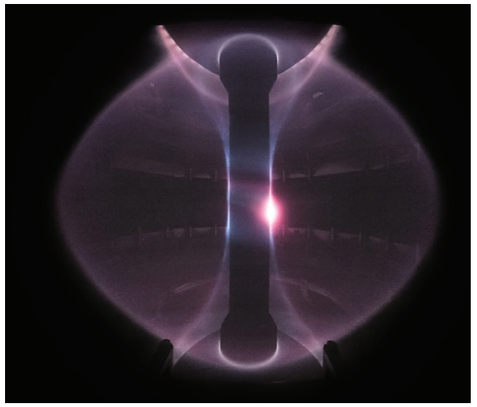
During experiments on original MAST machine, the plasma lasted for around 0.5 seconds and after upgrades it will last for 2-5 seconds on MAST-U which gives us enough time to accurately measure various parameters including shape of the plasma. Before we start measuring millions of °C, let us discuss protecting our measuring instruments. The magnetic field generated by coils, which surround the vessel, help shape the plasma and hold it stable within the tokamak without touching the inside wall. This makes machine body temperature measurements easier by using K- or T-type thermocouples.

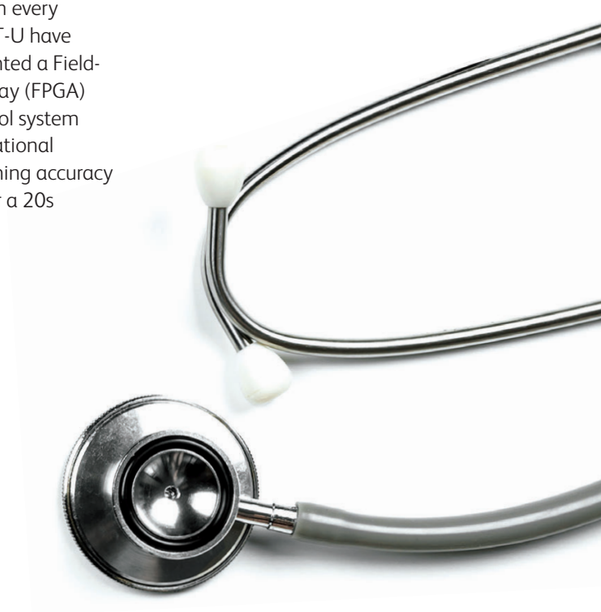
And more...

Now, once we have active equipment like a reciprocating probe connected to the machine, our challenge is to expose it to the extreme high temperatures within the machine for the shortest possible duration during the pulse. This is achieved by using precisely controlled gate valves to operate and allow the equipment to enter while maintaining vacuum inside the vessel. Also, it becomes imperative to capture every milli second of the activity on every shot. Engineers at MAST-U have designed and implemented a Field-Programmable Gate Array (FPGA) based Fast Timers control system which provides an operational window and ensures timing accuracy better than ±0.5ms over a 20s period. Again, thanks to FPGAs, Real Time Protection (RTP) control system is designed to detect any coil fault and kill the power to coils within 600μ seconds to protect against flashover/sudden high loads.

A closed loop z-control system is in development which will control vertical movement of very light weight and jelly-like plasma in real time. But these discussions are for another day.

Figure 2: Plasma test inside the original MAST machine





ELECTRICAL MATTERS AT HOME

FOR NEW TECHNOLOGIES – PART 1

BY PETER NORMAN
IENG MINSTMC MIETC

As we move towards what is looking like an increasingly electric future in the world's quest to reduce man-made damage to the environment, we are entering an age where electric devices will become more technically sophisticated but also more powerful if electricity is intended to be the prime mover of heavy equipment for transport.

Domestic properties with modern equipment and appliances already feature such technologies as LED lighting, induction cooking hobs, IT equipment which may include smart home and data networks, solar PV panels and electric vehicle (EV) charging equipment .

The proliferation of electrical equipment containing micro and small-scale, electricity generators means the presence of switch-mode power supplies where integrated electronic device require AC/DC power converters.

Electrical Safety Protection Devices

Many domestic homes already have electrical consumer units containing Residual Current Detectors RCDs often used generically to refer to trip-switch safety protection devices that can detect residual current and which are capable of fast disconnection of mains electrical faults, within milliseconds when the RCD meets a high sensitivity specification. Retrofitting modern technologies, into domestic premises, create DC currents that are a real issue with their tendency to leak to earth. The original type AC RCDs are only effective if used to protect more traditional household equipment possessing resistive, capacitive and inductive loads. Therefore, such RCDs cannot operate as they should when the equipment generates pulsating DC, smooth DC and high frequency AC current faults. More sophisticated RCD types can now cope with these additional parameters more effectively. For example, energising specific appliances or a combination of electrical loads such as LED lighting, can produce electrical transients at switch-on, in the order of several thousand amps for a very short time duration. Such transients can cause nuisance tripping of standard, non-delay Type AC and Type A RCDs. To overcome this problem RCDs, including 30mA devices, can be manufactured with transient-resistant features.

At this point of technical sophistication, it is best left to the equipment manufacturer to specify the correct protection device to be installed in the home consumer unit. The qualified installation electrician really needs to know the manufacturer's recommended RCD specification and then ensure that the customer's consumer unit is capable of accommodating the necessary device to permit such an upgrade to the correct safety standards.

When it comes to finding suitably qualified installation electricians, the City & Guilds offer courses covering solar PV panel installation and electric vehicle charging point installation.

The current 18th edition of the Wiring Regulations, BS 7671:2018 (in force since 01 January 2019) details the variety of RCDs for the different electrical requirements within its 'protection for safety' content. Some may prove surprisingly expensive to obtain.

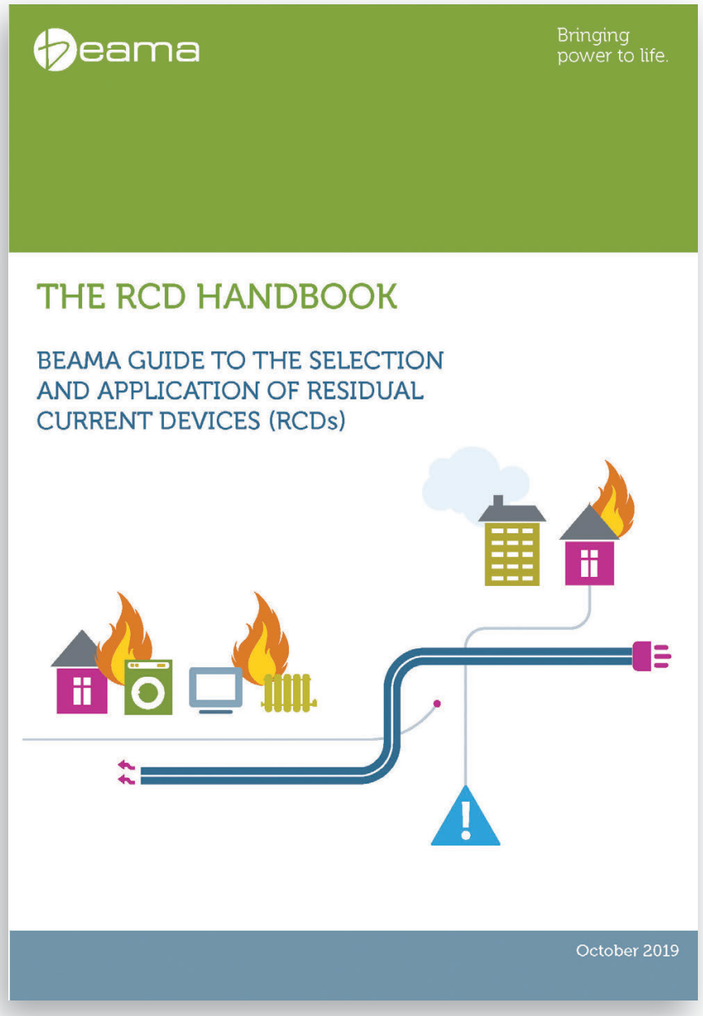
The risks of electric shocks due to stray currents are well worth noting since it doesn't take many milliamperes (mA) flowing through the human body to cause problems and damage:

- 5-10mA can cause muscular reaction that prevents letting go of the current-carrying conductor until de-energised by isolation;
- 40mA can cause ventricular fibrillation – irreversible damage to the normal cardiac cycle; or, death by electrocution;
- 230mA is the typical electric current that flows through the body when a person makes direct contact between mains voltage and earth.

There are many factors, of course, which determine the nature of the electric shock, such as the age and gender of the person, which parts of the body make electrical contact, the presence or absence of moisture or any water-immersion and the presence of resistive materials in the circuit such as clothing and footwear[1].

Appreciating the safety concerns

Members of the Institute should find themselves better placed than many people to be able to grasp the technical aspects and appreciate the safety concerns. Therefore, any efforts that the Institute can initiate for the greater public good would seem to be a very worthy endeavour to undertake.



[1]Source: BEAMA's The RCD Handbook. BEAMA being the UK trade association for manufacturers and providers of energy infrastructure technologies and systems.

Read Part 2 in Issue 16 which will focus on technical aspects of Electric Vehicle charging at home.

SPOTLIGHT ON STAFF:

Q&A with InstMC Staff Member Jane Seery, Marketing & Events Officer

How long have you been with InstMC?
Just over six months. I joined in August 2019 so still a relative newbie.

What is your background?
I studied Art & Design at University then went on to have a 20-year career as a Production Manager in film, television and radio, working for the BBC, Channel 5 and freelance for several independent production companies. In 2009 I had a career break, changed direction and over the following six years set up a technology company, a food business and began freelance writing. Before joining the Institute, I was the Marketing & Communications Manager for a pharmaceutical and clinical data science membership organisation.

What is your role at InstMC?
Overseeing all marketing activity on behalf of the Institute. This includes updating all social media channels, writing and gathering content for Precision magazine and The Wire newsletter, preparing and sending out communications, setting up and attending events and generally trying to come up with bright ideas!

Can you describe a typical day in the office?
I don't think there is a typical day as my role is so varied. I arrive in the office at about 9am and, like most people, open and deal with emails first. As a meticulous list-maker, I will start by jotting down my tasks for the day then probably grab a coffee while checking social media for any interesting stories.

What do you bring to the team?
Apart from laughter and joy? Good organisational skills, attention to detail and ideas.

What do you like best about working for the InstMC?
The challenge and variety. With many membership organisations facing the prospect of declining numbers, the challenge is to adapt and evolve. As we become accustomed to living in an increasingly digital world, it's important to make changes without losing sight of the human interaction element. The InstMC has a history to be proud of and as a learned society, plenty to offer in terms of experience, development and knowledge. As a non-engineer I am enjoying learning more on the subject every day!

What do you do to unwind, once your working day is over?
Photography, music and cinema. As well as taking pictures, I really enjoy the editing process so spend a fair amount of time tinkering with images in post-production. I always travel with two i-Pods so am never far away from music, and regularly go to live gigs. I'm a big film buff and have been a member of BAFTA for over 20 years. I'm on the voting juries for Film, Television and Craft and as the awards season has just finished, have spent the last few months watching a LOT of films!

Can you tell us a fun fact about yourself?
I am a registered Super-Recogniser which essentially means I have a photographic memory for faces. I regularly take part in research and trials for the University of Greenwich in London, who use the information to assist police, governments and intelligence services in identifying people.

OUR CORE TEAM

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1st "EMPRESS 2" Workshop

Enhanced temperature measurement techniques for improved process control 2

Tuesday 5 May 2020

Advanced Forming Research Centre (AFRC), UK
Organised by AFRC and NPL

EMPRESS 2 is a European project with the goal of enhancing process efficiency through improved temperature measurement. This workshop is an excellent opportunity to bring together scientists and engineers from academia, research institutes and industrial establishments to present and discuss both:

- The latest developments in traceable temperature measurement for process control
- End-users' requirements and challenges

WORKSHOP THEMES

Technologies
- Thermocouples
- Phosphor thermometry
- Surface temperature probes
- Combustion and flame thermometry
- Fibre-optic thermometry

Application areas
- Heat treatment
- Casting
- Forming
- Welding
- Forging
- Gas turbines
- Internal combustion engines

WORKSHOP HIGHLIGHTS

- Invited speakers will present reviews of the latest developments and state of the art
- Opportunities to contribute with oral presentations on process control challenges as well as technical solutions
- Networking opportunities

LOCATION AND VENUE

The workshop will be held at
Advanced Forming Research Centre (AFRC)
85 Inchinnan Dr
Inchinnan
Renfrew PA4 9LJ

Details at: **www.npl.co.uk/events** • Contact: **jonathan.pearce@npl.co.uk**

FS Engineer & Technician (TÜV Rheinland) Certificate Training 2020

FS Engineer SIS:

Aberdeen: **2-5 March**
1-4 June
7-10 September
Weekends: 7-8 + 14-15 November *(run over two weekends)*
7-10 December

Manchester: **15-18 September**

Paris: **8-11 June**
16-19 November

FS Engineer PH&RA:

Aberdeen: **18-22 May**
30 November-4 December

Manchester: **5-9 October**

FS Technician:

Aberdeen: **23-26 March**
5-8 October

Introduction to Functional Safety:

(The ideal 1 day workshop for any staff/managers or to prepare for the FS Engineer course)

Aberdeen: **27 March & 9 October**

C & C Technical Support Services is an accepted course provider of the TÜV Rheinland Functional Safety Training Program.

We also run in-house training on request.
Please contact us for more details or to register:

Email: *info@silsupport.com*
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View our full Global schedule at:
www.silsupport.com