THE MAGAZINE OF THE INSTITUTE OF MEASUREMENT AND CONTROL

INSTMC.ORG

InstMC

OPTIMISING WORK INSTRUCTIONS AND TRAINING WITH AUGMENTED REALITY FOR HIGHLY RESILIENT AND EFFICIENT MANUFACTURING

NETZERO ENGINEERING FOR UK WIND TURBINES: FOCUS ON PREDICTIVE MAINTENANCE

NEW DEVELOPMENTS IN FLAME AND COMBUSTION THERMOMETRY

SKILLS FOR THE FUTURE OF METROLOGY

CYBERKNIFE: PRECISION RADIOTHERAPY TREATMENT

MARCH 2022 ISSUE 23

PRECISION

InstMC Membership

WHAT DO I GET?

- Career and Professional Development guidance and support including mentoring, accreditation of employers training and development programmes
- Free copy of our quarterly PRECISION magazine and The Wire monthly digital newsletter plus access to the members only section of our website and technical online library
- Opportunities to participate in the proceedings of an influential Institution through mentoring, accreditation, technical panels, seminars and conferences
- Recognition of your professional status through use of post-nominal letters, MInstMC (Corporate Member) and FInstMC (Fellow)
- Participation in a Local Section and Special Interest Groups to network, attend events and share expertise and knowledge
- Opportunity for qualified employees to apply for specialist engineer status; Registered Functional Safety Engineer (RFSE) and Registered Explosive Atmospheres Engineer (RExE)

Internationally recognised professional qualifications including:

CEng – Chartered Engineer – **CHARTERED ENGINEER**

IEng – Incorporated Engineer – **INCORPORATED ENGINEER**

EngTech – Engineering Technician – **ENGINEERING TECHNICIAN**

Scan QR Code to apply for membership

or visit:
https://www.instmc.org/Membership-Registration/Individual-Membership

For further details and application forms, please visit our website or contact the Director of Membership & Registration on +44 (0) 20 73878 4949 Ext 3 or email: membership@instmc.org

www.instmc.org

InstMC

VOLUNTEER WITH INSTMC AND HELP SET THE STANDARD

BY IAN CALLENDER, CENG MINSTMC, NRG ENGINEERING

I've been a member of the InstMC for a long time; however, to me it was an annual subscription, the quarterly Precision magazines and the more regular emailed Wire newsletter.

In the last few years, I've become actively involved; I'm no longer a passive member and things have changed – this short article is about the benefits so hopefully you'll read on.

InstMC Special Interest Groups

The InstMC has championed Special Interest Groups (SIG's) covering the following topics: Cyber Security, Digital Transformation, Explosive Atmospheres, Flow Measurement, Functional Safety, Measurement and Standards. I put my name forward to join a few of these, as I wanted to be kept up to date with the relevant subject areas beneficial to my consultancy business. Initially I wasn't planning to take on an active role however, that has changed.

Standards Special Interest Group

Without the various Special Interest Groups (or more to the point 'active' SIG members) there would be no InstMC reviews, no discussions and/or no further works on many subjects, all of which impact our working lives, people's safety, protection of the environment and indeed the updating of our knowledge and the ability to work in a changing world.

In 2020, the BSI national committee for Measurement and Control identified the need to bring BS:6739 up to date as it concluded much had changed (it being the engineering 'bible' for those designing, installing and commissioning process control systems).

I was approached by the Standards SIG to chair its rewriting; what could I say, this was the end of my passive world of InstMC and the BSI.

Standards

Would it come as a surprise if I told you, it's volunteer engineers like you and I that nominally write British and International standards - it was for me!

In the rewriting of BS:6739, I work with a group of amazing engineers, who have made time available in the pursuit of making something valuable for others.

Active Membership

Personally, the difference, since I've been an active member of both the InstMC and the BSI, is so much more rewarding; I can't say it isn't without a challenge, but I guess there's no gain without pain.

I have met some amazing people; I have learnt new skills and I'm doing something worthwhile. Due to COVID, I'm still to personally meet these amazing people. I have been positively challenged, I've updated my technical knowledge and I've learnt so much more about industries I've never been involved with.

Without the dedication and contributions of amazing volunteer engineers, the quality and content of InstMC presentations, publications and documents would not be available for all.

Can you help?

Why not consider volunteering yourself? Perhaps sharing something you have worked on in an InstMC publication, your experience and/or knowledge as part of a SIG or even the BSI; or you could arrange a visit or presentation somewhere that a Local Section group might like to go (i.e., your workplace)? Get in touch with the Institute on marketing@instmc.org to participate. Alternatively, if you have the relevant knowledge, we are actively seeking assistance in rewriting the BS:6739 standard so please drop me an email at ian.callender@nrg.engineering if you would like to get involved.

I would suggest that you will enjoy an active role, much more than a passive one and you can take advantage of the knowledge you will gain - win-win!

CONTENTS

ARTICLES

FOCUS ON A SIG: EXPLOSIVE ATMOSPHERES

The Institute's Special Interest Group dedicated to Explosive Atmospheres (Ex-SIG) continues to promote good practice in matters of explosion hazards, IEC 60079 and related standards.

17

LOCAL SECTION NEWS

A round-up of the latest news and activities from our UK Local Sections.

22-25

SKILLS FOR THE FUTURE OF METROLOGY

18-19

The CIM International Metrology Conference, 7th – 9th September in Lyon, France played host to a roundtable discussion about the skills that will be needed for the future of metrology.

COMPANION COMPANY SCHEME (CCS) SHOWCASE

26-27

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.

ACCREDITATION CORNER ASK TREVOR

28-29

Trevor considers the potential issues encountered when applying management system standards such as ISO 17025:2017 to testing and calibration work in universities and technical colleges.

CYBERKNIFE: PRECISION RADIOTHERAPY TREATMENT

This article will cover the main engineering design features of today's ultimate robotic system for precision Stereotactic radiotherapy delivery to cancer patients as used by the Royal Marsden NHS Foundation Trust in the London area since 2011.

20-21

PRECISION

The magazine of the Institute of Measurement and Control
Published by: Institute of Measurement and Control
297 Euston Road, London NW1 3AD T: +44 (0) 20 7387 4949
www.instmc.org
www.twitter.com/instmc
www.linkedin.com/company/institute-of-measurement-and-control-the-

Chief Executive Steff Smith
E: steff.smith@instmc.org

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

Cover price, where sold, £15

OPTIMISING WORK INSTRUCTIONS AND TRAINING WITH AUGMENTED REALITY FOR HIGHLY RESILIENT AND EFFICIENT MANUFACTURING

BY DR LORENA MOREIRA, RESEARCH FELLOW, INSTITUTE FOR ADVANCED MANUFACTURING & ENGINEERING (AME) & DR MARCOS KAUFFMAN, DIRECTOR, AME

Manufacturing companies are constantly confronting the challenges of competitive markets and lack of know-how of application of technology innovations within their manufacturing environments.

The current global scenario, represented by fast changes in customer requirements, ultimately impacting on products' complexity and shorter time to market requires that manufacturing companies become more resilient (i.e., productive, flexible, agile, responsive, integrated and interoperable) to remain competitive.

Improving manufacturing resilience is more challenging in the presence of manual operations due to the limitations in human adaptation and learning. How best to adapt manual operations poses unique challenges for manufacturers that seek effective workforce (re)training and undertaking right-first-time solutions.

Given the above scenario, we hereby present a real challenge faced by an automotive manufacturing supplier, and a case study demonstrating step-by-step how we addressed it by deploying Industry 4.0 (I4.0) technologies, augmented reality and machine vision to develop real-time work instructions.

Case Study: Digitalisation of manual assembly of battery modules for electric vehicles

An automotive manufacturing supplier working on a new battery module for electric vehicles (EVs) was highly concerned with the health and safety (H&S), quality and efficiency of the training and operations. The principal challenges faced by the engineers were the high costs of poor quality and the high H&S risks due to the hazardous voltage during the assembly process. There was no business case for an automated solution given the low volume and high product variants, resulting in the choice for a manual assembly operation. The manual operations raised additional challenges given the human operators, which could increase the process vulnerability to errors, leading to possible delays, defects, poor product quality, and accidents in the workplace.

Given the scenario, the manufacturer was faced with two main challenges:

- How to improve the efficiency and H&S of the training practices of the battery modules assembly; and
- How to optimise the work instructions to ensure the worker is assisted in a safe and timely manner and reduced process vulnerability to human errors.

To address the challenges, we investigated how core I4.0 emerging technologies would support optimising the training and operating capabilities of manual assembly operations. By optimising, we have considered improving training effectiveness (i.e., knowledge retention) and enhancing

the accuracy of task execution or reducing human error.

Technology selection

After screening several technologies, a projection-based augmented reality (AR) system, coupled with machine vision and a manufacturing operations management (MOM) software was selected to address the challenge. Such a system brings key features and capabilities to provide real-time and interactive work instructions, in addition to object and action recognition, which were appealing to tackle the challenges of efficiency and H&S in the manual assembly of EV's battery modules.

How the technology works

The projection-based AR system simply works based on a set of process steps designed within the MOM software (a digital twin of work instructions). For that, the object recognition feature of the machine vision system, based on RGB, infrared and depth cameras, is used to teach the system all the components and outcomes of the process steps, and the projection-based AR feature is trained to provide light-guided assistance such as picking/placing by light and further information such as written or visual instructions (e.g., text, image or video). Once the process is initialised, in training or operation mode, augmented work instructions are given for each process step, where the machine vision supervises the operator's actions in real-time and the MOM uses those inputs to trigger the next action autonomously. The system recognises when a mistake is made by the operator and action can be defined accordingly, i.e., stop the process until it's done correctly or call for help.

Proposed solution

The proposed solution deployed the projection-based AR system to develop the real-time work instructions method, the so-called AR-enhanced assembly. The development of the AR-enhanced assembly method comprised of the following steps (also illustrated in Figure 1):

1. Define the standard operating procedure (SOP) for the EV's battery module assembly which comprised 10 process steps;
2. Develop the digital twin of the SOP in the MOM software, which required the process steps, the CAD or JPG parts for visualisation, the requirements and tolerances, and the actions/instructions of each step;
3. Use the physical components to train the object recognition using the machine vision system, for real-time verification and validation; and define the light-guide assistance specifications using the projection-based AR for each process step, including features such as pick/place-by-light, written and visual instructions.
4. Test the system for both training (which will include more details and collate feedback from the operator) and operating mode; set additional features for the critical to safety and critical to quality process steps such as poka-yoke, extra safety and quality verification and validation, and define the (re) actions in case a mistake is made by the operator, e.g., stop the process or call for help.

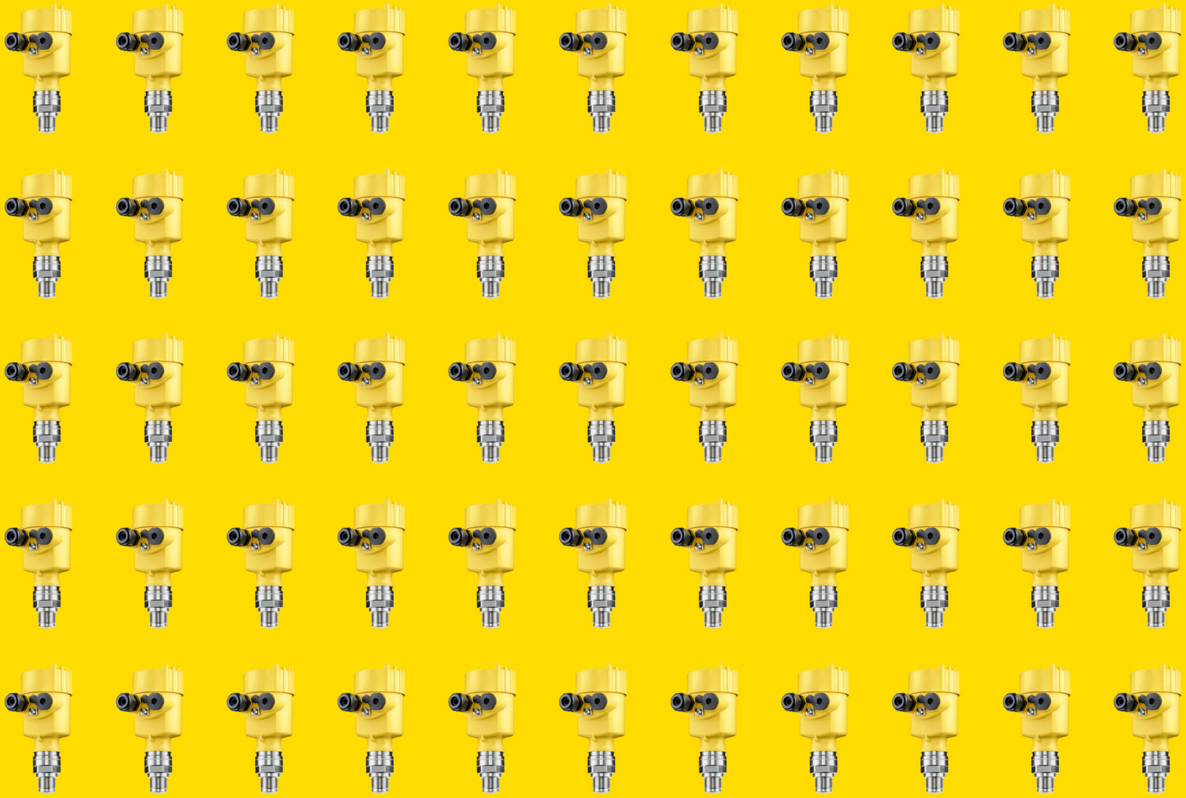


Figure 1.

Figure 1. High-level steps to develop the AR-enhanced assembly method for battery modules.

The AR-enhanced assembly method was tested and compared with a paper-based method for validation. Two criteria were considered for assessing the methods: i) training effectiveness, determined by the knowledge retained by the operators; and, ii) H&S, determined by the number of errors made by the operator when performing the assembly process (or accuracy of the tasks executed). The test included two groups of 30 people each, and each group used one method (paper-based and AR-enhanced) to perform the EV's battery module operation. The results of the tests showed that the operators who performed the process assisted by the AR-enhanced assembly retained more knowledge about the process and performed the process with 2x more accuracy when asked to reproduce the process steps.

CONCLUSIONS

The results of this project showed that augmented reality systems have great potential to support companies in becoming more resilient through improved training and operating practices. The proposed AR-enhanced assembly method improved the training outputs of EV's battery modules assembly by doubling the knowledge retention levels and increasing the accuracy of task execution by more than three times. By doing so, the investigated core I4.0 technology can help optimise work instructions of manual operations by minimising human errors, maximising quality, productivity and operators' H&S.

The proposed solution also demonstrated great capabilities to improve process traceability and connectivity. Such aspects will be considered in future research. We can conclude that given the current challenges faced by manufacturers, such emerging technologies bring great capabilities to overcome the challenges of human factors, and businesses can therefore become more resilient to both internal and external changes, yet saving jobs.

For information:

Institute for Advanced Manufacturing and Engineering, Coventry University

Dr Lorena Moreira, Research Fellow, Lorena.CairesMoreira@coventry.ac.uk +44(0)7599 861011 /

Dr Marcos Kauffman, Director, Marcos.Kauffman2@coventry.ac.uk

Prof. Trevor Toman, Coventry University, t.toman@coventry.ac.uk

REFERENCES

[1] Schmitz, C., Tschiesner, A., Jansen, C., Hallerstede, S. and Garms, F., 2019. Industry 4.0: Capturing value at scale in discrete manufacturing. In Technical report. McKinsey & Company.

[2] Hankel, M. and Rexroth, B., 2015. The reference architectural model industrie 4.0 (rami 4.0). ZVEI, 2(2), pp.4-9.

[3] (Online) RS Components: available at https://uk.rs-online.com/web/generalDisplay.html?id=footer1/release/210308_resilienceindex_uk Accessed in April 2021.

[4] Ganji, E.N., Shah, S. and Coutroubis, A., 2018, June. Mass Customization and Technology Functions: Enhancing Market Responsiveness. In 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC) (pp. 1-6). IEEE.

BY PETER NORMAN, IENG, MINSTMC, MIET

NETZERO ENGINEERING FOR UK WIND TURBINES: FOCUS ON PREDICTIVE MAINTENANCE

A range of extreme weather events such as stormy weather, rough seas, and lightning strikes can have serious consequences for a wind turbine.

Precision sensors are already being used in the production of wind turbines for the essential role of proactive condition monitoring of machinery assets before catastrophic damage occurs.

With large wind turbines now having rotor diameters ranging between 110m and 220m, plus rotor hubs elevated to heights in excess of 100m, maintenance access is never easy and 24/7 monitoring is required for 365 days per year in order to start remedial actions and plan maintenance activities. A number of possible problems can occur in the generator and drive mechanisms such as: gear faults, gear wheel wear, drive shaft issues, bearing clearances, lubrication faults, material fatigue, imbalance and temperature differences.

Predictive maintenance to prevent sudden plant downtime or failure can be minimised by analysing and evaluating trends and changes in real-time measurement data.

There are many different types of electronic sensors used in wind turbines. The key functions and types of miniature, precision sensors used to detect and monitor important parameters for signal transmission and data logging are described below.

Wind Sensors

Essentially, of course, wind sensors are mounted on the top of the nacelle and are either mechanical or ultrasonic anemometers. Ultrasonic anemometers measure wind speed by measuring the transit time between transmitted and received very low frequency sound waves. They are increasingly used on wind turbines because they do not need manual recalibration.

Offset Measurement of the Drive's Coupling Ring

Above 100m in rotor tower heights the rotor blades, their housing, and the tower itself experience high wind loads. The gearbox and generator therefore have an elastic bearing which is why couplings within wind turbines must balance the relative movement of gearbox and power generator.

Non-contact inductive sensors can induce eddy currents to monitor the offset of the metallic coupling ring which can lead to determination of the load profile. These tri-axial sensors permit multi-directional measurements in the axial, radial, and tangential movements. They also provide a greater bandwidth than other inductive switches and sensors which makes them suitable for precise detection of high-speed movements.

Elimination of any need for field calibration of these sensors is managed by factory calibrations for ferromagnetic and non-ferromagnetic materials.

Some sensor manufacturers can offer temperature-compensated versions for high measurement stability in strongly fluctuating ambient temperature conditions.

Oscillation Measurement of the Drive Chain

Acceleration sensors can be used for accurate measurement of oscillations occurring in the rotor bearing; the rolling bearings and gear wheels in the gearbox; and, the power generator unit.

Monitoring Supporting Moments of the Nacelle

Inductive sensors are able to use eddy current displacements to measure the distance between the nacelle of the wind turbine and the supporting tower for early warning of oscillations occurring. This enables the unit to be switched off in time when the wind load becomes too high for safe operation.

Gap Measurements in Bearings

Wind turbines use hydrostatic bearings which require the gap size between the bearing surface and the drive shaft to be monitored. Direct contact between the shaft and bearing surface is prevented by an oil film within the lubrication gap. Inductive sensors are also useful here with an integral controller mounted horizontally to the bearing shoe to measure through the oil film using eddy current displacement directly onto the shaft. Such sensors offer excellent resistance to high pressures, lubricants, and extreme temperatures.

Generator Air Gap Monitoring

It is important to determine the radial run-out of the rotor compared to the stator within very large generators or motors. Operational imbalances can occur due to extreme wind and weather conditions causing wear. The rotor might then touch the stator which could lead to catastrophic failure. Non-contact optical and capacitive sensors are therefore used to monitor the rotor gap by measuring their respective distances. The average temperature experienced during air gap monitoring in a wind turbine generator is 120˚C. Some available capacitive sensors are specially adapted for such measurements to enable flush installation into electrically conductive materials and are also vibration resistant and protected by a special housing.

Gearbox Temperature Measurement

Gearbox components heating up due to friction during operation can indicate a potential component problem. Compact thermal-imaging cameras suitable for high speed and high accuracy measurement can be usefully deployed here. Platinum temperature sensors that combine a group of Resistance Temperature Detectors (RTD) use thin-film technology platinum resistors as the sensing element to measure an extreme environment range from -200˚C to +600˚C.

Air Flaps Position Monitoring

Air flaps in the form of louvres are automatically opened and closed to control the flow of cooling air as the external medium for temperature control of the machinery. Draw-wire displacement sensors act as a simple and robust method for distance monitoring of the opening position status of the flaps. Measurements of linear movements are made by a highly flexible steel wire held in tension but coiled on a small cable drum. This rotating drum is attached to a sensor element which provides an output signal that is proportional to the displacement of the draw-wire.

Monitoring the Tower and its foundations

Inclination and acceleration sensors can be deployed for accurate and reliable detection of loads and detect any tower sway oscillations.

Laser triangulation sensors can be used to measure the position and distances between the top of the tower relative to the foundations. Depending on the number of laser sensors installed around the tower periphery, detailed evaluations of vibration behaviour are possible. When the tower movement is too great the rotor blades are removed from the wind force so as to prevent possible asset damage.

Oscillation Monitoring for environmental noise reduction

Although not strictly an essential maintenance issue, another use for acceleration sensors is the measurement of oscillations causing noise to evaluate the effectiveness of noise reduction measures in populated neighbourhoods. Wind turbine drive chains are a source of noise due to the gears and the power generator.

Q&A

Dave Green

In the hot seat this issue is **Dave Green**, Principal Consultant at RPS Consulting UK & Ireland and InstMC Central Northwest Local Section Chair.

What was the root of your interest in Engineering?

My interest in engineering began in high school, where I particularly enjoyed technical drawing and the way that the correct dimensioning and specification was important. The GCSE course (Graphic Communication) took that further in converting the drawings into real engineered items. The teachers really encouraged me into the engineering arena.

Having reviewed my options for a career I decided that I wanted to become a pilot, one of the routes to this career was to pursue engineering and then divert into flying later. This was the plan: get an engineering degree first and then aim to fly. So, you could say that I fell into it accidentally, unlike many of my peers none of my family had a background in engineering.

I decided on the route to the degree was to study through an apprenticeship. I began my modern apprenticeship employed by ICI Chemicals & Polymers at Technical Training Enterprises Limited (TTE) at Ellesmere Port. This was where I discovered Instrumentation and Electrical Engineering.

The pilot plan failed when I developed Type 1 Diabetes at the age of 20 whilst I was studying for my bachelor's degree in Mechatronics at Manchester Metropolitan University.

So I ditched the flying plan and continued in the career of Electrical / Instrumentation Engineering on an upper tier petrochemical facility for ICI (which became INEOS Chlor in 2001).

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

In the next 10 years, Britain should be looking to improve innovation in all aspects of engineering. The improving of innovation and efficiency will allow sustainable developments of technologies and processes to maintain the advanced living standards that are afforded by many.

Globally, the energy demand is going to grow massively in the next decade with the adoption of electric vehicles and home heat pumps (all whilst reducing the reliance on fossil fuels).

The challenge is how this can be done sustainably, moving fossil fuels from vehicles to power generation doesn't satisfy the agenda. The adoption of renewal / sustainable solutions, in addition to reducing emissions by industry and within our communities, is the key to becoming more sustainable. The hope is that the scheme works, reduces global warming and improves air quality.

I welcome the UK government's moves to electrification and hydrogen. The very decisive arguments between the two camps that each one is the sole answer is bonkers, both are needed in order that the end goal can be completed.

"I welcome the UK government's moves to electrification and hydrogen. The very decisive arguments between the two camps that each one is the sole answer is bonkers, both are needed in order that the end goal can be completed."

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

The government should be encouraging engineering subjects, in the school curriculum, and supporting the staff to share opportunities with children of all abilities. Having a daughter who has just been through high school it was disheartening that there were very few teachers of the type that I had in my school days, encouraging me into engineering.

What do you do in your free time to relax?

Free time! Now that is an interesting concept. I'll detail my non-working time instead. The time is spent on many things, currently I am the Local Section Chair of Central Northwest, so with vacancies in the team quite a bit of time goes here.

I like to contribute to the wider engineering community and aim to produce at least one technical article per year, in various publications including Precision (of course), Process Industry Informer, Control Engineering Europe and Industrial Electrix (Australia) to name a few.

These articles are in addition to supporting technical networks and committees. I sit on the FS SIG, Standards SIG, InstMC Council (currently due to Chair position), Professional Registration Committee, BSi committee MCE/3 and IEC committee TC44 WG15.

I have been trying to improve my personal health for the last few years, and try and get to the gym two to three times per week (this was massively affected with COVID restrictions / infection rates and Diabetes).

I do also spend time with my family (the article writing etc are done while the soaps are on). My daughter has just turned 18 and she has started learning to drive during the pandemic. So we get time together when we are out (with my daughter driving), although I do get abuse from her for telling her where to drive and making her practice manoeuvres. It's all good fun and an investment for the future when I need a lift!

Oh and I can't forget my four-legged friend who we walk every day. It's amazing how many calls you can take whilst on a walk!

Given one wish what would that be?

My first wish is for improved access to technology for those with Diabetes. I watch with interest the advances in technology deployment and treatment advances. I recently attended a Diabetes UK technology conference. The use of measurement and control techniques in the progression of treatments is fantastic. I am lucky that I have access to an insulin pump and continuous glucose monitoring (partly self-funded). My wish is that this technology develops further and that it is not restricted to people based on their postcode or other factors.

My second wish is that the lessons from incidents that occur in industry are learnt by all. Working in the area of risk management it is never rocket science when someone is having risk management issues. The majority have been seen before or the existing techniques can be applied. By applying these techniques the potential harm to people and the environment can be massively reduced.

NEW DEVELOPMENTS IN FLAME AND COMBUSTION THERMOMETRY

BY ALEXANDER FATEEV, DANMARKS TEKNISKE UNIVERSITET, GAVIN SUTTON AND JONATHAN PEARCE, NATIONAL PHYSICAL LABORATORY, JUAN MELENDEZ AND GUILLERMO GUARNIZO, UNIVERSIDAD CARLOS III DE MADRID, HENRIK HOFGREN, BABCOCK & WILCOX VØLUND AND FRANCISCO CORTÉS, SENSIA SOLUTIONS

Accurate measurement of flame temperature and gas combustion can lead to increased combustion efficiency, reduced fuel consumption and minimisation of harmful emissions.

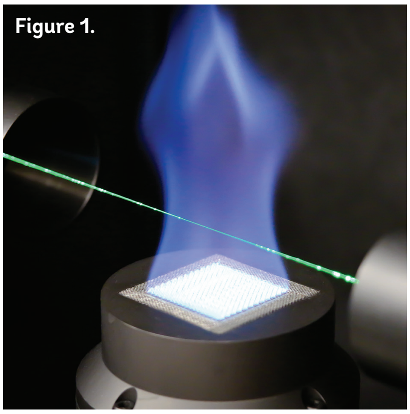
However, current thermometry techniques are generally complicated, comprising of active probing using laser-based techniques and passive techniques such as gas emission spectroscopy. Due to the complexity of these diagnostic methods and the harsh environments found in combustion, uncertainties are difficult to assess and traceability of combustion thermometry to the International Temperature Scale of 1990 (the practical approximation to the SI unit of temperature, the kelvin) is non-existent.

In this article we explore new flame and combustion thermometry developments as part of the European Metrology Programme for Innovation and Research (EMPIR)[1] project 'Enhanced process efficiency through improved temperature measurement – EMPRESS 2'. In this project, the partners have brought together their resources to improve in-process temperature measurement.

Portable standard flame

To help facilitate more reproducible flame and combustion thermometry, NPL developed a portable 'standard flame' which comprises a Hencken flat-flame diffusion burner with associated gas flow and mixing control. This provides a very well characterised and highly stable gas temperature profile and gas composition. The pre-mixing of gases and the burner geometry maximises the temperature and spatial uniformity of the flame, and also its reproducibility when disassembled and moved elsewhere, for example to an end-user's process facility to provide an in situ calibration.

In order to assign a temperature to the portable standard flame[2] it has been characterised at NPL using Rayleigh scattering thermometry, which analyses the Rayleigh scattering (i.e. the elastic scattering of light from the gas molecules which is a characteristic function of temperature) of laser light passing through the hot gas (Fig 1).



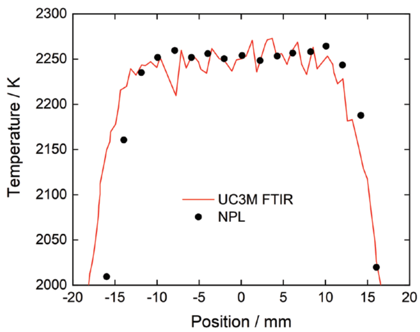


***Fig 1:** NPL portable standard flame. Right: Representative temperature profile along the middle line of the flame at a height 20 mm above the burner, as measured with Rayleigh scattering thermometry at NPL and hyperspectral thermometry at UC3M.*

Low-cost multispectral flame imager

Hot CO_2 and H_2O are the major combustion products and give rise to strong thermal emission in the mid-infrared (1.5 μm to 5 μm) spectral range. The spectral distribution of the CO_2 and H_2O emission depends on the molecules' temperature and the gas density. By measuring the emission spectra over selected CO_2 and H_2O bands in the mid-infrared with a Fourier-transform Infrared (FTIR) spectrometer, and by comparing this with the known temperature-dependent emission spectra for each species determined a priori, the temperature and the density of gas in the optical path can be deduced. Using a FTIR spectrometer equipped with an InSb array detector, 2D maps of species and temperature can be produced.

[1]The EMPIR is jointly funded by the EMPIR participating countries within EURAMET and the European Union.

[2]G. Sutton et al., Validation of Emission Spectroscopy Gas Temperature Measurements Using a Standard Flame Traceable to the International Temperature Scale of 1990 (ITS-90), International Journal of Thermophysics Vol. 40, No. 99 (2019)

This ‘hyperspectral’ thermometry method has already been validated with the NPL portable standard flame, and it yielded temperature measurements in agreement with those obtained by Rayleigh scattering within about 1 % (see Fig 1).

These measurements require use of an expensive hyperspectral imager and are time-consuming, so UC3M and DTU have pioneered a simplified technique that dispenses with the need to resolve individual spectral lines, relying instead on an iterative approach whereby low resolution spectra are measured over a set of relatively wide wavelength bands, which are selected using a set of six different filters. This is referred to as ‘multispectral’ thermometry. The measurement is then compared with simulated spectra generated using the HITEMP2010[3] database which contains necessary spectroscopic information for spectra simulations. By iteration, the simulated spectrum is parameterised until it agrees with the measured spectrum, and in this way the temperature and CO_2 and/or H_2O density can be deduced.

The practical consequence of this is that instead of measuring the spectral radiance of the gas with a large and costly high resolution spectrometer, an inexpensive low resolution device can be used with a set of filters to select different wavelength bands in turn. This low-cost method has been validated against the high resolution FTIR measurements, again by using the NPL portable standard flame as a reference. A map of the temperature profile of the flame obtained with the two methods is shown in Fig 2.

Fig 2: *Temperature of the standard flame (average over the optical path being viewed) obtained using the low-cost multispectral imaging (left) and the (ten times more expensive) high resolution hyperspectral imaging (right), showing agreement within about 4.5 %.*

Currently the low-cost multispectral thermometer reads on average about 100°C higher than the hyperspectral imager, which sounds a lot, but in fact is only about 4.5 % at 2,500°C, rendering it very competitive with existing flame thermometry techniques.

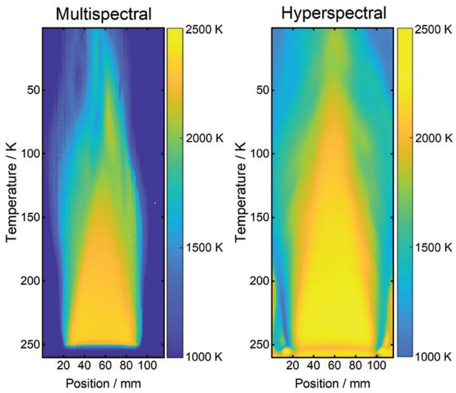


Figure 2.

Reducing harmful emissions during waste incineration

NH3/urea solutions added to combustion gases at an optimum temperature can significantly reduce harmful NOx emissions using a selective non-catalytic reduction process. However, this is most effective only in a narrow temperature range. One application of this is in waste incineration, and a multi-line-of-sight measurement system based on a fast scanning low resolution FTIR spectrometer, calibrated against the NPL portable standard flame (Fig 3), was demonstrated by DTU, in collaboration with Øresundskraft (a Swedish energy supplier) and Babcock & Wilcox Vølund, at the Filbornaverket waste incinerator plant in Sweden. The challenge was to improve the thermometry – in process – to facilitate better temperature control in order to minimise NOx emissions from the incineration process.

The system was installed at an access port in the boiler house (Fig 3). The measurements were performed at various lines-of-sight and were supported with a conventional suction pyrometer (a probe containing a shielded thermocouple with an arrangement to suck through the hot gas at high speed) to make measurements from an access port facing the FTIR system. The gas temperature profile up to the middle of the boiler was measured and temperature variations up to ±60 °C were found at 1000 °C, with both systems in good agreement.

Suction pyrometer measurements are time consuming and assume a direct contact of the thermocouple with the hot reactive gas and therefore require frequent thermocouple replacement and calibration. In contrast, use of the FTIR-based system which is not in physical contact with the media has great potential and will be of interest to the plant operators.

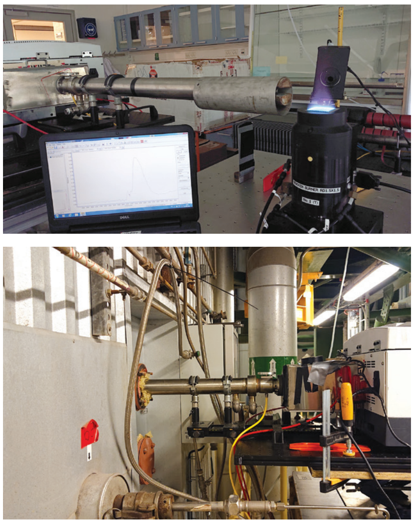


Figure 3: *Fast FTIR-based system being calibrated against the NPL portable standard flame (top) and installed at the access port at Filbornaverket (bottom).*

This work is ongoing, and the authors are keen to discuss exploitation opportunities for these techniques. For further details contact gavin.sutton@npl.co.uk, alfa@kt.dtu.dk or melendez@fis.uc3m.es.

[3] L. S. Rothman et al., “HITEMP, the high-temperature molecular spectroscopic database”, J. Quant. Spectrosc. Radiat. Transfer 111, 2139-2150 (2010). See also https://hitran.org/hitemp/

INSTMC SPECIAL INTEREST GROUPS

InstMC SIGs provide an opportunity for like-minded engineers to network, share ideas and expertise, collaborate and learn, and keep updated on industry news and developments.

We currently have 7 Special Interest Groups covering the following technical topics within the measurement and control fields: **Cyber Security, Digital Transformation, Explosive Atmospheres, Flow Measurement, Functional Safety, Measurement** and **Standards.** Driven by groups of volunteers who work, or have expertise, within the relevant topic area, SIGs promote the sharing and advancement of knowledge through a range of activities. These include producing white papers and briefing notes, as well as hosting and attending conferences, seminars and exhibitions.

How to join

Members can join any SIG through the members only area of the InstMC website. Click 'MyInstMC' on the homepage and login to your account. Select 'Manage Personal Details' and under Special Interest Groups, click the 'Edit Special Interest Groups' button. Click 'Join' for any SIG you wish to become a member of.

If you are interested in finding out more about a particular Special Interest Group visit https://www.instmc.org/Special-Interest-Groups or email the relevant contact below.

Cyber Security Cevn Vibert
cevn@vibertsolutions.com

Digital Transformation
Maurice Wilkins
Maurice.Wilkins@instmc.org

Explosive Atmospheres
Harvey Dearden
Harvey.Dearden@instmc.org

Flow Measurement
Katrina Davidson
FlowMeasurementSIG@instmc.org

Functional Safety
Harvey Dearden
Harvey.Dearden@instmc.org

Measurement Jeremy Stern
measurementsig@instmc.org

Standards Maurice Wilkins
Maurice.Wilkins@instmc.org

FOCUS ON A SIG: EXPLOSIVE ATMOSPHERES

The Institute's Special Interest Group dedicated to Explosive Atmospheres (Ex-SIG) continues to promote good practice in matters of explosion hazards, IEC 60079 and related standards.

As with our sister Functional Safety SIG, one area in which the group can contribute is in nailing the myths that appear to proliferate. For example, there is a notion that painting of the flanges of Ex 'd' enclosures is unacceptable – NOT TRUE! – it is often claimed that this is because of the need to maintain a gap, but the actual requirement is to make sure any gap does not exceed permitted dimensions. There is no requirement for a gap. (The subject of a previous SIG briefing note.)

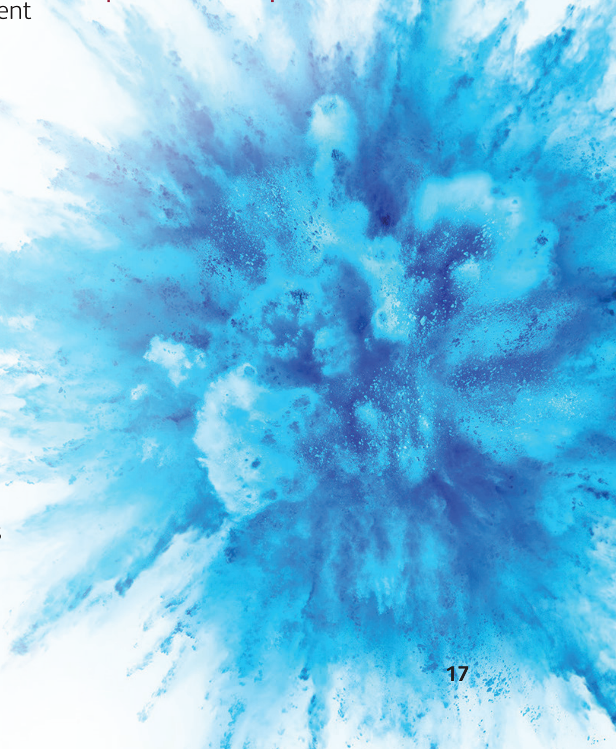
The SIG produces occasional 'Briefing Notes' to explain key issues and these are first distributed to the SIG membership before they are offered for wider publication. Recent notes have addressed inspection sample nomination, and junction box certification. A forthcoming one will consider equipment electrical bonding practices.

The SIG also administers the Registered Explosive Atmospheres Engineer (RExE) qualification on behalf of the Institute. If you are actively engaged in Ex matters at a professional level, this qualification may be of interest. The qualification is based on a peer review of the candidate's wider professional engagement with the Ex-discipline, and considers experience, qualifications and Continuing Professional Development (CPD) activity. The assessment process is modelled on that for registration with the Engineering Council UK (as IEng or CEng). Such registration is a prerequisite and provides demonstration of general professional competence, underpinning knowledge and understanding (UK&U) and a commitment to CPD. These we consider essential to the development and maintenance of professional competence in Ex matters.

We are often asked about how this qualification stands in relation to others in the field. A key point is that it requires a demonstration of competence and commitment at the professional level over an extended period – short course attendance will not satisfy the requirements. The qualification is intended to help practitioners substantiate claims of competency.

Members may join the SIG through the InstMC website https://www.instmc.org/Special-Interest-Groups/Explosive-Atmosphere, where they will also find details of the RExE qualification and application forms. https://www.instmc.org/Professional-Development/Qualifications

Harvey Dearden
Explosive Atmospheres SIG Chair



SKILLS FOR THE FUTURE OF METROLOGY

BY PETE LOFTUS, EVALU8TION LTD & CIM ROUNDTABLE CHAIR

The **CIM International Metrology Conference**, 7th – 9th September in Lyon, France played host to a roundtable discussion about the skills that will be needed for the future of metrology.

The discussion was well attended with 56 present in person in Lyon and a worldwide audience of 30 online. As with discussions on this topic at previous conferences, there was impassioned debate and an encouraging degree of consensus. We benefitted from having a panel of speakers (both in-person and by recorded video) who are very passionate and knowledgeable about this subject.

The discussion, of course, needed to consider what the future of metrology is, before addressing the skills required. New technologies such as quantum sensing were highlighted but, more significantly perhaps, the trend toward measurement processes being embedded in systems where the human operator does not interact directly with the measurement task. Such systems are generating exponential increases in the volume of data produced, stored, and processed, making the task of ensuring that it is metrologically correct an ever-increasing challenge. Not only are the operators, or system designers, less connected to the measurement, but the number of people involved in the process increases all the time. The focus on data analytics is very clear to see but the commensurate focus on the source of the data itself is lacking.

I convened the roundtable, arguing in my introduction that, not only will metrologists need new skills, but so will the users of measured data – which actually means everyone! Professor Trevor Toman from Coventry University challenged the audience of metrologists to measure the competence of a metrologist - the only thing that has escaped the community until now, he suggested. He is working on an ambitious project to define a framework of skills which he hopes could be adopted internationally. Tim Jones from the UK's NPL suggested that the pandemic has highlighted the challenges of people not fully understanding metrology in clinical settings. He sees digitalisation as an opportunity but also a threat, as it hides the process from decision makers.

Vincent Barbier, speaking for CETIM who chaired the discussion in Lyon, brought the subject around to recruiting good metrologists. Oriano Bottauscio representing INRIM felt that there are many university courses at Batchelor and Masters level in Italy for maths, statistics etc but no, or very few, tracks specifically in metrology and measurement science. He felt that a career in metrology is perceived as not sufficiently attractive and changing this perception would need to be addressed at European level. Jean-Clair Ballot of IUT d'Orsay highlighted the benefits of industrial placements to give students exposure to how metrology is done in industry and the huge impact that it has.

David Vasty of Trescal concurred with all the panellists that people are not sufficiently attracted to the vocation. He said that Trescal hires people who have not studied metrology and trains them internally. They are also building links with universities. A speaker from the audience interjected that to attract students it is necessary to educate them at an earlier stage about what metrology is. M. Ballot felt that graduates were not aware of the opportunities in industry to continue to learn, so opt for further academic study.

M. Barbier summed up this part of the discussion as "we are not selling what metrology is and how interesting and diverse it can be". M. Bottauscio suggested that the incredible tools that metrologists have at their disposal may be an attraction. He went on to describe the efforts of the EURAMET technical committee to address training through the NMIs. A member of the audience highlighted that metrology needs to combine practical skills alongside the academic ones and this too could be a motivator for some.

Sébastien Denaës of Colas suggested an ISO standard on the role of a metrologist to help promote the discipline and engage students. The panel agreed that action at the international level is needed, and Prof. Toman highlighted the excellent track record that NMIs have in working internationally.

Turning to some of the barriers to attracting students, M Denaës spoke of the risk of intimidating potential students with the mathematics and statistics and suggested that we need to work harder to turn this into a toolkit which is easy to use. Broadening the approach to skills, M. Ballot emphasised the need to help students step back and critically review the data obtained, to consider the physical phenomena then the processing of the data – two key pillars. He said that his research centre has very successfully brought the analysts and metrologists together. If we do not have a metrologist involved at the start, we are just talking about numbers not information. We are asking metrologists to take a higher-level view and learn the language of the designers and analysts. People thought we were crazy, but now we have metrologists helping design machines and 90 % of calibration is done on site. He felt that it takes 15 years to learn the fundamentals of metrology rigorously then much less time to adapt to new technology as it develops.

M. Bottauscio brought up the importance of attitudes – the need for students to take a critical view of what they are doing and an interdisciplinary approach. The tools must not undermine the metrologists' authority to interpret and approve decisions and stand by their decisions.

An audience member highlighted the importance of getting young people to take over this campaign and provide leadership for the future. This seemed a fitting point to close the discussion but the panel were keen to take part in further work on these topics before the next CIM.

Summary

There was broad consensus that

• The key need is for a greater awareness of metrology in society, and an attractive career path for future metrologists. This will stem from an enhanced identity for the discipline of metrology and internationally recognised competencies and qualifications.

• We should (re)-claim for metrologists the role of ensuring data integrity. In a world which focuses on data processing and tends to treat data itself as a given, metrologists need to bring their critical attitude to measurement to restore the balance.

• Future metrologists will be system designers, data scientists and decision makers with recognised competence in metrology supplementing their broader skill sets.

• New skills requirements will be driven by advances in measurement technology e.g. quantum, and by its applications in all sectors of society.

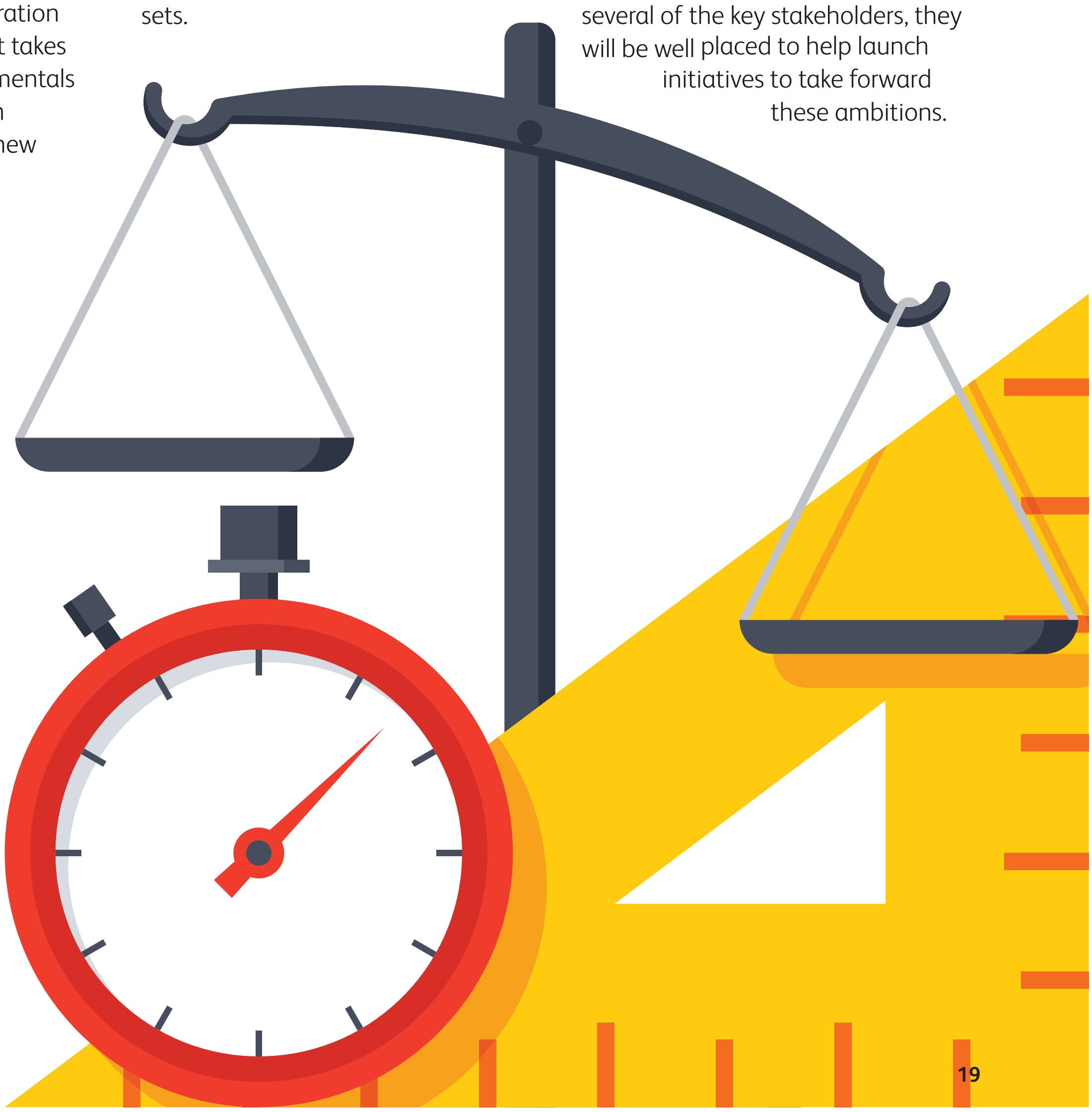
• Some existing metrology skills and critical attitudes need to be preserved in the age of embedded sensors, edge computing and big data.

• We need to highlight the attractions of metrology careers using, for example, the technology and equipment involved, the combination of practical and theoretical skills, the importance and ubiquity of metrology (e.g., its impact on the pandemic) and the range of disciplines that metrologists interact with.

• We need to engage young and early career metrologists in championing the discipline.

• All the above need to be driven internationally if we are to succeed.

This provides an exciting agenda for the profession and, given that the panellists are representatives of several of the key stakeholders, they will be well placed to help launch initiatives to take forward these ambitions.



CREDIT: Royal Marsden Hospital

CYBERKNIFE: PRECISION RADIOTHERAPY TREATMENT

BY PETER NORMAN, IENG, MINSTMC, MIET

This article will cover the main engineering design features of today's ultimate robotic system for precision Stereotactic radiotherapy delivery to cancer patients as used by the Royal Marsden NHS Foundation Trust in the London area since 2011. This robotic delivery system is known as Cyberknife, introduced in the early 1990s, and is manufactured and serviced by a company in the USA.

'Stereotactic Ablative Body Radiotherapy (SABR) refers to the precise irradiation of an image-defined extra-cranial lesion with the use of high radiation dose in a small number of fractions.'

For the patient, SABR provides an accurate, painless, delivery of external beam radiotherapy over fewer treatment sessions, using high-energy X-ray beams to deliver high doses to an internal body tumour with pinpoint (sub-millimetre) accuracy. This method is extremely useful for treating soft-tissue areas in the body and locations where surgery would be difficult such as the brain and spine.

Scanning and Planning by the Medical Team

Prior to treatment with the CyberKnife System, pre-treatment cross-sectional imaging procedures determine the size, shape and location of the tumour. The process begins with a standard high-resolution CT (Computerised Tomography) scan. For certain tumours, other imaging techniques such as MRI (Magnetic Resonance

Imaging), angiography or PET (Positron Emission Tomography) may also be used. Multiple scan images can then be merged together for a superior result for the radiologists' treatment delivery plan.

Following the scanning process, image data are digitally transferred to the CyberKnife system's treatment-planning workstation for target mapping. A qualified clinician uses the CyberKnife software to generate a treatment plan to provide the desired radiation dose to the identified tumour location without damaging surrounding healthy tissue. This treatment planning process also involves selection of the most appropriate machine control tracking algorithm to be deployed.

Imaging System and Target Tracking Accuracy

The imaging technology enables the robotic system to automatically adjust the patient positioning table as target motion is detected in the living body and ensure constant beam accuracy.

The robot's imaging system consists of two ceiling-mounted X-ray sources and two corresponding in-floor image detectors. The ceiling-mounted sources are positioned at 45˚ to enable the generated imaging beams to intersect orthogonally at a centre point located at 92cm above the floor. Treatments rely upon the patient positioning table accurately bringing the patient into the imaging field of view. Live X-ray images are then digitised and compared with images synthesized from the patient's treatment plan.

System targeting accuracy depends upon numerous attributes including: system calibrations; imaging alignment and the efficacy of clinical elements including patient CT acquisition and treatment planning delivery to the body region.

3D Workspace and Patient Positioning System

A three-dimensional (3D) workspace is created for the robotic manipulator arm to move within and to travel safely between treatment positions. The workspace is subdivided into anatomy-specific travel paths keeping track of the positions of objects in the treatment region, including the treatment couch, patient, imaging components and detectors. Pre-assigned nodes, which are points-in-space, populate the workspace from which the manipulator arm can then deliver radiation via the Linac unit with its beam-focussing Collimator.

The treatment couch position is integral to the workspace for correct adjustment of the patient's horizontal position. With the RoboCouch option the point of rotation is variable such that all axes can move simultaneously about a set point in space. A wall-mounted green laser light beam is deployed to centre the patient on the couch. The patient can remain conscious and normally dressed, laying still and face up.

Robotic Patient Positioning System (RoboCouch)

The RoboCouch System automatically positions the patient with a highly flexible six degrees-of-freedom mechanism consisting of five rotational axes and one linear axis. The combination of the RoboCouch System and the robotic manipulator for Linac positioning enables the Treatment Delivery System to deliver radiation doses to the right location precisely and automatically.

Linear Accelerator (Linac)

The Linac head unit comprises an Electron Gun, a 9.3GHz X-band Magnetron, a waveguide and Linear Accelerator with the Collimator on the output end for radiation beam delivery to the patient from multiple beam angles at each node within the created 3D workspace. The actual treatment path chosen by the robotic manipulator depends on many factors, including the location of the target, the size of the patient and the part of the anatomy being treated.

Collimator System

The Collimator system can either be of the Iris Variable Aperture type comprising two banks of six tungsten segments that create a hexagonal aperture but offset by 300 to thus become virtually circular (dodecahedral); or, can be of a multi-leaf internal design which permits a greater variety of beam shapes to be created for faster precision treatment delivery to larger target areas.

Equipment Room

The Equipment Room needs to house: a computer rack; Advanced Magnetron Modulator (AMM) rack; the User Control Console (UCC) workstation; Power Distribution Unit and Robot Controllers. The computer rack includes the UPS as well as an Iris temperature controller; E-STOP Interlock Control; Target Locating System; Data Management System (iDMS). The AMM houses a Linac Control Computer (LCC); Linac Power Distribution Unit (LPDU); and, Modulator Control Chassis (MCC).

User Control Console (UCC) Workstation

The UCC workstation is installed in the equipment room's computer rack to acquire UPS power and includes a mouse, keyboard and twin display screens at the Control Console area to enable operators to monitor and to control the robotic treatment process.

iDMS Data Management System

The iDMS System has capacity to store patient records, system commissioning data, and system licensing information.

Safety Systems

The robot is engineered to avoid any direct physical contact with the patient. It therefore has numerous contact sensors that can trigger an emergency stop (E-STOP) function. The upper manipulator arm integrates a contact sensor on its outer surface and the E-STOP is triggered if an object makes contact with it. The robot workspace also considers the patient's position in order to avoid patient contact. This is achieved by creation of a safety zone around the patient and the treatment couch by Fixed and Dynamic elements.

LOCAL SECTION NEWS

LONDON

Webinar: 'Analyser's Developments to Measure Trace Components' 12th October 2021

Orbital Gas Systems are a leader in innovative gas solutions, with more than 30 years' experience in design, installation and the commissioning of industrial gas sampling, measurement and delivery systems.

Orbital Gas Systems advise, for a gas sample to be representative in the context of natural gas analysis, the requirements are far more complex than initially perceived:

- The sampling location should be selected so it is not in a dead leg, source stream flow disturbance is minimised, and the location is suitable and relevant to your analytical objectives.
- The sample identity should be preserved throughout every step of the sampling process. Anything that comes into contact with the sample has the potential and the proclivity to alter its identity
- The allocation of analytical results should be fast and reliable.

Many significant assessments, calculations and decisions are based on the correlation of real-time data with the analytical data resulting from sampling. To deliver a sample from a source stream to an analyser, you need to achieve a number of steps while adhering to the requirements of representative sampling.

- Take a sample of gas from the source stream.
- Reduce and control the pressure for analysis.
- Stabilise and control flow.
- Protect the analytical instrument from particulates and droplets and unexpected pressure/flow 'excursions'. Orbital have introduced VE Technology which reject traditional methods and technology. The sampling is no longer just protecting your analyser, representative analysis requires advanced engineering solutions.
- To deliver the necessary steps for sampling faster, more simply and more efficiently than ever before is now possible.
- Eliminate all visible issues and some unseen and ignored issues, by scientifically addressing root causes.
- Respect and perfect the laws of representative sampling; challenging what was previously acceptable, to deliver better performance for end users.

VE Technology delivers this through three modular sampling components, that can be configured to meet almost any customer's analytical and spatial requirements. With this new technology, sampling equipment is designed to work as an integrated system and the result is a versatile sample system.

Delivering sampling solutions for natural/shale/bio gas, petrochemical and LNG applications, VE Technology is a sample trace element to sub ppm levels including mercury, moisture, H2S, ammonia, siloxanes and is an optimum solution for fast accurate CV/BTU measurement, improving combustion efficiency and the accuracy of fiscal metering.

"VE Technology is a sample trace element to sub ppm levels including mercury, moisture, H2S, ammonia, siloxanes and is an optimum solution for fast accurate CV/BTU measurement, improving combustion efficiency and the accuracy of fiscal metering."

Using a constant optimised ID, the inner volume of the sample channel is minimised speeding up the time it takes to reach the analyser. This, combined with special surface treatment and coating which eliminates hazardous or erroneous data reaching the analyser.

Helical strakes on the VE sample probe structure, eliminate coherent vortex shedding removing the need for wake frequency calculations, so you can sample from the ideal location, while the precisely designed probe tip actively rejects contaminates entering the sample pathway. The VE Conditioning unit heats the gas prior to pressure reduction truly avoiding any retrograde condensation where others just mask the problem. By taking a smaller, cleaner sample, VE Technology improves response, enhances accuracy, increases safety, decreases cost and reduces wastage.

VE Technology is an innovative solution to many of the common issues encountered by traditional thermowells. The problem of vortex-induced failure is traditionally solved by structurally reinforcing the thermowell body. However, this method actually exacerbates the issue and transfers the stress to the mounting point, which can cause even more of a problem (e.g., fatigue, stress and cracking of the pipeline wall). The VE Thermowell designed to provide safety and performance with a helical strake into the body of the probes, producing a design to eliminate all vortex induced vibration and wake calculations are no longer needed to be confident your equipment is safe from vortex induced vibrations, and concerns about thermowell failure or a major pipeline failure caused by poor thermowell design are eliminated. The wall thickness of the thermowells is reduced which means there is less thermal mass in the thermowells, resulting in a much faster and more accurate temperature response.

The VE Conditioning Unit (VECU) is a multi-functional unit with a primary function to reduce and control the pressure and flow rate in preparation for analysis. The challenge during this process is managing the gas-liquid phase boundary, also known as the dew point curve: as the gas pressure is reduced, the temperature decreases also. This is called the JouleThomson effect as a problem in Natural Gas sampling because of retrograde condensation – crossing the phase boundary – irrevocably and invisibly changes the sample. This is a common function and a common challenge in all high-pressure gas sampling systems. The VECU pre-heats the gas molecules to be sure the sample remains unchanged during pressure reduction. The VECU provides much more than protection of the sample from adverse Joule-Thomson effects. The unit has fully integrated filtration, sample pre-heating, temperature monitoring and pressure/flow control. The VECU is ATEX and IECEx approved for Zone 0, allowing its use in any configuration with the other VE modules, across a huge range of applications. As with the other sample system modules, 2mm ID electropolished tubing is used throughout to minimise internal volume and purge time and improve efficiency and running costs. It is fast, simple and inexpensive to install, economic and efficient to run and provides confidence in retrograde condensation avoidance. This practical product is designed to be mounted directly to the VE sample probe, or adjacent to it in a mounted cabinet.

The VE Analyzer Interface Module (AIM) operates with the VE Sample Probe and VECU. The VE AIM allows required conditions to be safe and effective analysis as close to the analyser as possible.

- 2mm ID, electropolished, minimized transport length.
- No control components.
- Available with proprietary Silconert coating.
- Can be backflushed to clean entire sample system pathway in situ.
- ASME/PED safety relief valve.
- Pressure transmitter.
- Flow alarm.
- Flow meter and pressure gauge.
- Back pressure regulator.

The modular arrangement of the VE sampling solution can be configured and installed to suit specific requirements, with no need for infrastructure works.

Barry O'Regan
Honorary Secretary

Engineering
EngTech
Technician

ENGINEERING TECHNICIANS

(EngTech) apply proven techniques and procedures to the solution of practical engineering problems.

What is professional registration?

- **Recognition** through membership of a relevant Professional Engineering Institution (PEI), that an individual's knowledge, understanding and competence have been assessed and confirmed through Professional Review.
- **Verification** that they have attained the standard required for inclusion on the national register in the appropriate category of registration.
- **Commitment** by an individual to maintaining their competence through Continuing Professional Development (CPD), professional behaviour for the benefit of society and their commitment to the engineering profession.

Registration is open to any competent practising engineer or technician, with different levels and pathways to registration available.

Why you should become professionally registered?

For yourself
- Recognition of your competence as an engineer or technician.
- Demonstrable evidence of your commitment to the profession.
- Internationally recognised status.
- Enhanced career prospects.

For your employer
- Increased technical/managerial credibility.
- Competent workforce.
- Competitive advantage.

For society
- Ensures the public is safeguarded through provision of independent and trustworthy advice, products and services and safe and reliable infrastructure.
- Assurance of ethical and sustainable behaviour.

Engineering Technicians are required to apply safe systems of work and are able to demonstrate

- **Evidence of their contribution to either the design, development, manufacture, commissioning, decommissioning, operation or maintenance of products, equipment, processes or services**
- **Supervisory or technical responsibility**
- **Effective interpersonal skills in communicating technical matters**
- **Commitment to professional engineering values**

www.instmc.org

For further details and application forms, please visit our website or contact the Director of Membership & Registration on +44 (0) 20 7387 4949 Ext 3 or email: membership@instmc.org

Scan QR Code to apply for professional registration via InstMC

LOCAL SECTION NEWS

NORTH EAST

InstMC North East 34th Annual Control + Electrical Exhibition

On Wednesday 10th November, 2021, the InstMC North East Local Section hosted their 34th annual Control + Electrical Exhibition at the STEM Centre, Middlesbrough College.

Twenty vendors, including various local educational and training establishments, displayed and demonstrated their measurement and control equipment. Regular discussion ensued over coffee & during the lunchtime buffet.

Although COVID-19 saw the cancellation of the 2020 exhibition, the appetite for this year's event to continue was evident where this table-top exhibition continues to be a popular draw with local engineers, buyers and students alike.

In addition to the exhibition, the STEM Centre management team accompanied a number of groups on a tour of the Centre's adjacent process plant, which is a student's 'hands-on' operational simulator designed to familiarise them with the rigours of real-time plant control.

The North East Section realises that the pandemic continues to thwart some of our measurement and control colleagues in attending such public events, however, with its previous success and the endeavours of the organising sub-committee, it is hoped that future Control + Electrical Exhibitions will continue and numbers, of both Exhibitors and visitors will return to pre-pandemic levels and continue to grow.

Ian Tyzack, MInstMC
Exhibition Coordinator

COMPANION COMPANY SCHEME (CCS) SHOWCASE

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.

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.

Beamex

BEAMEX is a leading worldwide provider of calibration solutions with the sole purpose to create 'a better way to calibrate' for the global Process Industry. Beamex offers a comprehensive range

of products and services, from portable calibrators, to workstations, calibration accessories, calibration software, industry-specific solutions and professional services. Through Beamex's subsidiaries, branch offices and an extensive network of independent distributors, their products and services are available in more than 80 countries. Beamex has more than 12,000 customers worldwide.

Tel: +44 (0)1455 821920
Website: www.beamex.com

FLEXIM Instruments UK Ltd

For 31 years, FLEXIM has pushed the boundaries of flow measurement from outside the pipe. Founded on research from Berlin & Rostock Universities, FLEXIM's sole ambition is to develop & deliver the world's most advanced non-invasive flow metering solutions. FLEXIM has permanent clamp-on metering

solutions for every industry; safety critical metering in the Nuclear sector, SIL 2 for O&G, Chemical or Petrochemical, MCERTS metering for water, and we are also proud of our work supplying critical O2 metering to countless hospitals across the UK and Ireland since the start of the Covid pandemic. FLEXIM's meters are also used extensively in the UK gas network and are proven in use for the burgeoning Hydrogen economy.
Our PIOX meters are also a non-invasive, zero leak path alternative to inline meters in hazardous media mass metering applications, delivering not just drift-free mass flow, but acid or caustic strength from outside the pipe.

Tel: +44 (0)1606 781420
Website: www.flexim.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

Spirax Sarco

From its origins in nineteenth-century London, Spirax Sarco has been characterised by a commitment to quality products, customer service and industry-leading expertise. Listed on the London Stock Exchange in 1959, and in the FTSE 100 today, Spirax Sarco continues to grow and deliver value to its shareholders.

Spirax-Sarco Engineering consists of three world-leading businesses, each one combining expert knowledge with industry-leading products.

Spirax Sarco and Gestra are world leaders in the control and management of steam, a Natural Technology key to our sustainable future. Chromalox and Thermocoax offer industry-leading, expert electric thermal solutions. Watson-Marlow provides customers with world-leading peristaltic pumps and associated fluid path technologies.

Through these businesses, we provide a diverse range of industrial customers with vital products, services and engineered solutions to maximise efficiency and overcome their process challenges.

More and more industries and organisations are recognising steam as the Natural Technology that fits with their sustainability agendas. With new steam generation technologies, we're on a path towards carbon-free steam generation.

Tel: +44 (0)1242 521361
Website: www.spiraxsarco.com/global/en-GB

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

ACCREDITATION CORNER ASK TREVOR

Can academic establishments comply with ISO 17025 or be accredited?

Trevor considers the potential issues encountered when applying management system standards such as ISO 17025:2017 to testing and calibration work in universities and technical colleges.

Often university measurement facilities are very advanced, at the frontiers of the science, very expensive and sometimes complex. These are the very reasons why making use of these facilities to provide a testing or calibration service may appeal to industry. This clearly benefits industry by providing often unique and special measurement services, but also benefits the university by providing financial income and raising its industrial profile.

It should be possible for university facilities to comply with ISO 17025 and even to obtain accreditation — indeed many do — but several rather daunting issues become apparent and need to be overcome.

Of course, all compliant laboratories need to abide by all the clauses in the Standard but it is certain topics that tend to trouble academic establishments.

Care and Control of Equipment

An important point is an expectation that equipment must be maintained in a known and good condition, with use being limited to authorised staff who are trained in its proper use, often within stated limits. This applies not only to measuring equipment that is calibrated but also to any other kit such as jigs, that could affect the validity of results. Using that equipment as part of teaching students is problematic. Ideally the kit should be duplicated with one set for controlled use and another for teaching, unless the students have been individually trained, competency tested and authorised. Sometimes that is not feasible, so alternatives might include ensuring 100 % supervision by an authorised person and limiting the use to the same limited parameters as those for calibration or testing service. The authorised person would spot and alert situations of abuse or overload, so the equipment may be immediately taken out of service pending rectification. Other possible options include routine re-verification or re-calibration of the equipment prior to ISO 17025 use. Difficulties such as the lack of drift history may preclude some possibilities in particular cases, but this very much depends on the nature of the work and the uncertainty budget. A blend of some equipment being accessible to students, such as big, rugged rigs, but the more delicate measuring devices being duplicated is often a viable solution.

Authorised Staff

ISO 17025 requires all staff involved in the testing or calibration being known, competent and authorised. This is relatively easy if only identified staff and long-term students, such as resident PhDs, undertake the ISO 17025 compliant work and the competence criteria is documented. If anyone else is to touch the equipment it is essential that this is known and that either it cannot affect performance or that the equipment is revalidated or recalibrated after such exposure as discussed under Care and Control of Equipment above. All staff undertaking the other functions such as contract review, recording and reporting also, of course, are required to be trained and authorised but this does not usually need to involve any transient students.

Legal Entities

Legal entities, ownership and impartiality are other requirements sometimes exercising academic establishments. Compliance, whether accredited or not, does require a single legal entity to be identified as responsible and that normally undertakes the work itself. This means that the entity shall employ the staff although that may be by contracting the people from another entity. That is not the same as subcontracting the activity. Those staff may be bought, usually by the day or hour, to follow the laboratory's management system and will have records within that system.

This may be an issue for universities that set up a spin-out associated limited company for tax or other reasons. If it is the limited bolt-on that seeks to comply, then it would need to show that it had the care and control of the equipment and of the staff. However, the ownership of the equipment and of the staff is not the issue: it is a matter of care and control. It is essential that all staff working with the equipment understand the management system requirements, the impartiality and confidentiality issues such that, in a university environment, one might expect a greater than average attention to doing this demonstrably well and documenting it.

Students

Students are sometimes considered the main problem but this may not be the case. In any laboratory there are new staff undertaking training who are closely monitored because they pose a risk. In a university the students clearly pose a risk that should be studied under the risk and opportunity regime in order to identify where, what and who are involved and how high the risk is. This will mean some processes and some equipment being identified as potentially at risk. It would be that area where duplicating the kit should be considered or, alternatively, 100 % supervision by authorised staff and all use well controlled and documented.

Is all this economically viable?

That is very hard to answer! At one extreme, situations have been seen where the service offered is very competitive with the private sector because only marginal additional cost recovery is sought, the fixed main costs continuing as before financed within the education spend. At the other extreme, the service offered under a "full economic cost" type regime may appear excessively expensive and non-appealing to industry. However, if the offering is unique, some customers may want it.

Those of us scientists and engineers that also dabble in business and economics will know that there is no such thing as "true cost" and the split between different cost or recovery centres is a matter of policy. In any case, university laboratory measurement work that is ISO 17025 compliant or accredited may have greater credibility when publishing research work containing such results. That alone inspires some applicants.

Trevor Thompson was for many years an assessor, assessment manager and senior manager at The United Kingdom Accreditation Service. He represented the UK in the writing of the latest version of ISO 17025 and has now retired.

He presently offers Accreditation and Metrology Consultancy for the UK, Europe and Beyond – bestmeasurement.com

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

> It should be possible for university facilities to comply with ISO 17025 and even to obtain accreditation — indeed many do — but several rather daunting issues become apparent and need to be overcome.

2022

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 these activities, 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.

ADVERTISING RATES

Discounts can be given if 3 or more adverts are taken. POA.

Full Page	£1,400
Half Page	£845
IFC	**£2,250**
IBC	**£2,250**
OBC	£2,250

INSERTS

A4 & A5 Inserts	**£845**

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

PRECISION MAGAZINE

OUR CORE TEAM

OFFICERS

President
Martin Belshaw

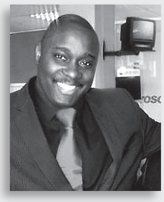
Honorary Secretary
Billy Milligan

Honorary Treasurer
Ian Craig

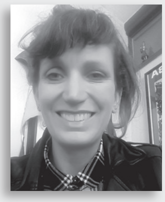
Engineering Director
Dr Maurice Wilkins

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

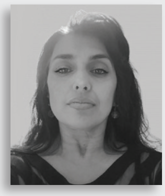
Marketing Executive
Ernest Kyei
+44 (0)20 7387 4949 Ext 4
ernest.kyei@instmc.org



Membership Development Manager
Jane Chandler
+44 (0)20 7387 4949
jane.chandler@instmc.org



Membership & Accreditation Officer
Lucille Morgan
+44 (0)20 7387 4949
lucille.morgan@instmc.org



Business Executive
Sydney Reed
+44 (0)20 7387 4949
sydney.reed@instmc.org

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

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