

NET ZERO ENGINEERING FOR UK WIND TURBINES: A MEASUREMENT AND CONTROL FOCUS



INSTMC AWARDED
FOUNDING MEMBER
STATUS OF THE UK CYBER
SECURITY COUNCIL

CISMA — A STUDENT-LED
SCIENCE GROUP OPEN TO ALL

ELECTROLYTIC CAPACITORS
IN POWER SUPPLIES



SEPTEMBER 2021 ISSUE 21

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INSTMC AWARDED FOUNDING MEMBER STATUS OF THE UK CYBER SECURITY COUNCIL

Recognising the contribution made by the InstMC, and the additional 15 members of the Cyber Security Alliance in establishing the UK Cyber Security Council, the designation 'Founding Member' was officially awarded by the Council in June 2021.

The UK Cyber Security Council is a new independent body, funded by government, aiming to set standards, define career and learning paths and increase diversity in the cyber security sector. As one of the founding members of the collaborative UK Cyber Security Alliance, which helped to form the UK Cyber Security Council, the InstMC is delighted to support UK Cyber Security education and skills development. The UK Cyber Security Alliance is a consortium of cyber security organisations that

represent a substantial part of the cyber security community in the UK. Its members include (ISC)², BCS, The Chartered Institute for IT, Chartered Institute of Information Security (CIIS), CIPD, CompTIA, Council of Professors and Heads of Computing (CPHC), CREST, Chartered Society of Forensic Sciences (CSFS), Engineering Council, Information Assurance Advisory Council (IAAC), The Institution of Analysts and Programmers (IAP), The Institution of Engineering and Technology (IET), Institute of Measurement and Control (InstMC), ISACA, Royal Academy of Engineering, Security Institute, techUK, The Worshipful Company of Information Technologists (WCIT).

The newly launched UK Cyber Security Council will work in partnership with the National Cyber Security Centre (NCSC), be developed with broad representation, and be tasked to support the Government's National Cyber Security Skills Strategy by providing recognition across the practicing community, while enhancing standards and thought leadership for the future. The aim is to have initial programmes operational in 2021, with the development phase of the work serving to align relevant investments that were made by the UK Cyber Alliance members over a number of years.

The voluntary commitment to collaboration projects for three years has seen the UK Cyber Alliance



form structures, governance and funding plans to create a sustainable Council with clear definitions. The Cyber Alliance create a number of workstreams supported by a growing number of volunteers on each workstream. The InstMC worked on the overall Management Committee and dipped into several workstreams ensuring that Industrial IACS Cyber Security was included in the threads being formed.

The UK Cyber Security Council is now the self-regulatory body, and voice, for UK cyber security education, training and skills. It has a mandate from the UK government to be the focal point through which industry and the professional landscape advise, shape and inform national policy on cyber security professional standards. The Council will drive progress towards meeting the key challenges the profession faces and develops, promoting and stewarding nationally recognised standards for cyber security qualifications and learning.

The InstMC will collaborate with the Council and ensure that Industrial Cyber is firmly on the agenda. Find out more by visiting the UK Cyber Security Council website. <https://www.ukcybersecuritycouncil.org.uk/>

Cevn Vibert
Cyber Security SIG Chair

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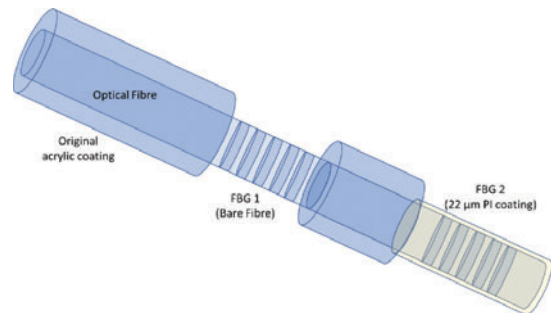
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NET ZERO ENGINEERING FOR UK WIND TURBINES: A MEASUREMENT AND CONTROL FOCUS

BY PETER NORMAN,
IENG, MINSTMC, MIET

UK energy suppliers are already using a growing proportion of wind power as a part of their energy fuel mix and are seeking Net Zero Energy options. Some larger energy suppliers actually generate wind power from their own Onshore and Offshore wind farms.

Challenges ahead include sufficient UK renewable power generation capacity. This will need to increase at a sufficient rate of progress to meet future electricity consumption demand, given that we have natural limits of geographical space for wind turbines when aiming to preserve wildlife habitats and protect the natural environment against further climate change effects. Wind turbine blades are not currently recycled at the end of an expected 25-year life-

span. However, research is underway at Strathclyde University, Glasgow into ways of recycling old blades instead of cutting up for landfill burial.

Wind turbine equipment manufacturing on home soil has previously been limited. An existing blade factory at Hull on Humberside was opened in 2016 but is now intending to double in size by 2023 due to new investment announced in August 2021. On 11th March 2021, however, awaited plans were announced to build a new facility at the Teesworks Freeport Zone on Teesside. This facility is also scheduled to be completed by 2023. Large wind turbine blades have been steadily increasing in length from about 50m to more than 80m. In the quest for even more powerful electricity turbine generators, the latest turbine design will have massive 220m diameter rotors needing 107m long individual blades. Blades of this size are clearly challenging items to ship to UK shores, even from neighbouring countries such as Denmark, without danger of incurring damage from the physical demands of transit operations. A further ideal of eliminating some carbon-emitting, ocean-polluting, heavy sea transport can also be realised by UK manufacture.

Although turbine blades may not instantly seem the most exciting

pieces of technical hardware there is quite a significant technical effort required to test and validate the mechanical integrity of their fibre composite material construction. The ever-increasing size of the rotor blades makes this more critical than ever before.

The ORE Catapult organisation is a UK technology and research centre for Offshore Renewable Energy (ORE) at Blyth on the Northumberland coast which already operates a UKAS ISO/IEC accredited, full-scale facility for structural testing of rotor blades. Dynamic testing tends to involve forced flexures of the blade. The organisation complies with the IECRE-IEC System for Certification to Standards relating to Equipment for use in Renewable Energy Applications. More detail including some dynamic visual images can be



ORE Catapult welcomes one of the world's longest wind turbine blades at 88.4m (Image courtesy of ORE Catapult)



Turbine rotor shaft and blades

found on their website
<https://ore.catapult.org.uk>

Alternative current manual methods of blade examination require engineers to carry out physical inspections, which entail capturing a large number of high-resolution images. These inspections are time-consuming, impacted by light conditions, and can be hazardous if personnel have to scale vertical blades.

Unmanned Aerial Vehicles (UAVs), in the form of small drones equipped with video cameras, can quite conveniently be used to capture photographic images of turbine blades in onshore locations to help speed up the completion and safety of routine inspections.

Computer scientists at Loughborough University have developed an Artificial Intelligence (AI) deep learning algorithm tool that can currently analyse images and videos captured from inspections to identify faults such as crack, erosion, void, and 'other' problems. Future research will further explore using the AI tool directly with drones, to help eliminate manual inspections altogether.

A British start-up company has been developing a blade-crawling, hexapod robot with surface-gripping foot pads to perform non-destructive test and repair tasks. This has been developed over a number of recent years with the aid of grant funding and is capable of walking up vertical, in situ, turbine rotor blades. This was tested on a Scottish offshore wind turbine in October 2020 and is

intended to assist technicians with repair operations working out of human line of sight. The modular design of the robot body can accept different non-destructive testing and repair equipment thus giving it flexible capabilities while offshore. It is also regularly utilised at the onshore, indoor, blade-testing facility where blades are horizontally examined and tested. The ORE Catapult website highlights the application on this promising technology in use.

Clearly, such applications of remotely controlled UAVs, robotics and artificial intelligence can help to transform the world of industrial inspections and potentially improve efficiency and results consistency as well as removing otherwise hazardous physical tasks for humans to undertake.

Looking at the more technical aspects of all the moving parts of a wind turbine's mechanisms, there are numerous applications for sensors to help protect 'Man and Machine'. Force measurement transducers can be found within the product portfolios of some instrumentation equipment suppliers.

Naturally the moving parts of a wind turbine require reliable lubrication. Lubricant pressure can be monitored by strain sensors or pressure switches. Lubricant temperature and the reservoir level also need monitoring. Adjustment of the rotor blade angle and the directional alignment of the nacelle to the wind are controlled hydraulically, driven by a hydraulic power pack. Safety

functions such as the disc brakes control and the maintenance bolts holding each rotor blade also employ hydraulic fluid pressure.

Air conditioning of the electricity generator and its power electronics equipment is required due to the generation of waste heat despite often very low temperatures at the head of the wind power plant. The nacelle's electrical equipment chamber also requires suitable temperature measurement sensors, as does the operation of refrigeration units to guard against overheating.

Fire suppression control employs safe gas extinguishing systems, requiring pressure gauges or pressure switches to monitor the pressure in gas cylinders and to trigger alarm functions if any critical pressure drops occur that would compromise the fire control system's critical function.

The modular structure of wind turbines means they have numerous threaded connections that can be loosened by unexpected strong vibrations. Tightening torques can be monitored by ring force pressure transducers that are installed between the screwbolt head and the support flange, thus sandwiched within the bolted assembly as a simple form of smart device.

Mechanically, the rotor blades are regularly heavily stressed. Strain sensors, probably of a thin film type, can detect material changes at an early stage using resistance bridge imbalance circuitry to transmit an electronic signal.

CISMA – A STUDENT-LED SCIENCE GROUP OPEN TO ALL

BY UTKARSH DWIVEDI,
SALVA BARRANCO CÁRCELES,
KAYLEIGH DOHERTY & OLIVER HIGGINS

The only way to sustain knowledge is to keep disseminating it – we are not sure who said this (and we would not hesitate to take the credit) – but this is the philosophy that inspired the formation of CISMA (Colloquia in Intelligent Sensing, Measurement and Actuators) in March 2019 by three PhD students; Salvador Barranco Cárcelos and Kayleigh Doherty from the University of Edinburgh and Conor Coughlan from the University of Glasgow.

Building on this philosophy, our aim was to form an entirely student-led organisation to promote interdisciplinary research between various fields of academia and industry, ranging from science to arts to engineering to commerce. Over the past three years, CISMA has brought together a diverse range of researchers and industrial representatives to share their cutting-edge work as part of our monthly academic seminar series, and several one-day conferences. CISMA has become a hub for high-quality events addressing different aspects of the broad fields of sensing and measurement and their social impacts and have now ventured into doing outreach events. Our committee currently consists of 20 volunteers from across Scotland, as well as partners across Europe. Since its founding, our organisation has raised over £35,000 from organisations including the Centre for Doctoral Training in Intelligent Sensing and Measurement, (Engineering & Physical Sciences Research Council (EPSRC), the Scottish Universities Physics Alliance, and, of course, InstMC, and has organised over 25 seminars with more than 70 speakers.

After finding our feet in our first year, we made plans for 2020



that included monthly seminars and three full-day conferences hosted in Edinburgh and Glasgow. Of course, in early 2020 a certain virus disrupted our plans, so we began looking into ways to grow our organisation online and bring seminars to people in their own homes. We seized the opportunity to expand our reach beyond Scotland, broadcasting talks from world-class speakers from countries including Israel, Portugal, Spain, the USA, and Italy, and reaching over 1500 attendees from around the world. We have organised technical seminars on themes including 2D materials, space technology, and wearable technologies, but we are also keen to explore the social impacts and philosophy of science, hosting seminars on topics such as entrepreneurship and scientific bias and misconduct. Our expansion over the past year and a half has

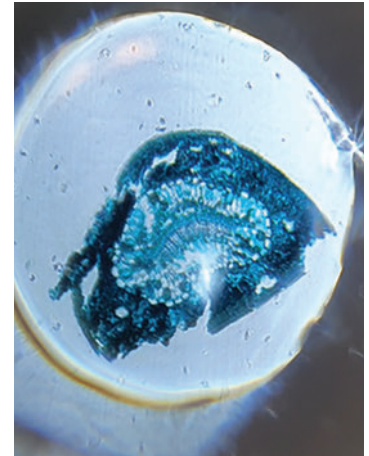
allowed us to widen our reach by forming ongoing collaborations with universities across Europe, working with OSA Milan, FISUA Aveiro, EPS Young Minds, SCOPE, and the IEEE Student Chapters from Scotland, among others. This has provided us with a continuing opportunity not only to reach a wider audience, but to further engage with the international scientific community.



This has been a fun ride for us so far and we are keen to expand even further on our path of bringing together multiple disciplines and engaging them in impactful scientific discussions.



This has been a fun ride for us so far and we are keen to expand even further on our path of bringing together multiple disciplines and engaging them in impactful scientific discussions. We really enjoy the way our work allows us to engage our own research community, so this year we decided to expand our communication to public outreach. We started 'Enlighten: The Science Podcast' in an effort to engage the public in discussions of cutting-edge science by speaking to researchers not only about their work, but about their lives, their inspirations, and their career paths. We have also teamed up with Optopus [https://](https://www.optopus.co.uk)



Some of the activities we delivered during the ESF: 3D glasses mosaic (left), and water droplet microscope (right).

www.optopus.co.uk to create a series of fun smartphone science activities for ages 9+ that could be done from home during the COVID-19 pandemic.

The purpose of the Optopus activities is to allow children (and adults!) to make use of household items coupled with a smartphone to teach engineering-based concepts, such as slow-motion imaging, polarisation and machine learning. Thanks to funding provided by InstMC, we were able to enter Optopus's Smartphone Science activities into the Edinburgh Science Festival, which was a great opportunity to spread the word about these simple yet cool experiments. This was a resounding success as we had over 150 visits from just Scotland alone. Furthermore, there was a lot of international engagement as users from 13 other countries, including India, Norway and the United States accessed the content. This has driven us to develop these activities even further and make them adaptable to be used in schools.

Amidst, all of this, we still believe in our core philosophy, and continue to organise high-quality events in the field of STEM to bring together as many minds as we can within academia, industry, and the wider public. We are always open to ideas, collaborations, and new members. We are an independent student-led group open to anyone

with an enthusiasm for science and communication. For updates on our future events (and we have plenty lined up) visit our website at <https://cisma-colloquia.com> or reach out via social media: Twitter @CISMA_Colloquia, or CISMA on LinkedIn. We look forward to engaging with you soon!



Amidst, all of this, we still believe in our core philosophy, and continue to organise high-quality events in the field of STEM to bring together as many minds as we can within academia, industry, and the wider public.



Q&A

Navdeep Mehay

Navdeep Mehay, Group Leader at the UK Atomic Energy Authority, shares his thoughts on the past, present and future of engineering.

What was the root of your interest in Engineering?

I grew up in Punjab, India admiring the work of my uncle as an engineer within a coal-fired power station. My uncle belonged to a small village and observing the knowledge and respect he gained as an engineer working and adapting to life in the big city fuelled my passion for engineering. In the Punjab there was a shortage of electricity, I could see first-hand the importance of his contributions through engineering. I wanted to follow in his footsteps and with a keen interest in maths and problem solving I pursued the study of engineering.

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

The decade ahead that awaits us, will see technological advancements that we haven't yet seen. In which, I believe engineering will have a major role to play. We already know that young kids today will be going into jobs that have not yet been created.

An area I am passionate about is the automotive industry and I believe this industry will keep growing exponentially, making our commute/travel faster, easier and economical by sharing and minimising the wasted resource. Once we have settled on electric and hydrogen cars, I envisage it won't be long before we see flying cars in action.

One definite thing to watch out for is the Nuclear Fusion Industry. Science has already proven that electric power can be produced by recreating the Sun on earth (yes, it's true), now it is time for engineering to overcome the challenges to make it a reality and produce efficient power on a large scale.

We are closer than ever to achieving this goal with the UK government's new experiment machine 'MAST Upgrade' in operation, and an ambitious prototype powerplant STEP (Spherical Tokamak for Energy

Production) in the design phase along with other developments worldwide. In the next decade, I see new engineering businesses (SMEs) set up in Britain and large corporations working towards making safer and carbon-free power generation from fusion possible. The government has already started the funding to back up this vision with the UKAEA's Innovation Challenge Scheme offering funding to deliver feasibility studies for innovative solutions to fusion's technical challenges.

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

The shortage of UK engineers (especially women) is a big challenge, and this can only be met collaboratively. The government can run more schemes to provide additional support for engineers and teachers to work together in the classrooms. Employers should encourage their employees to participate in such volunteering opportunities. However, as I mentioned, this challenge can only be met with a collaborative effort from the government, engineering institutions and us - technicians and engineers. We play a big part in this and should take the available opportunities to show or talk to our future generation explaining what it is like to be a technician or an engineer. I am sure someone will be inspired by listening to our stories and begin their journey into engineering.

Some of the organisations and institutions have already provided platforms to bridge this gap and I feel proud and lucky to be a STEM ambassador and to support initiatives like the 'Big Bang Fair' and 'First Lego League' as a career captain and competition judge. InstMC's mentoring scheme with Cambridge University Engineering Society is an exceptional step in helping guide students towards the industry for which I am a registered mentor.

From one of my favourite books: 'Simple Thinking: How to Remove Complexity from Life and Work' by Richard Gerver, I learnt the concept of Curiosity Quotient (CQ). In today's educational and industrial environments, we often hear about Intelligence Quotient (IQ) and Emotional Quotient (EQ). I believe it's the CQ, which is a little spark highly active at a young age, that must be kept alive by explaining things in a much simpler way throughout one's learning. As a result, young minds will develop towards producing innovative engineering solutions while tackling the biggest challenges faced by humanity.

What do you do in your free time to relax?

To take a break from the ever fast-paced technological world, I do like watching a bit of comedy sometimes quite a lot! These days, I have completed 'The Office (British TV series)' and currently working my way through the US version (it goes without saying that the UK version is much better)! Bhangra music always helps me relax and is at the top of my personal free time agenda.

I do believe that the pandemic has changed how we used to live our lives and our hobbies. In my case, it has helped put things in better perspective too. It has enabled me to spend more time at home, so I go for long walks with my family and friends. On week nights I can

read; playing board games such as Scrabble and Ludo with my family have been popular during the weekend while Monopoly is always there when we are all full of energy and up for a late night.

I believe that irrespective of our culture, age, experience and knowledge, we all can learn from each other. To fulfil this appetite, I tend to book some of my evenings talking to young engineers mentoring them or supporting experienced professionals to achieve their professional registration. This also gives me the opportunity to reflect on my own development.

Given one wish what would that be?

A very famous genie once said, "Here's the thing about wishes - the more you have, the more you want". So, it's difficult to pick one, however, If I have to pick one, (I rub the lamp) I wish the technology to encourage

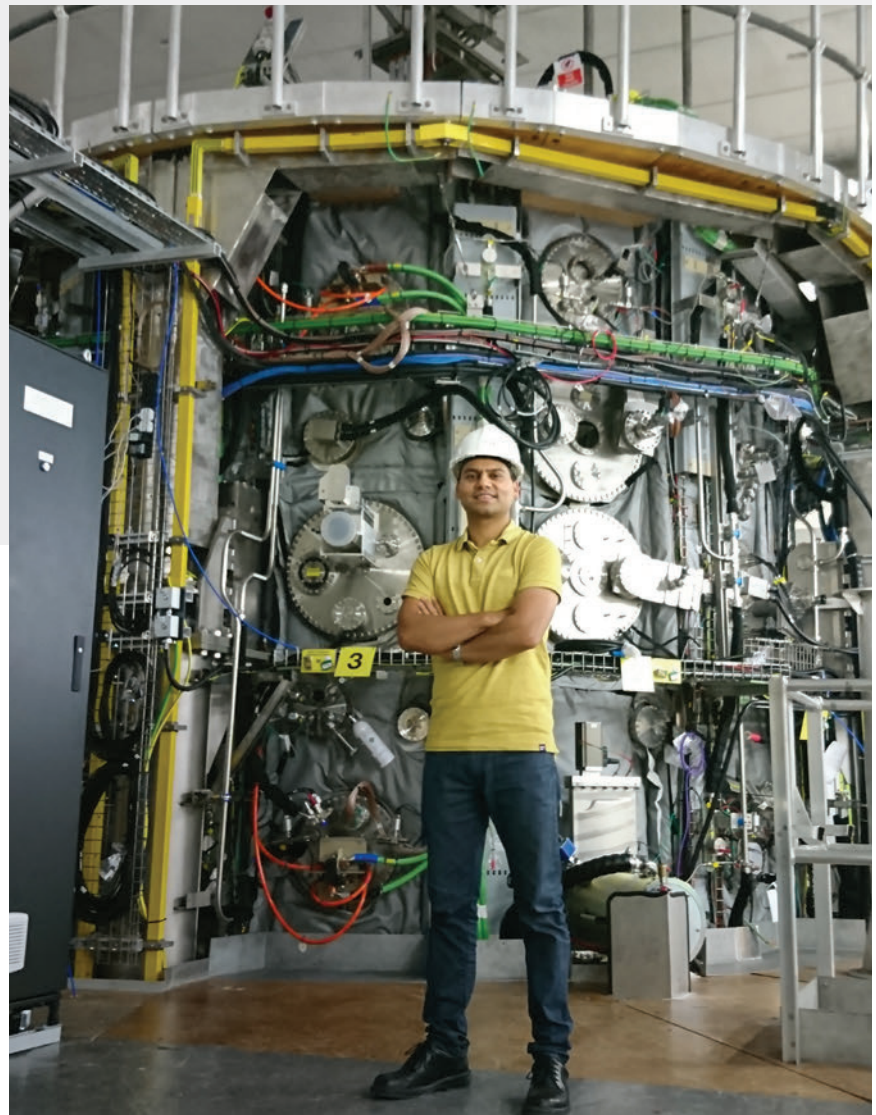
and provide only a fair world.

When I hear of cyber-attacks, companies and organisations using technology and social media to mould their audience's thinking, spreading propaganda it makes me think that if such a resource is put in the right direction, this world will be such a better place and will enable global equality.

Like I said, once one has one wish, we always want another. So, my second wish will be for all organisations to have one of their goals to realise at least one of the United Nation's 17 Sustainable Development Goals (SDGs).

"The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere." (source: www.un.org).

We all know in the story you get 3 wishes and so my third wish is...





CHARTERED ENGINEER

(CEng) develop solutions to engineering problems using new or existing technologies, through innovation, creativity and change and/or they may have technical accountability for complex systems with significant levels of risk.

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.

Chartered Engineers are able to demonstrate

- The theoretical knowledge to solve problems in new technologies and develop new analytical techniques
- Skill sets necessary to develop other technical staff
- Successful application of the knowledge to deliver innovative products and services and/or take technical responsibility for complex engineering systems
- Effective interpersonal skills in communicating technical matters
- Accountability for project, finance and personnel management and managing trade-offs between technical and socio-economic factors



EMPRESS 2 Workshop (online)

Enhanced temperature measurement techniques for improved process control 2

Thursday 7 October 2021

Organised by
Advanced Forming Research Centre (AFRC)
National Physical Laboratory (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
- Networking opportunities



SPEAKERS FROM

InstMC	Land Instruments
Metrosol	University of Strathclyde
NPL	University of Southampton
CCPI Europe	Heraeus Conamic UK
Oxsensis	Princeton University / HiT Nano



Details at: www.npl.co.uk/events

• Contact: jonathan.pearce@npl.co.uk

BY EUR ING DAVID GREEN BENG (HONS)
CENG MIET FINSTMC, CHARTERED
ENGINEER /FUNCTIONAL - MACHINERY
SAFETY ENGINEER

CONTINUING PROFESSIONAL DEVELOPMENT (CPD) – GROW YOUR KNOWLEDGE AND CONTRIBUTE

Continuing Professional Development (CPD) is the demonstration of professionals keeping up to date with the latest developments in standards, practices and innovations.



What is CPD?

CPD activities enable people to develop their knowledge and skills throughout their professional careers. This is irrespective of the role that individuals have, be the individual an apprentice or a senior technical authority.

There are different activities which can contribute to an individual's CPD activities:

- Formal training (via courses and academic study)
- Self-study
- Events and Seminars
- Volunteering
- Work Experience / Informal Training (including learning from peers)
- Contributing to the Profession

How do I benefit from CPD?

CPD allows me to refresh and improve my technical knowledge. The ever-changing world of engineering means that previous studies and work experience can become outdated. This may be a slowly changing area, such as Functional Safety or Hazardous Area Engineering which are well established concepts that are improved over time. Likewise, these may be in areas of rapidly changing techniques or technologies, such as Cyber Security, Artificial Intelligence or carbon neutralisation techniques.

The different activities have enabled me to grow my knowledge and additionally contribute more effectively to my company, clients and others in the technical networks such as the InstMC Local Sections,

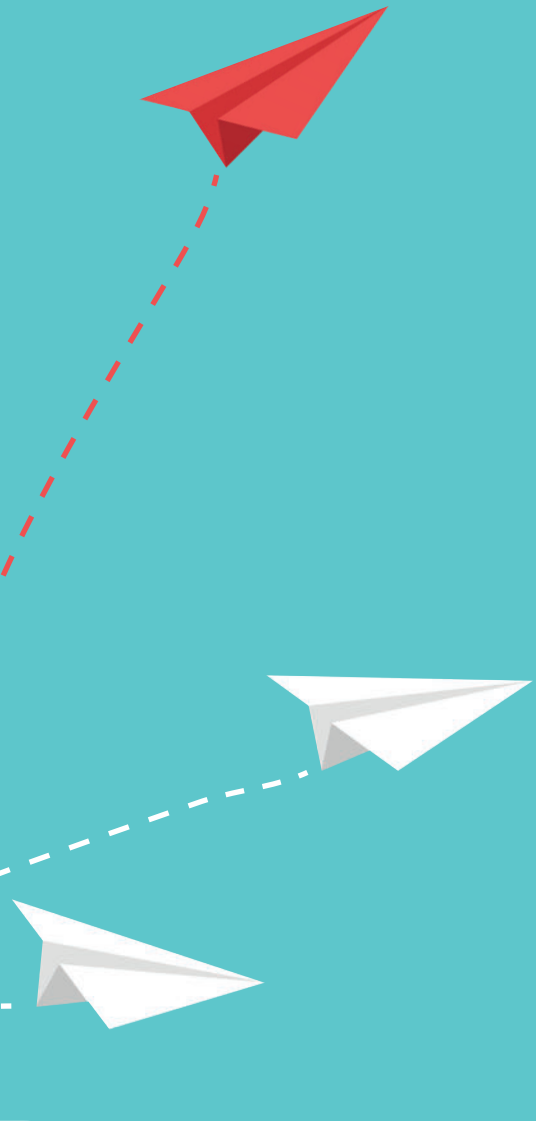
Council and SIGs. CPD activities have also enabled me to review the path that I wish to take with my career, focusing on specific areas to grow and develop further. This allows me to progress towards future roles or opportunities with more confidence.

What have I completed as part of my CPD?

Over the past couple of years, I have tried to vary my CPD activities, with the aim as stated previously, of broadening my horizons and improving myself as an engineer and manager.

My activities have included:

- Formal training courses (Cyber Security, Leadership and Management Diploma);
- Attending the InstMC Local



Why do I complete and record CPD?

Being a Chartered Engineer (CEng) and an InstMC member I am obliged to complete and record my CPD activities to retain my chartership status with the Engineering Council. The CPD activities relating to Functional Safety and Machinery Safety activities also contribute to the continuation of my Registered Functional Safety Engineer's (RFSE) qualification too.

The recording of my CPD is completed in a simple log, although some choose to use My Career Path. I use an offline log as I am a member of multiple organisations which request copies of my CPD and using My Career Path would need the entry adding to all systems (there is no ability to have one account for all memberships).

The record can then be produced when required. The reviews can include:

- Input to workplace appraisals
- Provided for CPD surveys

I have a plan at the start of the year of what I hope to learn and develop throughout the year. Having a plan may encourage your employer to fund formal training or provide time for additional learning sessions, such as conferences and webinars or technical talks. I try to include some of my CPD targets as part of my company appraisal targets.

The plan can, and will change during the year, but having an outline of what you wish to learn will enable you to watch out for activities that will support your learning goals.

The CPD surveys are important as the CPD being conducted could be heavily influenced in one area without achieving the goals that you set for yourself. The review can provide feedback that you may not have noticed yourself. They also allow the organisation to demonstrate to the accreditation bodies that those professionally registered members are maintaining their commitment to CPD as part of

the registration process. (Note, that, under the current rules, if you don't submit your CPD when requested on three consecutive requests then you will lose registration and will have to start again!)

Conclusion

The perception that CPD is a chore is one that I held until a few years ago. I had seen myself as being in the twilight of my career, but recently realised that there is still 'life left in the old dog', encouraging my continuation in thirst for knowledge and new experiences. My CPD activities in the last few years have contributed to changing my mind.

The obligation of completing CPD, and submitting CPD surveys, has encouraged me to try and complete different activities as part of my CPD which has re-ignited my passion for engineering.

My focus of improvement for the next five years of my career will be in broadening my technical knowledge in other areas of risk engineering and application to new scenarios, rather than trying to increase my management activities and focus. Technical sessions and conferences have influenced this decision, sparking my appetite for more knowledge and learning.

But as I said earlier, plans can change so who knows what will actually transpire over the next five years!

Go for it, plan your CPD, try many different aspects of engineering and don't forget to record (and submit for the survey if requested) what you're doing.

Please note: The obligation cited within this article is valid for all Engineering Council registrants (CEng, IEng, EngTech) and all Institute Members (including those retired from work, but who support InstMC activities).

Section technical talks (with varied topics including technology advancements and case studies);

- Researching and authoring technical articles and guidance documents (engineering publications, Institute magazines, industry guidance documents etc);
- Preparing and presenting training courses and technical seminars for the benefit of others' learning;
- Peer-to-peer discussions within the workplace on areas with which I am less familiar;
- Volunteering for the InstMC on BSi committees, SIGs, Local Section and HQ bodies, contributing to the improvement and development of standards and guidance documents etc..



BY ALEXANDER MEZIN,
SENIOR FIELD
APPLICATION ENGINEER,
SL POWER ELECTRONICS

ELECTROLYTIC CAPACITORS IN POWER SUPPLIES

Electrolytic capacitors play an essential role in the design of switched-mode power supplies. They may be found in the power factor correction boost stage or as part of the wide input voltage range circuitry for energy storage. Electrolytic

capacitors are also common components for filtering on the output of the power supply for low ripple voltage and stability. The specification of the power supply often states the lifetime of these electrolytic capacitors as a

metric of quality. This article will discuss their characteristics and their importance within power supply design.

An electrolytic capacitor is a type of capacitor which uses electrolyte in its internal construction. The electrolyte is a liquid with a high ionic concentration allowing much higher capacitance compared to other technologies. There are subcategories with liquid or solid electrolytes but in most applications, the former is the first choice for a

cost-effective yet small solution. The basic materials used in this type are a combination of aluminum foil, aluminum oxide, and electrolyte. Tantalum capacitors can provide better performance but are also more expensive. Ceramic capacitors offer excellent high-frequency performance but require more PCB surface area decreasing the power density of the power supply. The major advantage of the electrolytic capacitor is high capacitance density, typically between $1\mu\text{F}$ and $100,000\mu\text{F}$. The broad availability of different form factors allows the designers to select the best fitting capacitor with respect to width and height. Another advantage of electrolytic capacitors is the impedance response versus frequency in complicated designs where the electromagnetic interference is close to limits. The equivalent series resistance (ESR) of electrolytic capacitors is not the lowest but compared to other types it remains at the relatively same level with increasing frequency. This is due to increasing resistivity of the electrolyte, and so the compensation with capacitive reactance at higher operating frequencies. Very low ESR capacitors are available, and do not suffer from the derating voltage effect that can be found in ceramic capacitors. The typical capacitance value of electrolytic capacitors is however not accurate; it is common to have a 20% tolerance of stated data in the datasheet as a result of the manufacturing process.

The global market forces every new power supply design to be more efficient, smaller but also to remain affordable. While manufacturers of active components find new technologies and ways of achieving better performance, the evolution of passive elements is very slow. The challenges for a switched-mode power supply designer remain to be creative, not only in how better to control the power transfer chain but also how to achieve the highest power density without stressing the components. When it comes to the

electrolytic capacitor, the boundaries are set by the physical characteristics and sensitivity of the liquids to heat.

The lifetime of the electrolytic capacitor is limited by its construction structure. The key limitation is the fluid electrolyte which evaporates out through the end seal with time. Higher temperature accelerates this physical process. It is therefore obvious, that the lifetime of the power supply is primarily dictated by the electrolytic capacitors among all other components on the PCB board.

The temperature of an electrolytic capacitor is due to two factors. The first is the ambient temperature near the capacitor and the second is the AC ripple current through the capacitor which causes additional internal heat. Designers use both these factors to estimate the lifetime based on information from capacitor manufacturer's datasheets which provide an expected lifetime of the part at the rated voltage and ripple current at maximum operating temperature. Exceeding these values shortens the lifetime and may even damage the component. Operating at a lower temperature allows an extended lifetime. The AC ripple current capability of the capacitor is also provided in the datasheet or additional application notes and has a similar impact on the lifetime of the unit. The combination of both factors predicts the estimated worst-case capacitor's lifetime and indirectly the expected safe service life for the power supply itself. In total, the guaranteed working hours by using a selected capacitor in the target application can be accurately estimated from simulations and validation tests.

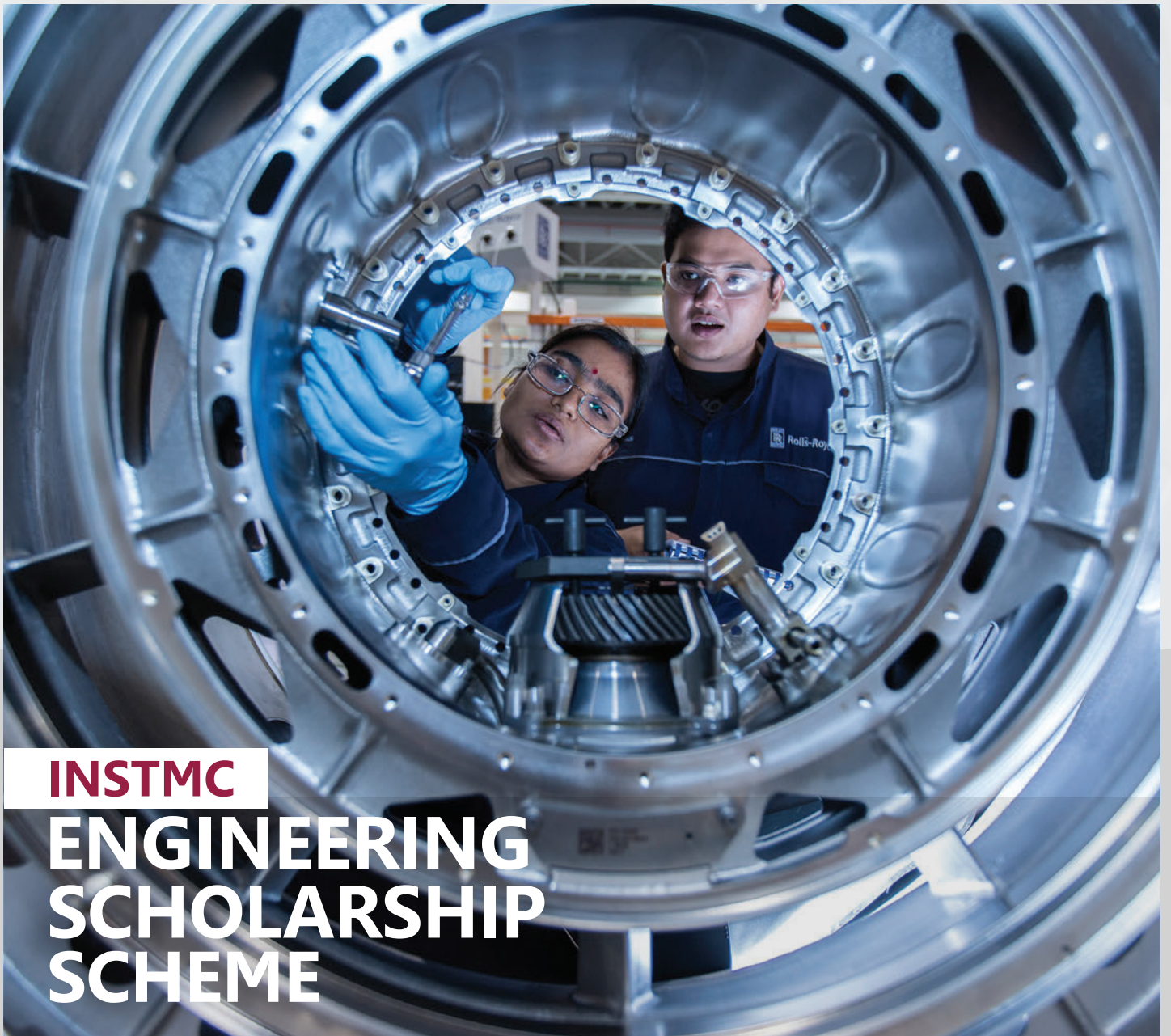
There is however an indirect influence on the capacitor's temperature that is dependent on the environment or the manner of mounting it on the PCB board. The leads of the capacitor can act as a heat sink but also as a heat absorber, contributing to conductive thermal coupling. If the capacitor

itself is the main heat creator and the surrounding components are cooler, the leads would transfer heat from the capacitor's core into the PCB board and so dissipate the heat outside. On the other hand, if there is another component like a transformer, FET, or another hot spot close to it, heat will be conducted via the leads directly into the capacitor. In most cases, this effect has a low impact on total temperature rise but should be kept in mind. Besides the conductive heat transfer, it is common to observe radiated thermal emissions close to a capacitor. This effect is especially observed close to transformers, where for example two or more capacitors with the same value and electrical connections located close to each other on PCB show different behaviour. The capacitor mounted near the hot spot will absorb more radiated heat and will have a higher surface temperature. This capacitor needs to be evaluated closer to avoid issues later.

A capacitor that has reached the end of its lifetime can be considered as not functional because the output ripple voltage is no longer guaranteed or, for the intermediate PFC storage capacitors, the hold-up time is below the defined ratings.

Deep benchmarking of the power supply under normal and/or harsh conditions investigates the weaknesses of the unit for each scenario, and so allows the designer to take these results into consideration during the integration phase. Assuming the capacitors are the limiting factor with high sensitivity to temperature, the assembly of the system parts needs to be reviewed closely to avoid unnecessary additional stress.

The common practice for application engineering teams is to work together with the end customer on the thermal concept to avoid unnecessary heat traps close to lifetime limiting components such as electrolytic capacitors in the final system design.



INSTMC

ENGINEERING SCHOLARSHIP SCHEME

2 0 2 2

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WE ARE PLEASED TO ANNOUNCE THE LAUNCH OF AN INSTMC INDUSTRY-FOCUSED SCHOLARSHIP PROGRAMME, WHICH WILL PAIR EXCEPTIONAL ENGINEERING STUDENTS WITH METROLOGY AND ENGINEERING COMPANIES

If you are interested in participating in the scheme, please contact Steff Smith | Email: steff.smith@instmc.org

To view or download a copy of the **InstMC Scholarship Scheme flyer and T&Cs for Sponsor Companies**, go to: www.instmc.org/news or scan the QR CODE with your mobile device.



www.instmc.org



THE MIDLANDS CENTRE FOR DATA-DRIVEN METROLOGY

Supporting UK manufacturers to adopt measurement techniques for the digital age.

The Midlands Centre for Data-Driven Metrology (MCDDM) was launched in October 2020 to combine the expertise of the University of Nottingham, Coventry University and Loughborough University. Focused on preparing UK manufacturers for the adoption of digital manufacturing processes and technologies by using measurement to gain trust in critical data, especially with surface and co-ordinate measurement and associated sensor development, the MCDDM delivers support to companies through fundamental research, shop-floor implementation, and opportunities for training and education.

The MCDDM offers support directly to small and medium sized companies based in the UK through fully-funded short research projects. Previous beneficiaries of these short projects have spanned a range of manufacturing sectors, including aerospace, transport and medical devices. Companies have received expert advice and recommendations on their measurement needs, including key performance indicator reviews of specialist measurement equipment, comparisons of existing measurement technologies for specific applications, and assessment of novel systems for new measurement challenges. By accessing this support through the MCDDM, companies are provided

with the expertise of three leading research and technology application groups combined under one collaborative, integrated project.

In addition to this direct support, the MCDDM is developing its own novel digital metrology demonstrators. At Nottingham, the first state-of-the-art demonstrator, capable of performing fast, automated in-process measurements in near real time is being created. Combining technologies that involve advanced optical coordinate and surface texture measurement techniques, automatically optimised measurement set-ups, measurement workflow minimisation algorithms, data fusion and high-speed data processing, the aim is to present a system capable of performing complete-object measurement of shape and surface texture with minimal operator intervention. The Loughborough demonstrator combines networks of sensors with advanced high-speed computing and artificial intelligence, to provide multi-purpose data; for example, to control processes and automation, track factory operations or inspect large and complex products. A third installation at Coventry University takes a commercially available teaching demonstrator of a digital manufacturing line and, working with the supplier, extends its capabilities to address real customer manufacturing issues with controller software developments and in-line metrology and data analysis.

But MCDDM is not all about research; ensuring that skills for the future are embedded into the UK manufacturing workforce is a key objective in the transition to

Industry 4.0. The MCDDM is driving this skills transformation through the development of a national framework for metrology education, supported by a wide range of industry stakeholders. Following a consultation workshop in April 2021, the MCDDM team has been working with the Institute for Measurement and Control and Rolls-Royce Plc to devise a framework of metrology skills to serve manufacturing industry, from fundamental understanding for all engineers through to the attainment of expert knowledge in the field.

The development of this framework represents a key new offering in an underserved area; the terms “measurement” and “metrology” are not mentioned in the syllabus of Engineering Chartership, and discussions undertaken during the MCDDM workshop revealed that a lack of education in measurement science is a pain point for manufacturers seeking to recruit graduate engineers. By developing this framework, the MCDDM and its partners are integrating multiple offerings from existing stakeholders in metrology training and ensuring that the most appropriate sources of expertise can be identified and developed where needed.

To find out more about the MCDDM, access short project support, or contribute to ongoing discussions surrounding training needs for your organisation, email charlotte.blake1@nottingham.ac.uk or visit our website at www.mcddm.ac.uk The Midlands Centre for Data-Driven Metrology is funded by the Research England Development Fund.

Experts in Precision Hygrometry

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For industrial and laboratory trace moisture and humidity applications.

Dew point measurements you can trust:

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- Highly repeatable, low drift
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- Wide measurement range: from -100 °C frost point to $+120$ °C dew point

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S8000 RS high precision dew-point hygrometer

Accurate and versatile reference hygrometer where precise control of moisture is needed – such as semiconductor manufacture. Wide measurement range from -90 to $+20$ °C dew point.

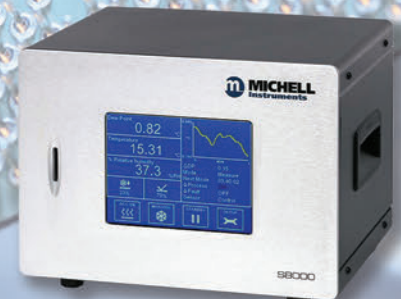
S8000 precision chilled mirror hygrometer

Low-drift humidity measurements as a laboratory reference or for industrial processes. ± 0.1 °C accuracy down to -60 °C frost point.

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MEET THE SIGS EVENT - VIEW THE PRESENTATIONS

Over the summer, the InstMC hosted an online 'Meet the SIGs' event aimed at members and non-members interested in finding out more about the Special Interest Groups. More than 70 attendants heard from representatives of each SIG on their group's activities and projects. InstMC President, Martin Belshaw, also shared news on two new planned SIGs - Net Zero and Far Future Technologies – which the Institute is planning to set up before the end of 2021.

Net Zero

Subjects within this SIG will include Energy systems, Oil & Gas, Buildings, Digital Infrastructure, Decarbonisation, Aviation, Biogas/ BioFuel and Agriculture.

Far Future Technologies

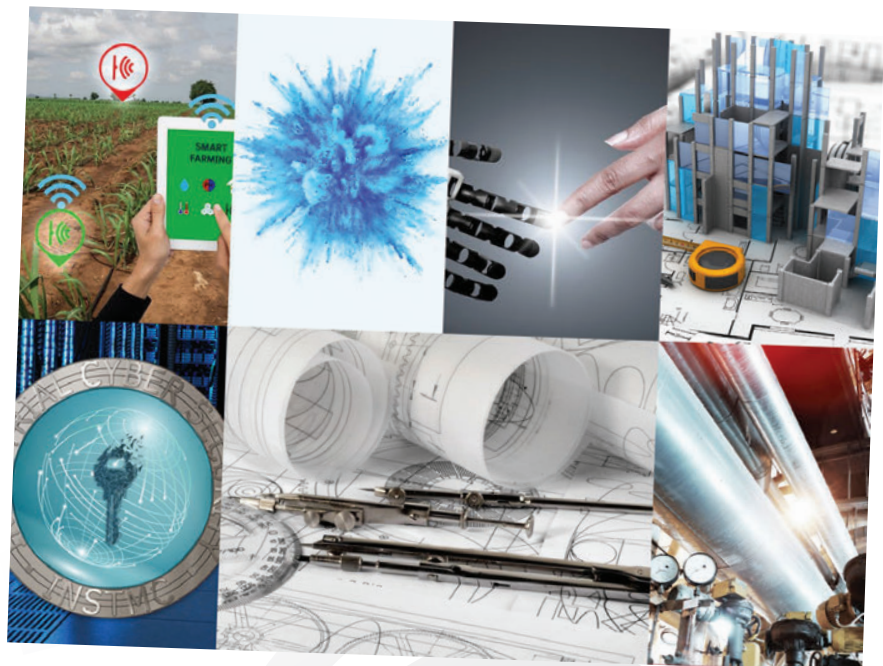
This group will cover the following topic areas, Measuring Future Civilisations, History of the Future, Detecting Other Dimensions, Anatomically Precise Manufacturing, Artificial Consciousness, Space Elevators, Whole Brain Emulation, Speed of Light Travel and a Dyson Sphere.

AGENDA

- Net Zero & Far Future Technologies – Martin Belshaw, InstMC President
- Cyber Security SIG – Cevn Vibert (CHAIR)
- Digital Transformation SIG – Billy Milligan
- Flow Measurement SIG – Bill Priddy (CHAIR)
- Functional Safety SIG – Dave Green
- Measurement SIG – Jeremy Stern (CHAIR)
- Standards SIG – Brian Sprowell
- Q&A

To view and download presentations and recordings from the event, visit <https://www.instmc.org/Special-Interest-Groups/Meet-The-InstMC-SIGs>

If you are interested in joining a Special Interest Group or would like to find out more, visit <https://www.instmc.org/Special-Interest-Groups>



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BY FRED MCCLINTOCK CENG MINSTMC MIMECHE
MIET, WORLD FUTURE SOCIETY MEMBER

FAR FUTURE TECHNOLOGY: PESSIMISTIC PART 2



This is the second of two articles addressing far future technology from the measurement and control engineer's perspective. This is the flip side, and the two sides should be read together.

I contend that this era is the best ever for most humans to be alive, because more than not, our advancing technology continues to make life better and the wonders that await our progeny could potentially be truly astounding. I use the word potentially, because the risks that face humanity within this century and beyond makes our very survival as a species uncertain.

Part 1 Optimistic ignored all obstacles to continued human progress. In this follow up article I elucidate some of the great threats.

Each of the threats is categorised as A, B, or C, defined as follows:

- A – from 50 to 100 years
- B – from 100 years to 1,000 years
- C – from 1,000 years to 1 million years

A **Measuring the Human Extinction Threat (The Doomsday Clock)**

– Whilst still a boy in the early 1960's living near the estuary of the river Clyde, where both British and American nuclear submarine bases were sited (the British base is still there), the threat of nuclear annihilation loomed large in my mind practically every day. I knew that my home was close to a centre designated for annihilation by Soviet nuclear missiles should war break out.

At about this time, I became aware of the "Doomsday Clock". It was founded in 1945 by Albert Einstein and others who helped develop the first atomic weapons in the Manhattan Project. The clock uses the imagery of apocalypse (midnight) and the contemporary idiom of nuclear apocalypse (countdown to zero) to measure the severity of threats to humanity and the planet.

The Doomsday Clock has since become a universally recognised indicator of the world's vulnerability to catastrophe from nuclear weapons, to which has been added, climate change, pandemics and disruptive technologies such as artificial intelligence.

At the time of writing, the clock is set

at 100 seconds to midnight!

A
The Revenge of Gaia – The revenge of Gaia was the phrase used by celebrated British scientist and Fellow of the Royal Society, James Lovelock, to encapsulate the climate woes that humanity faces. Now in his 102nd year, he points out that humans have refused to accept the concept that we and the rest of life from bacteria to whales are parts of the much larger and diverse entity that is the living Earth.

It is hard to believe that our governments will not now resort to climate engineering as a way out of the catastrophe that we face. As a privately funded prelude to this,

Elon Musk announced earlier this year his X prize of \$100 million for the development of engineering solutions for removal of carbon dioxide from the environment. Who amongst us will rise to the challenge?

A, B
Human Germline Engineering – The future measurement and control engineer will need a grounding in ethics, because it is hard to believe that the idea of humans genetically editing themselves will not happen.

Within 50 to 100 years it will be possible to manipulate easily and comprehensively the human genome, as more effective methods

of germline engineering techniques than are available today are developed (successors of CRISPR/Cas9).

We must be prepared to confront the prospect of creating humans that are not actually human.

B

Robot Takeover in the Intelligence Explosion

– As measurement, control and robotics engineers continue to develop intelligent machines, the price we might have to pay eventually is the loss of our status as the most intelligent creatures on earth. This should signal danger, because such machines might consider that the earth has too much water and that oxygen is a dangerous gas that is not necessary for life, as they know it.

Humans must beware of a new arms race in which their governments are already engaged. At the international conference on Artificial Intelligence in Buenos Aires in 2015, the late Stephen Hawking called for an urgent ban on killer robots and an end to the global artificial intelligence arms race.

C

Contact with Extra-terrestrials

– In his recently published book “Extraterrestrial”, Harvard University professor of science, Avi Loeb, speculates that the strange object that entered our Solar System from the vast reaches of the galaxy in late 2017, known as ‘Oumuamua’ was a piece of advanced technology created by a distant alien civilisation. However, our instruments were too primitive to examine it properly as it traversed our Solar System. In the far future measurement engineers will ensure a better preparedness by developing high fidelity deep space scanners.

A, B, C

Existential Threat – A direct hit by an extreme coronal mass ejection (CME) from the Sun, such as the one that luckily missed Earth in July 2012, could cause widespread power outages, disabling everything that uses electricity. It was a narrow escape. An extreme solar storm

could knockout all power grids for weeks or even months, destroying the automatic control technology that powers our civilisation, from

communications to hospitals, to the water supply.

The message for measurement and control engineers is this: Retain and practice the ability to “go manual”. Strive to get your Local Authority to introduce this as a core subject in the school curriculum.

B, C

The Reverse Engineering of God

– On the present course to the future, it could be said that we are attempting to reverse engineer God. Let us therefore ask, how does God do it all? What technical powers does God possess?

We might say that God has dominion over:

Nature; life; death; the Earth; the Solar System; hyperspace: dark matter; dark energy; the universe; the multiverse and heaven.

God also possesses a quality that is often called *wisdom*.

Humans are already on the way to achieving dominion over some of the things highlighted above. However, I contend that the brain of the human animal, as currently configured, does not possess the necessary wisdom to survive the perils that will arise through our engagement with the other domains on that list. Unless we can find ways in the far future to re-engineer and enhance the human brain in a way that endows a much higher quotient of wisdom, then I suggest that we are doomed.

A, B

Cyberwarfare – The likelihood of cyber wars in the future is great, simply because in all of recorded history, there has not been a time when some group of humans has not been at war. Indeed, war has been the main process by which the modern world has been constructed.

In the far future we will live very much more within the digital realm

than we do today. Our brains will become ever more connected to the brains of other humans, and to the brains of our pets for instance, as well as the ‘connectomes’ of our

deceased forebears in virtual form.

This will take place through the medium of the ‘Web of the Future’. An inevitable consequence will be an enormously increased exposure to the dangers of cyber disruption at the most intimate level and also at the global level. The enemy will inflict suffering by denial of connectivity with all that we love and all that we need for mental sustenance. What we see today by way of cyber-attacks are simply the first ‘baby’ steps. In the future, cyberwar will become the only method of war for the human animal - It is perhaps time to pause and reflect.

A

Global Governance – The challenges ahead are enormous, such as new and more widespread water shortages in certain parts of the globe, mass migrations of people seeking refuge from intolerable climate conditions, pandemics which target the young, the as yet unsolved problem of nuclear proliferation, growing deforestation and spoiling of habitats for animals, fish and insects. I mention also the remaining nationalistic, racial, sectarian and fundamentalist passions of the present.

I contend that to meet all of these world challenges we must move towards a system of global governance. The League of Nations, formed after the first world war, was the first worldwide inter-governmental organisation. The United Nations was established after World War II in 1945. Hopefully, before it is too late, we will set about the common purpose of creating an organisation for truly global governance and, as engineers and technologists, we must do everything we can to facilitate this.

LOCAL SECTION NEWS

CENTRAL NORTHWEST

Central Northwest has continued with the Technical Talk programme, running as 'Lunch and Learn' sessions over the spring and summer 2021, with four webinars hosted, including a joint event with the North Lincs section.

- **Humber – Refinery of the Future 5th May 2021**

This joint event with North Lincs was presented by Kevin Hammond of Phillips 66. The session explained the importance of the refinery on the Humber bank and the challenges it faces moving to the future. The adoption of decarbonisation has presented new challenges to the refinery and Kevin shared how this needs to be included in its automation, measurement and control strategies, incorporating digitalisation and with an increased focus on energy efficiency.

The session was thoroughly enjoyed by all participants but as it was a LIVE only event, no recording is available.

- **Functional Safety Assessments – Learning for End Users 26th May 2021**

William Cowdroy of Engineering Safety Consultants Limited (ESC), an ERM company, gave a presentation on the importance of FSA's in Functional Safety. This session concentrated on why end-users ought to get more involved in the execution of FSAs and shared some common issues which consultants within ESC have observed across multiple industries and clients, to assist end users to implement strategies to avoid similar pitfalls. This session was recorded and is available via the local section webpage.

<https://www.instmc.org/Local-Sections/Central-North-West>

- **Benefits of Simulation in Process Control 23rd June 2021**

Andrew Rooney of Saker Solutions (part of ITI group) provided an insight on the benefits of using simulation in process control design. The presentation provided an insight into the area of simulation.

- What is simulation?
- Benefits of using simulation
- Typical projects that could benefit from simulation.

The presentation demonstrated the benefits of conducting virtual commissioning on the simulation in advance of trying to commission the real system on the facility. The reduction in commissioning time was shown on the example projects shared in the session. This session was a LIVE only event therefore no recording is available.

- **The Autorodder – 'Prevention is better than the cure' 14th July 2021**

Scott Gower of GPEC and Hans Sauer of Clearguard presented the Autorodder manufactured by Clearguard. The presentation explained the enhances in technology to keep clear process connections. The technology has been developed with the intention of reducing the potential H&S issues with staff manually rodding process connections. Additionally, reducing equipment downtime, which is usually required either through infrequent rodding (leading to blockages and lost process medium) or to enable the rodding to occur (as the hazards are too great to allow online rodding). The technology periodically clears the process connection without interrupting the

process medium being passed to the sensing elements. The session was recorded and will be linked from the local section webpage once uploaded to the InstMC Youtube channel.

The CNW committee would like to formally thank the presenters that have given their time to develop and present these enlightening sessions. The programme took a break in August but is back for autumn, with three more sessions taking place from September to November.

- September 22nd – Why Automation isn't the answer – The Smiler Incident.
- October 27th – The Art of Flying with no Hands.
- November 24th – HSE share their perspective on the Electrical, Control and Cyber Security Operational Guides.

The committee welcomes the easing of COVID restrictions with caution. The annual dinner has been scheduled for 14th October 2021 at The Edwardian Hotel (Radisson), Manchester. Initial bookings have been very promising and we hope that the COVID situation remains healthy enough to allow the event to take place. If you are interested in attending the event, please check the section webpage for full details in how to book your place.

<https://www.instmc.org/Local-Sections/Central-North-West>

Dave Green

CNW Local Section Chair

LONDON

'Intelligent Wearables – Improved Productivity, Safety & Competency'

This Honeywell online presentation demonstrated the handsfree, wearable Connected Plant technology that allows industrial workers to more safely, reliably and efficiently accomplish their tasks in the plant or field.

Honeywell's Skills Insight Intelligent Wearables feature a head-mounted visual display that responds to voice and brings live data, documents, work procedures, as well as health and safety information into view. The new wearable technology also connects field workers with remote experts in real time and allows them to assimilate valuable skills and knowledge while working.

The Honeywell Connected Plant technology offers industrial workers the information they need when they need it, wherever they are, this means workers carry with them decades of relevant expertise that is accessible at any time by simple voice activation. This solution is a particularly good fit for all process industrial workers who have an affinity for technology and who need more physical freedom to efficiently accomplish their work.

Honeywell's new technology uses the latest in handsfree mobile computing, augmented reality, Industrial Internet of Things (IIoT) and mobility software. It combines the RealWear HMT-1Z1™ handsfree wearable computer with Honeywell's Movilizer platform, an industry cloud-based workflow solution, to support field service operations, specifically in hazardous locations.

Skills Insight Intelligent Wearables offer several key features:

- Operator task automation: Guided work instruction and procedures plus visualisation of documents to facilitate field work.
- Visualisation of live data: Real-time IIoT data made available to the field worker.
- Video capture and playback: Learning on demand and on site through playback of video, captured by expert operators working on similar tasks and searchable using voice.
- Expert on call: Instant access to remote experts via video chat, who can see what the field worker sees and can provide advice, share documents or annotate the video feed.
- Geo-localisation, navigation and asset visualisation: Locates a field operator in the plant and provides navigation and visualisation as required for a task.
- Rapid emergency evacuation: Locates workers in the plant and guides them to an assembly point using geo-localisation.
- Man-down assistance: Detects a man down, identifying the location and notifying the emergency team for assistance.

"RealWear's 100% handsfree, rugged head-mounted computing platform can achieve the Zone 1, Class 1/Division 1 level of intrinsically safe certification, together with Honeywell's software and services this enables digital transformation that drives higher productivity and safety for people working in hazardous locations and across the industrial sector."

Honeywell Connected Plant is a suite of applications that delivers higher levels of safety, reliability, efficiency and profitability. These proven industry solutions are based on decades of domain knowledge and controls experience. They turn data into actionable insights so industrial manufacturers can optimise operations, predict plant failures and eliminate unplanned downtime. This new level of consistent high performance makes every day the best day of production.

After a break in August, the London Section is looking forward to the start of our Autumn webinars which will begin in September 2021. <https://www.instm.org/Local-Sections/London>

Barry O'Regan
Hon Secretary, London Section



Honeywell's new technology uses the latest in handsfree mobile computing, augmented reality, Industrial Internet of Things (IIoT) and mobility software.



INSTMC 2021 AWARDS



Due to the Covid-19 pandemic and restrictions around social gatherings, the Institute cancelled the Awards Night ceremony in 2020. As lockdown ends and restrictions are gradually eased, we will be hosting an online ceremony, to honour this year's winners, on Wednesday 27th October 2021.

We are delighted to present to you, the recipients of the 2021 InstMC Awards.

Sir Harold Hartley Medal

Winner: Professor Graham Machin

For outstanding contribution to the technology of measurement and control.

Professor Graham Machin is a globally recognised temperature measurement scientist and one of the most influential figures in

the international thermometry community. He played a pivotal role in ensuring a successful redefinition of the kelvin, as part of the wider redefinition of the international system of units. His key achievements include, leading two major international consortia through the "implementing the new kelvin" projects. These made seminal contributions to the kelvin redefinition through; stimulating a resurgence in primary thermometry, performing multiple new measurements of the thermodynamic fitness of both current temperature scales and making major contributions to the mise en pratique for the definition of the kelvin (MePK). Ensuring NPL (and hence the UK) had a world leading experiment to determine the Boltzmann constant whose value was one of only two achieving sub-ppm uncertainty.

Honywell International Medal

Winner: Dr David Angeli

For distinguished work in control by Chartered Measurement and Control technologists.

David Angeli is a Reader in the Control and Power Research Group of the Department of Electrical and Electronic Engineering at Imperial College London. He is also an Associate Professor at the University of Florence. His research focus is on stability, performance and control of nonlinear systems. In particular, he has made major contributions to the fields of Economic Model

Predictive Control, to defining and extending the Input-to-State stability framework for analysing nonlinear systems of various kinds, to the qualitative behaviour of differential-equation models of networks of chemical interactions, to monotone control systems as they arise in Systems Biology, and on distributed solutions for demand-side management and energy storage in smart grids.

Callendar Medal

Winners: Professor Adrian Long and Professor P A Muhammed Basheer

For outstanding contribution to the art of instruments or measurement

Awarded for their joint development and invention of instrumentation to support new types of non-destructive measurement in the structural engineering industry. Their work is exemplified in the AUTOCLAM PERMEABILITY INSTRUMENT, developed by Long and Basheer to allow, for the first time, quantitative measurements of those surface properties of concrete influencing its durability and performance in normal or aggressive environments. AUTOCLAM measures air and water permeability and water absorption into the near surface zone of concrete and other building materials, including surface repair materials, without causing damage. It is an exceptionally good tool for assessing the durability of these surfaces when exposed to normal

or aggressive environments. It can measure the above properties both on site and in the laboratory, as well as measuring permeation properties to enable planned and timely maintenance.

Finkelstein Medal

Winner: Professor Frank Härtig

For notable contributions to measurement, internationally (by a UK or international figure).

Awarded to recognize his international leadership in the field, including PTB's (Physikalisch-Technische Bundesanstalt) contribution to the development of new standards for the kilogram (using the silicon sphere approach). Professor Härtig studied mechanical engineering at Karlsruhe University (TH) becoming a graduate engineer and took an external doctorate at the Institute for Tooling Machines and Industrial Engineering of Karlsruhe University, becoming Dr.-Ing (equivalent to PhD Engineering). After working for several commercial companies for more than a decade, he joined PTB in April 1995. After 25 years he became, in May 2020, Vice-President of PTB and a member of their Executive Committee. He is highly international in his outlook – in 2018 he became President-Elect of IMEKO, the International Measurement Confederation (he will become President in 2021 and host the IMEKO World Congress in 2024 in Berlin). He has also been Professor (honoris causa) from Harbin Institute of Technology 2016) and held a Guest Professorship at Beijing University of Technology from 2016 – 2018.

Cornish Award (Sponsored by WCSIM) City, University of London Team

Dr Miodrag Vidakovic
Dr Matthias Fabian
Dr Bruno Rente
Prof Tong Sun
Prof Kenneth TV Grattan
Dr Heriberto Bustamante
Dr Louisa Vorreiter

Awarded to an individual, group or company that has excelled in some dimension of scientific instrument making. For example, the award can be made to those from industry, academia, and national or independent laboratories.

The award is given to recognise the team's work in developing, a Fibre Bragg Grating (FBG)-based optical-fibre sensor system tailor-designed for a client to use in-the-field in remote locations to monitor both relative humidity and temperature in real-time and to provide alerts to the end users, using 4G/5G connections. In addition to use in sewers, the sensor system has been successfully deployed and used in biodigesters (an explosive environment due to the presence of methane) – ensuring the structural health of the whole construction where conventional sensors are hazardous to use due to explosion risks. The customized sensor design has been demonstrated to survive above harsh conditions through this case study over a period of >20 months, with active monitoring still on-going.

L B Lambert Award
Professor Eddie Lock

For meritorious service to the Institute particularly through involvement with local sections.

The award is given to recognise all of the work Professor Lock has done during his time as Vice Chairman of the Hong Kong Local Section. During this time there has been a substantial increase in membership, and an increase in members gaining professional registration. Prof Lock has also supported the section in the delivery of many symposia and seminars, and developed and strengthened links with other engineering organisations in Hong Kong, Macau and mainland China.

Honorary Fellow
Ron Summers

Recognising distinguished, and normally long, service to the Institute

Ron has offered considerable service to the Institute over very many years: and has served not only as a Vice-President (from 2000 to 2005) but was the first two term President for many years, in 2007 and 2008. He undertook what at the time was an unusual second year as President. In addition, he had been a member of the InstMC Board of Trustees for many years and has served as Chair of the InstMC Communications Board and as Editor of the Journal of Measurement and Control. Further, Ron was the convener of the Instrumentation Industry Liaison Group for many years, an organisation whose membership bridged industry trade associations, academia, the National Physical Laboratory, the National Measurement Office, WCSIM and InstMC, and whose remit was to act as a champion to the sector when interfacing with Government agencies and beyond.

Honorary Fellow
John Morley

Recognising distinguished, and normally long, service to the Institute

John Morley joined the Institute in 1981 and has been an active member in both the central office and London Section ever since. Within the London Section he was elected as Chairman for two years in the nineties and has remained active on the committee ever since. From his time as London Chairman, over a period of 15 years he served on the major Institute committees, commencing with Local Sections committee, including serving as Chairman, and was also responsible for organising the "Away Day" meetings for the Institute in the eighties and nineties. This overlapped with serving as a council member, an executive board member, then Vice President culminating in the Presidency in 2003, and remaining on the executive board until 2006.

CORNISH AWARD WINNERS: THE CITY UNIVERSITY TEAM

INNOVATIVE FIBRE OPTIC INSTRUMENTATION FOR HUMIDITY MONITORING IN WASTEWATER INFRASTRUCTURE

With the ageing of sewers worldwide, attention has been focused on better in situ monitoring of their condition and how that changes with time and use – as this will allow better simulation and thus understanding of the degradation of these crucial assets that most of us simply take for granted.

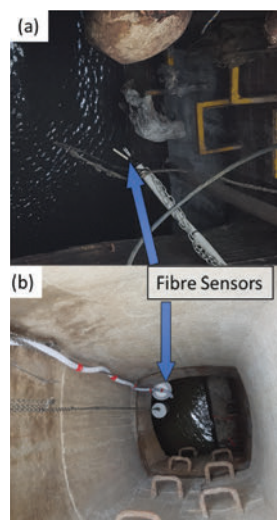
Having reliable data on the key parameters which are indicative of the system degradation – and thus potential failure – is crucial for modelling and planning active measures to allow better predictive maintenance. In particular if this is properly done it will avoid catastrophic, and often very expensive, failure events. It is well known that repair and refurbishment costs are closely linked to the state of these, often Victorian, sewers – where many of which were installed decades ago (and for which the detailed structural information is often lost) but are still

in continuous use. A key problem is that the degradation that occurs within them is due to the influence of natural, biogenically generated sulfuric acid (H_2SO_4), arising due to the oxidation process of hydrogen sulfide (H_2S) on the surface of the concrete sewer pipe. Further, the presence of a humid atmosphere is important in the biogenic conversion of hydrogen sulfide into sulfuric acid. Reductions in the level of humidity can significantly influence the rate of corrosion in sewers known to include high relative humidity, methane concentrations over 1%, and hydrogen sulfide concentrations up to 340 ppm.

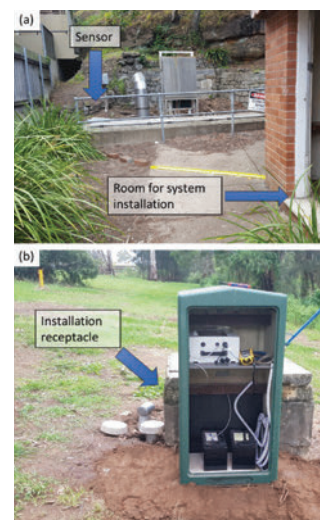
The award was based on the success of an innovative project commissioned by Sydney Water, which in this instance was faced with the challenge of measuring relative humidity and temperature in their harsh and acidic sewerage network, some of which is 100+ years old and in many places not well documented. Conventional sensors only provide accurate measurement for a short time (a few weeks) as they fail to deliver reliable long-term data due to the corrosive effect of the sewer

gaseous environment. Real-time monitoring of these parameters is one of the key challenges, given the well-established links between temperature and humidity and the rate of corrosion of the sewage infrastructure. Moreover, existing solutions do not offer the multiplexing capability needed to provide measurements at number of different points widely distributed across the multi-kilometre sewer network.

The solution created by the team involved the designing, constructing and implementing an innovative approach, a Fibre Bragg Grating (FBG)-based optical-fibre sensor system was tailor-designed for use in-the-field in remote locations to monitor both relative humidity and temperature in real-time and to provide alerts to the end users, using 4G/5G connections. Fibre



Sensor installation locations at the two sites chosen (a) Eustace Street Station and (b) Old Toongabbie Station



Photographs of the installation of the system located at (a) Eustace Street Station and (b) Old Toongabbie Station

optic sensors (by comparison to conventional electronic sensors) were chosen, as the highly humid environment in the sewer is not suitable for the continuous use of conventional, electronic sensors. In addition to use in sewers, the sensor system has been successfully deployed and used in biodigesters (an explosive environment due to the presence of methane) – ensuring the structural health of the whole construction where conventional sensors are hazardous to use due to explosion risks. The customized sensor design has been demonstrated to survive above harsh conditions through this case study over a period of >20 months, with active monitoring still on-going.

The work done enabled this long

which the series of Bragg Grating-based sensors had been installed. The locations were carefully chosen in different parts of Sydney: Eustace Street in Manly, Sydney and Old Toongabbie at Oakes Reserve, Western Sydney, as both had different operating environments and thus complementary conditions for evaluating the sensor system. The work done was designed to provide a solution to enable long term, low cost and more reliable monitoring in the harsh conditions of the sewer environments in terms of high relative humidity >95% and a broad range of hydrogen sulfide levels. The results of the study show that even after nearly two years of use, the same sensor system was able reliably to record the humidity and temperature data in the sewer

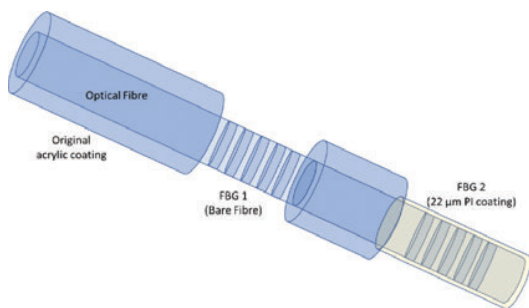
environment – overcoming the problems seen with conventional electrical sensors, which typically fail within a couple of weeks of use in this continuous high acid/high humidity environment. The data, recorded constantly from the sensor system, were stable throughout the full monitoring period and further, a comparison with the changing weather conditions could be made over the different seasons during the study. The sensor system developed was battery operated and had 4G connectivity for data transfer and debugging. These features have enabled the system to be installed in situations where power is not available and operate

successfully with minimal human operation, thus allowing for additional systems to be integrated to the measurement system in the future.

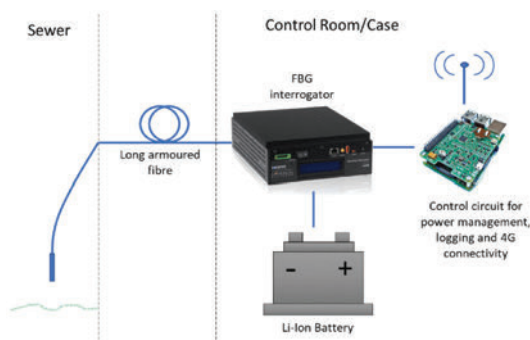
Having reliable data on the key parameters which are indicative of the system degradation – and thus potential failure – is crucial for modelling and planning active measures to allow better predictive maintenance.

The long-term outcome was that, as a result, Sydney Water has been able to monitor these key infrastructure assets (biodigesters and sewers) in real-time, while getting alerts on critical values so that timely remedial actions could be taken. The data collected and reported has given Sydney Water a significant insight into areas where ventilation procedures needed to be deployed or improved and more importantly relative humidity and/or temperature sensors installed were used to address corrosion problems that arise from humidity and H₂S. During this work, the reliability and long-term potential of the FBG-based relative humidity and temperature sensor-based monitoring system has been demonstrated, operating as it does in a harsh sewer environment, while being battery powered and connected via the internet.

On-going work is continuing to deploy fibre optic-based sensor systems on the monitoring of wider locations across Sydney Water's



Sensor design showing one bare FBG (for temperature-only measurement) and a second FBG coated with a hygroscopic material (for temperature and humidity measurement)



Hardware setup for the system used in this work, illustrating the sensor interrogation and data transfer approach used

period of monitoring of humidity in situ at two locations in the sewer network operated by Sydney Water using a fibre optic network into

sewer network creating a map of the conditions which most facilitate infrastructure corrosion and allow for more targeted use of Sydney Water's £30 - £40M annual maintenance budget in better preventative maintenance which creates major savings to the company.

Based on this, the Inaugural (2021) Cornish Award, for work done in the field of 'Humidity monitoring in Wastewater Infrastructure', has been made to an interdisciplinary industry-academic team comprising:

Dr Miodrag Vidakovic – Royal Academy of Engineering Enterprise Fellow at City, University of London and Managing Director, Sentech Analytics, London

Dr Matthias Fabian – Worshipful Company of Scientific Instrument Makers Beloe Fellow at City, University of London and Sentech Analytics, London

Dr Bruno Rente – Research Fellow at City, University of London

Professor (Mrs) Tong Sun OBE FREng – Royal Academy of Engineering/ Favelley Brecknell Willis Research Chair at City, University of London and Sentech Analytics, London

Professor Kenneth TV Grattan OBE FInstMC FREng – Royal Academy of Engineering/George Daniels Research Chair at City, University of London and Sentech Analytics, London

Dr Heriberto Bustamante – Principal Scientist, Treatment, Research & Innovation Team, Sydney Water

Dr Louisa Vorreiter – Asset Strategy Leader, Sydney Water

The team is highly diverse with

members from Serbia, Germany, Brazil, Chile, China, UK/Ireland, and Australia.

The specification for the award is for work which 'has excelled in some dimension of scientific instrument making within industry and academia' and in this case the team has been innovative in the field of 'scientific instrument making', developing both the hardware as well as the software needed to solve the problem.

The work has been published in several high impact journal papers including:

Rente, B., Fabian, M., Vidakovic, M., Sunarho, J., Bustamante, H., Sun, T., & Grattan, K. T. V. (2021). A Fiber Bragg Grating (FBG)-Based Sensor System for Anaerobic Biodigester Humidity Monitoring. *IEEE Sensors Journal*, 21(2), 1540-1547. doi:10.1109/JSEN.2020.3017108

Rente, B., Fabian, M., Vidakovic, M., Vorreiter, L., Bustamante, H., Sun, T., & Grattan, K. T. V. (2021). Extended study of fiber optic-based humidity sensing system performance for sewer network condition monitoring. *IEEE Sensors Journal*. doi:10.1109/JSEN.2021.3050341

Rente, B., Fabian, M., Chen, Y., Vorreiter, L., Bustamante, H., Sun, T., & Grattan, K. T. V. (2020). In-Sewer Field-Evaluation of an Optical Fibre-Based Condition Monitoring System. *IEEE Sensors Journal*, 20(6), 2976-2981. doi:10.1109/JSEN.2019.2956826



The long-term outcome was that, as a result, Sydney Water has been able to monitor these key infrastructure assets (biodigesters and sewers) in real-time, while getting alerts on critical values so that timely remedial actions could be taken.





Awards

2021



Save the Date

27th October 2021

Institute of Measurement and Control



www.instmc.org

AN INTRODUCTION

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 Institute launched a new quarterly magazine which is a high quality journal with technical features related to measurement and control. This coffee table type magazine is circulated to the InstMC 3002 individual and 100 company members. It is also aimed at anyone interested in the various uses of measurement and control. It is a positioning and marketing tool for the Institute as well as raising awareness to a wider audience of the use of measurement and control in the world today.

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CIRCULATION BREAKDOWN:

2376 UK Engineers / 626 Overseas Engineers
100 Companion Company Members



PRECISION MAGAZINE

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 78 CCS members and are pleased to introduce some of them to you here.



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SPOTLIGHT ON STAFF:

Q&A with InstMC
Staff Member
Jane Chandler,
Membership
Development
Manager

How long have you been with InstMC?

I have only recently joined the InstMC as Membership Development Manager. Engineering is new to me, and I am enjoying getting to grips with all the jargon.

What is your background?

I studied Sociology at the University of Leeds which I loved. I got my first professional career job as a membership assistant with the Royal Academy of Arts. From there, I went on to develop my career in membership gaining experience of managing and growing membership schemes at the Design Museum, the National Gallery and Westminster Abbey. In my previous role, I was responsible for planning and launching a brand-new membership programme. I really enjoy researching, creating new processes, developing ideas and problem solving.

What is your role at InstMC?

My role is to research and recommend how we can engage and retain early career members and grow the membership programme. I am excited by the challenge and looking forward to working out how we can achieve this.

Can you describe a typical day in the office?

At the moment, I am focussing on research and gathering insight. My day involves reading a lot, making notes and brainstorming. I'll usually catch up with Steff and the team a couple of times a week. I am also familiarising myself with InstMC and the world of engineering.

What do you bring to the team?

I do like having a chat and a laugh with colleagues over a cup of coffee. This has been done virtually so far... but hopefully I'll get to meet everyone in real life soon! I like the camaraderie of being part of a small team. I am very creative and I enjoy generating ideas. I'm also a bit of a planner and I would say that I bring a thoughtful and measured approach to projects.

What do you like best about working for the InstMC?

I like that there is no hierarchy. I love that everyone's input is valid and welcome. I seem to have joined at quite an exciting time for the Institute with a new website and CRM on its way. I enjoy having my own projects to work on but also being able to contribute to other projects such as the development of the new scholarship scheme.

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

I enjoy creating artwork in my kitchen studio. In the last ten years, I have studied print making, textile design and jewellery design in evening classes. I love learning new techniques and using different materials. I have even sold a few pieces of work! Since having children, I don't often go out in the evenings. Instead, we explore London at the weekend. I like going to places



like Columbia Road flower market, Hampstead Heath or the Southbank.

Can you tell us a fun fact about yourself?

I am not a natural performer by any stretch of the imagination but when I was at school, my school dance group was invited to the BBC studios to perform on Blue Peter. We performed a 'contemporary' dance piece and I even received a coveted Blue Peter badge. Thankfully this was in the 90s, so there is no way the footage can be found online!

OUR CORE TEAM

OFFICERS

President
Martin Belshaw



Honorary Secretary
Billy Milligan



Honorary Treasurer
Ian Craig



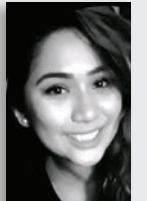
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