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THE KEY TO SURGICAL ROBOT DESIGN

ALL CHANGE FOR SELLAFIELD

IMEKO WORLD CONGRESS – 3RD TO 6TH SEPTEMBER 2018

SPECIAL INTERVIEW//

PROFESSOR SHEILA SMITH

DECEMBER_2017_ISSUE FOUR

PRECISION MAGAZINE

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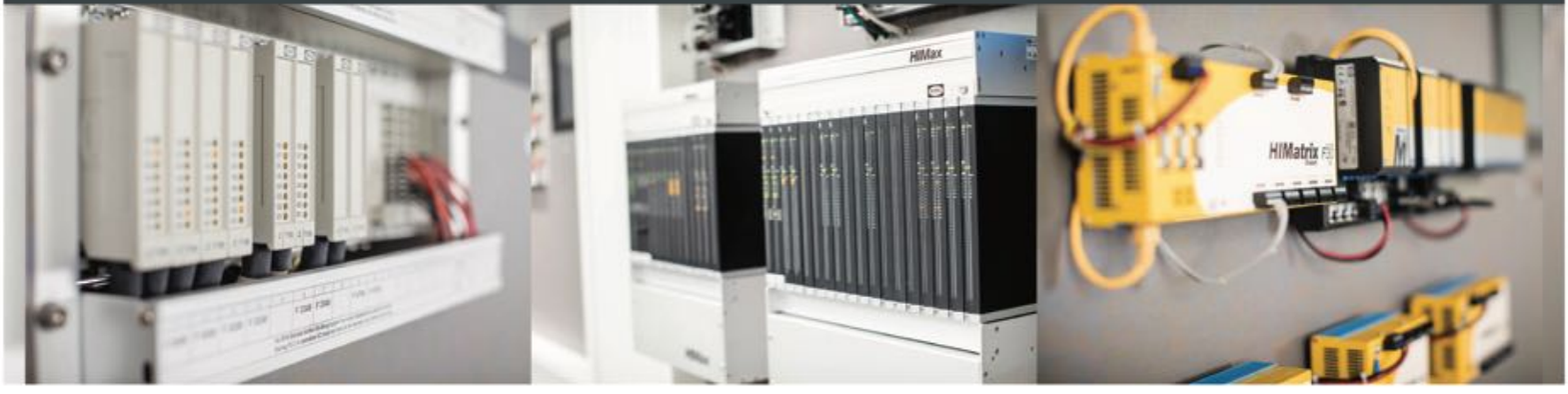

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HOW MUCH TO MEASURE AND CONTROL?

As part of our social media outreach we study the news media daily for any articles relating to measurement or control. It is unusual for a day to pass without finding something. Just looking at a couple of news websites today there are articles about the measurement of smog levels in cities, the value of fitting ultrasound scanners in ambulances, and the shortage of UK nuclear safeguards inspectors post-Brexit.

We are one of 35 chartered engineering institutions in the UK, and in terms of size we are mid-table. But our reach is much wider than our size suggests: every engineer alive measures and controls. As the news feeds demonstrate, our subject area is ubiquitous, and our challenge as the specialist professional body is to define our scope in a way that doesn't subsume the whole of science and engineering.

We have made a start by taking a fresh look at our learned society structures, where we have defined some Special Interest Groups based on key sectors and technologies. Of course we started with a measurement SIG and a control SIG, but we have also responded to growing interest in cyber security, functional safety and digital transformation, each of which now has a dedicated special interest group at some point of development. Other current SIGs are listed on our website and we are planning more in the future.

Our aim is to support our members with a set of tailored specialist groups that promote networking, sharing of best practice, conference and exhibition programmes and newsfeeds. We expect to be using social media forums, webinars and blogs alongside traditional communications and events. Our new website currently being rolled out includes a members-only section where every member can sign up for specialist groups of relevance or interest.

What we hope to end up with is a spread of topic areas, some cross-sector and some cross-technology. As society and technology develop, new interest groups will grow up and older ones will fade away. We will never cover everything, but hopefully the spread will be broad enough for all of us to find something that scratches where we itch.

Patrick Finlay PhD CEng
Chief Executive Officer

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PRECISION

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ALL CHANGE FOR SELLAFIELD

Tom Nobes has been in the control and instrument business for over 40 years. For the last 36 years he's been in the nuclear industry. As Process Instruments Capability Leader at Sellafield Ltd, he discusses the changes in C&I needed to take the company into the next phase of its lifecycle.

Sixty years of operations

Sellafield (formerly nee Windscale) has been operational since 1939. Built as a Royal Ordnance ammunition factory, supporting the UK's war effort, in September 1947 Windscale was re-purposed as a new atomic energy site. Work began on the construction of the Windscale Piles, with their two air-cooled reactors. These were distinguished by their very tall chimneys, one still visible today. By March 1952 the Windscale Piles were producing plutonium for military purposes. Later in the same year a plant to separate uranium and plutonium from that Pile fuel became operational. Almost all work done on the site up to the mid 1950s was in support of the UK's independent nuclear deterrent.

Later, the peaceful use of atomic energy came the forefront of world affairs and so the first commercial nuclear power reactors in the world were built at Windscale, . Construction of the power station commenced in 1953, called Calder Hall, and on 17 October 1956, Her Majesty the Queen opened Magnox Reactor 1. Three more reactors quickly followed and they all operated until 2003, completing 47 years of CO2-free, safe and economical electricity generation. They are now being decommissioned.

Twelve more Magnox power stations followed at sites throughout the UK. Their fuel was (and still is) reprocessed in a purpose built plant at Sellafield. In the 1980s, a fleet of Advanced Gas Reactors (AGR) was built in the UK followed by a single Pressurised Water Reactor (PWR). A second reprocessing plant (THORP) was built to reprocess this Oxide fuel, plus fuel from Japan, Sweden and Germany.

Sellafield today

Today the site is home to a wide range of operations. This still includes Magnox and Oxide fuel reprocessing but it also includes the decommissioning of redundant buildings associated with the site's early military work; spent fuel management; and the safe storage of nuclear fuel and the arising wastes. Sellafield is the largest and most complex site in the UK nuclear estate, indeed; it's the largest nuclear site in Europe with an annual budget of over £2 billion.

Sellafield's mission is to deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management. This means never compromising on safety, or security, taking full account of the social and environmental responsibilities, always seeking value for money for the tax-payer, and actively engaging with our stakeholders.

The changing business

For those familiar with control and instrumentation, a walk round Sellafield's plants today reveals a site with a lot of similarities to say an oil refinery, a chemical plant and the pharma industries. Most C&I is used in similar ways. Instruments measuring parameters from acidity to wind-speed connect to control panels, PLC and DCS systems. Control valves move under the hiss of compressed air and relays click as interlocks protect both plant and people from potential harm.

But soon much of this will change. In simple terms, the reprocessing of Oxide fuel ends in late 2018. Magnox fuel reprocessing will be completed by 2020, after which, Sellafield will be in the storage, decommissioning and waste management business.

Decommissioning and how to do it

Decommissioning nuclear plants is a complex and time consuming process, but can be thought of in four phases.

1. **POCO (Post Operations Clean Out)**
   Plant is flushed and drained. Solid and liquid wastes are consolidated and stored, allowing radiation levels to reduce naturally. That plant which is non-radioactive and no longer required is safely and conveniently decommissioned; this is mostly redundant services to the plant such as chilled water, compressed air, etc.
2. **Decommissioning**
   Essentially the dismantling of the radioactive parts of plant and equipment. This may be done by humans or via manipulators or robots.
3. **Decontamination**
   Dismantled plant is treated to remove radiation if possible. Any; now decontaminated; materials are released for recycling.
4. **Waste Management**
   Radioactive wastes are concentrated, passivated, transformed, stored or entombed (usually in concrete). They are then sealed in a variety of drums and boxes within purpose-built storage buildings for long periods of time (decades) pending an ultimate UK disposal route.

Future challenges for control and instrumentation

To undertake decommissioning, Sellafield will still need to install considerable quantities of instrumentation. This will be used for monitoring and control during POCO and subsequent decommissioning. Common-sense says installing equipment in a plant that is to be

> ...a walk round Sellafield today reveals a site with a lot of similarities to say an oil refinery or a chemical plant. But soon much of this will change.

decommissioned, dismantled and ultimately demolished is counter-intuitive and potentially poor value for money. Instrument installation in parts of nuclear plants is sometimes understandably costly, difficult and time-consuming. Decommissioning often means legacy (already installed) instrumentation is no longer appropriate nor in the correct location. In remote locations, or where access is difficult (stacks, chimneys, furnaces, areas with higher background radiation, ATEX Hazardous Areas, environmental monitoring outflows, etc.), cable and associated infrastructure costs would dominate instrument budgets.

Sellafield will need to take more "one-off" measurements, like –

- What's in this tank now?
- What is this substance?
- What's this piece of plant doing now, what condition is it in?

Also it will need more temporary measurements –

- On test-rigs and in POCO development.
- On short-term tasks and projects, as plant vessels are filled and emptied.
- In moving materials from one part of the now stopped process, to another.

It will also need more long-term measurements –

- In waste storage for up to 100 years.
- The condition of the drums, boxes and buildings used to store the waste.
- The services those store buildings will require. HVAC, steam, security, sumps and bunds, the physical location of drums and boxes, etc.

And more flexibility –

- As the site decommissions and reduces in size, adaption will be needed to adapt, change and move instruments and control rooms. How can that be done?
- The use of more commercial-off-the-shelf instrumentation and a greater use of the supply chain in general.
- As plants close and move into longer term care and maintenance, the option of the new technology of "mobile working".

We've already started

So for one-off, temporary, flexible, short-term measurements, one of the big answers to all this is wireless instruments. Suppliers like Fluidic®, Omniflex® and Yokogawa® plus bodies like National Physical Laboratory® and Evaluation International® are working with Sellafield to develop our wireless instrument capability. This includes the adaption of existing legacy instruments into wireless.

The use of new technology will mean it may not be necessary to do as much instrument maintenance as is needed now. Some instruments are and will continue to be SIL rated or they are environmental monitors, so these will continue to be managed as currently. However; most of the others will move more towards "fit & forget" with maintenance being done only when the instrument itself requests it. To this end, Beamex® has been working with Sellafield's instrument maintenance staff on the harvesting of instrument diagnostic data and calibration trend monitoring.

More use will be made of the technology that's already out there to meet safety, cost, time and quality goals.

There's one more hurdle

Sellafield and its supply chain will always be both physically and contractually large and physically diverse. West-Cumbria can be a somewhat geographically remote location and may seem to get more so as Sellafield's workload gradually reduces.

So the final problem is to join-up the dots between supply-chain and Sellafield. Working in partnership is certainly one of the answers and Sellafield is proceeding towards a long-term Programme & Project Partnership with various consortia.

So in conclusion

Sellafield is moving towards a new phase of its lifecycle. It is the era of decommissioning and waste management. This will present us with challenges both familiar and new and control and instrumentation will be a key part of success in this endeavour. Sellafield is determined to be one of the UK's early-adopters of suitable new technologies and the developer of new techniques in decommissioning and waste management.

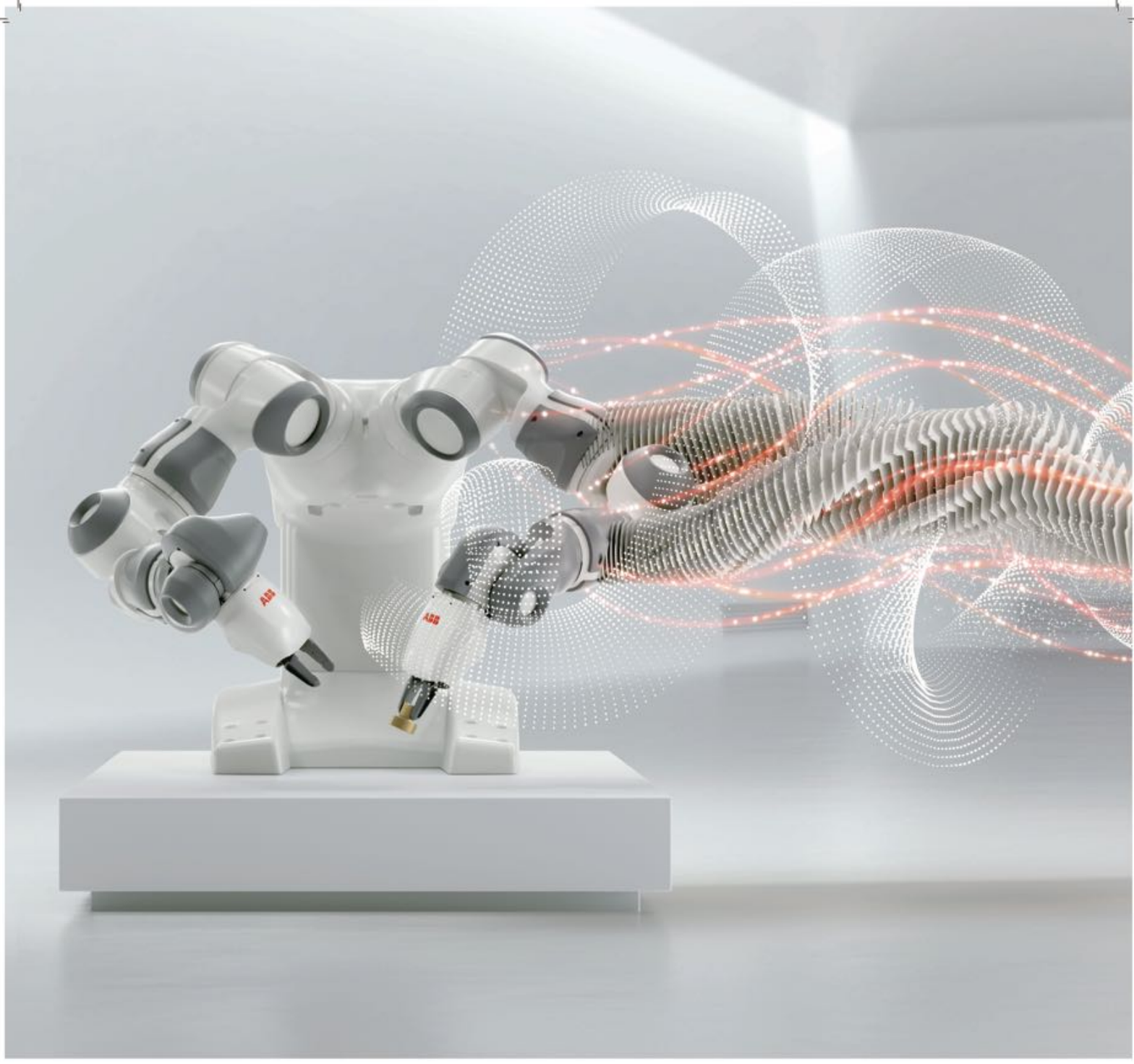

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ABB

by Inderpreet Shoker, ARC Advisory Group

IoT CAN HELP SAVE LIVES

Accidents like the Grenfell Tower fire keep happening across the globe. It is unfortunate that, in 2017, when we are at the cusp of a digital and industrial revolution, we have failed to use the technology at our disposal effectively. Accidents like these compel us to review and improve not only the existing technology and its implementation but also associated regulations, policies, and enforcement.

Overview

The fire at Grenfell Tower in London last summer resulted in scores of deaths and shocked us all. It made many of us wonder why, even with all the progress made in terms of technology and regulations, such large-scale incidents continue to occur.

While investigation is still under way to determine the exact cause of the incident and the reason why the fire spread so quickly, early reports highlighted some of the major issues.

Media reports suggest that the Grenfell Tower did not have a functioning central fire alarm system. Furthermore, not all smoke alarms in individual flats worked properly. Most residents claimed that they were alerted about the fire only when they heard people screaming for help or knocking on their doors. Experts expect that the building's new exterior cladding will be determined to be the main factor that caused the fire to spread so rapidly.

Based on established policy, the first responders instructed residents to "stay put" unless their own flats are on fire. This policy, frequently used in compartmentalised, high-rise buildings such as this, assumes that most fires in these buildings can be contained within the flat for at least 60 minutes, before the fire fighters arrive. The policy, and the subsequent delay in changing the instructions when it became apparent that the fire was spreading

faster than firefighters could contain it, appears to be the major cause for the high casualty count.

These early reports have raised several questions. Were the detectors in the building properly installed? Were safety inspections conducted regularly? Was the central alarm system properly maintained? Was the new cladding properly tested? Why were so many people unable to leave the building? Why were the instructions to "stay put" not changed sooner?

This accident highlights how we have failed to use the available technology to prevent a small fire from turning into such large-scale catastrophe. It has compelled us to review and improve not only the existing technology and its implementation; but also associated regulations, policies, and enforcement.

IoT Can Help

Fire safety is among the various areas that can benefit from Internet of Things (IoT) technology. The IoT has helped create a smarter and more connected world. We have various kinds of fire detectors and suppression systems to provide appropriate alerts and/or prevent fires from spreading.

Thanks to IoT-based technologies, these products are becoming more intelligent and connected. With IoT, centralized systems can now send safety alerts to hundreds of people quickly and effectively. Several leading fire safety companies have also developed IoT-enabled fire detectors that are appropriate for single-family homes or smaller multi-family dwellings.

The most popular connected smoke detector on market is offered by Nest Labs, a leading supplier of smart home automation products. The company, now a part of Alphabet Inc., offers the Nest Protect smoke and carbon monoxide detector. The Nest Protect detectors can communicate with the Nest thermostat and can alert residents if they detect fire or carbon mon- oxide. The detectors can be accessed remotely from anywhere using mobile apps. In the event of an alarm, the detectors sound a local alarm as well as send notifications on the mobile phone.

Kidde Systems, a leading safety product company, offers a monitor to add connectivity to existing detectors. With Kidde's RemoteLync Monitor, users don't have to change all detectors. The monitor listens for the specific frequency of smoke and CO detectors and sends an alert to its app when it hears them. One single monitor can cover multiple detectors on the floor.

Another retrofit option for users is available through a company called Roost. The company offers a connected, nine-volt battery that contains a Wi-Fi antenna and a microphone. Users can swap their regular batteries with Roost batteries in their old detectors to add smart features. The battery can send a push alert whenever the detector sounds. Users can also check the remaining battery life at any time with its app. Various other smart detectors and connectivity products are available through large players such as First Alert and new startups such as Leeo.

Slow Adoption of Advanced Solutions

Clearly, plenty of technology innovation is going on to help avoid tragedies such as the Grenfell fire and we continue to hear about new and upcoming smart products. So when we have such advanced detectors available, why aren't we using them? One reason is that while many high-end IoT-enabled safety solutions are available in the market, they are not cheap. Many smart detectors cost three to four times more than traditional detectors and current regulations do not require them. Against this background, it's likely that it will take some time before these smart detectors will be used in most houses and buildings.

Central Fire Alarms Could Enhance Safety

While the smart detectors discussed above are more suited for single-family homes or smaller multi-family dwellings, larger residential developments (such as the Grenfell Tower), should be equipped with functioning central fire alarm and voice evacuation systems.

In a central alarm system, all detectors are connected to a central controller and send signals directly to this controller. The controller actively monitors multiple locations and, when it receives alarm input from the detection de- vices, the controller activates notification devices such as horns, strobe lights, and speakers to alert the occupants.

Now, more and more connected and smart features are also becoming incorporated into central alarm and evacuation systems. Today's latest mass- notification systems include a paging component to relay live audio instructions throughout the building in case of an emergency. Many also include support for various types of emergency messages such as inclement weather, security alerts, "Amber" alerts for missing children, etc. Advanced features in mass notification systems include the capability to communicate alerts via SMS, text, e-mail, popup, app message and push notification to targeted recipients, thus helping create quick and effective awareness.

It's likely that these types of centralized advanced notification systems could have helped save many lives at the Grenfell Tower where many residents did not receive the alerts in time to get to safety.

Analytics Could Help Improve Planning and Response

Consumer and industrial IoT-enabled technologies could also improve emergency planning. Sensor and detector data and other surveillance data could be combined with algorithms and analytics to help improve emergency or evacuation plans. Analytics could consider multiple

factors such as the number of people in the building; individual building maps; location of fire; fire spread rates for different building materials and construction techniques; and likely direction of fire and smoke. Using the available data and analytics, these plans could be designed to prevent congestion and speed evacuation, by guiding residents in different parts of the building to take the optimum routes.

During a fire emergency, first responders could also use real-time data and analytics to battle the fire more effectively and provide the correct guidance to occupants to help prevent panic and avoid injuries or deaths. In the case of Grenfell Tower fire, for example, such analytics could have helped safety officials realize that pace at which fire was spreading was faster than the pace at which it was being controlled. Knowing this, they could have revised the "stay put" instructions sooner and use the sensor data to guide tower residents to open and accessible exits.

Recommendations

Even with the best of technologies, we cannot avoid safety incidents altogether, but much could be done to prevent minor incidents from developing into catastrophes such as at the Grenfell Tower. Connected products and solutions such as smart detectors, alarms, and notification systems could help us gather crucial alerts quickly and better plan for emergency situations. Users should evaluate and implement these connected technologies to enhance safety, minimize damage and save human lives.

Although safety technology has come a long way, technology alone is not sufficient and probably never will be. Often, disasters happen not because of faulty equipment or lack of appropriate technology, but from lack of proper implementation, poor planning, or – in industry – due to a poor safety culture. Deploying advanced safety technology will not help improve safety unless the technology is properly implemented and maintained. Appropriate regulations, policies and procedures should be in place and adhered to rigidly.

Governments all over the world should implement strict regulations and make sure these are enforced. They should continue to carefully evaluate these regulations and available technologies and, update as necessary. Governments and industrial organizations should also partner with technology suppliers and research institutions and promote research in advanced IoT safety technologies.

The Grenfell fire, along with many other incidents, have drawn attention to several factors that likely lead to catastrophic events. We should learn from these mistakes and work together to take the necessary steps to help minimize the frequency and severity of any future incidents.

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COMPANION COMPANY SCHEME BENEFITS

Companies involved in measurement, instrumentation & process control are welcome to become members of our Companion Company Scheme. Over 100 leading businesses already benefit from CCS membership.

Over the past 70 years, the InstMC has become an established and recognised professional body in the Measurement, Control and Automation industry. InstMC is widely acclaimed for its continuous efforts to facilitate the exchange of information aimed to improve instrumentation and control industry standards. The Institute supports the development of our Member Companies through a wide range of business oriented benefits:

- Opportunity to organise networking events and services;
- Discounted advertising space on InstMC platforms;
- Introductory article in InstMC journal;
- Certificate acknowledging InstMC Corporate Membership (CCS) and status within the industry;
- Possibility to submit internal news articles and technical material on InstMC Website and Journal.
- Discounted Exhibitors and Conference fees.

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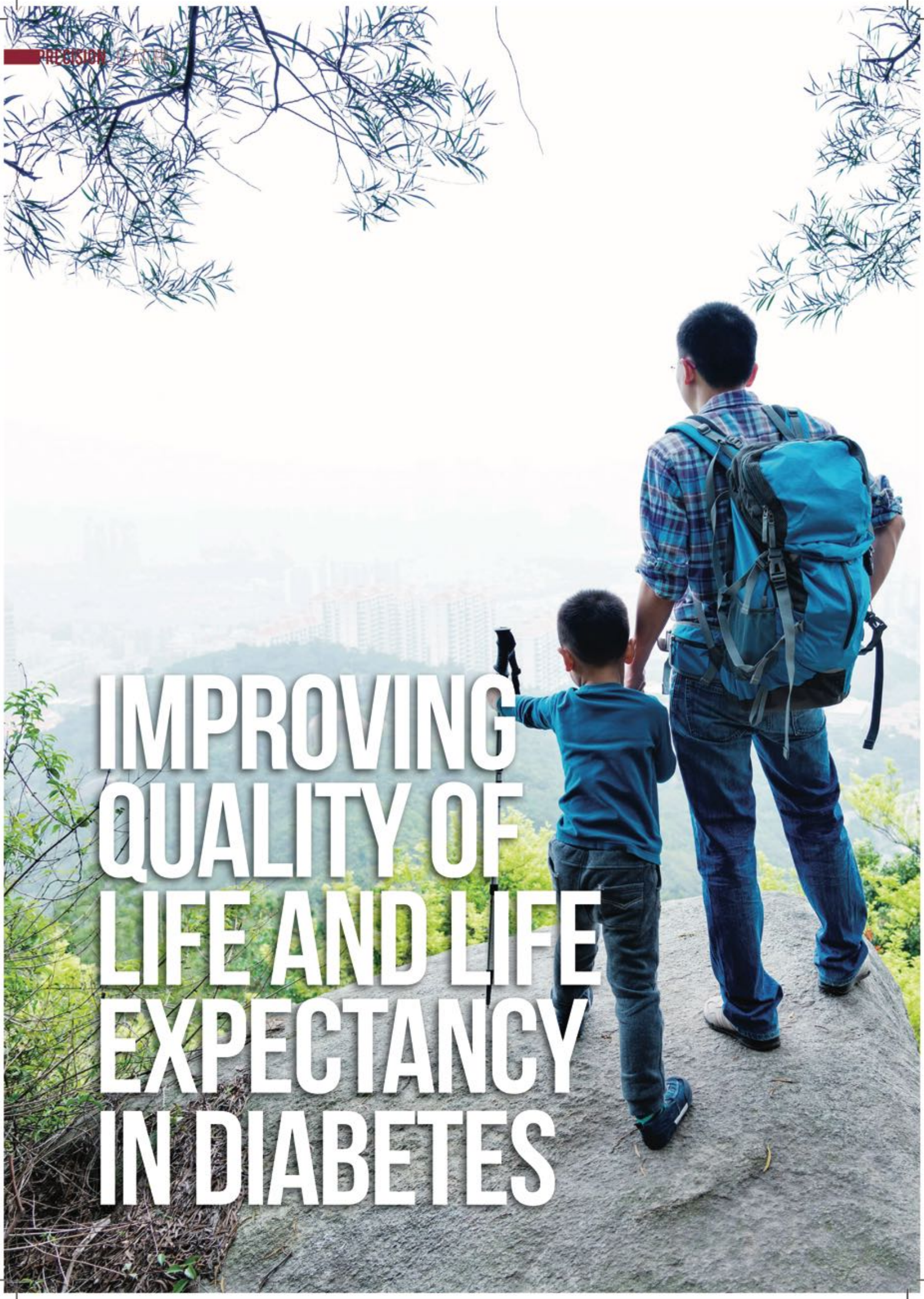

IMPROVING QUALITY OF LIFE AND LIFE EXPECTANCY IN DIABETES

Prof Graham Machin, President elect of the InstMC and Fellow in Temperature Measurement, National Physical Laboratory (NPL) explains how thermal imaging metrology is making steps in early diagnosis of diabetes.

There are at least 3.3 million people with diabetes in the UK, a number projected to rise to more than five million by 2025. In addition to complications with their eyes, diabetes sufferers are prone to serious, slow-to-heal ulcers in their feet (diabetic foot ulceration or DFU), which can become infected and lead to amputation. Mortality rates after DFU and amputation are high: up to 70 % of people die within five years of an amputation and around 50% die within five years of developing an ulcer.

Besides the adverse effect on patients, it has been estimated that DFU and related complications currently cost the NHS around £1 billion per year. These sobering statistics highlight that avoiding amputations is key to increasing the quality of life for diabetics and improving survival rates.

Detection of potential ulcer sites on the foot is critical to improving patient outcomes with DFU, enabling doctors to intervene to protect the foot before ulceration occurs. If DFUs are not prevented, there is significant danger of serious infection, which, if not rapidly treated, can lead to gangrene and amputation. Before any visible signs on the foot of possible

Besides the adverse effect on patients, it has been estimated that DFU and related complications currently cost the NHS around £1 billion per year.

ulceration, it has been found that, in the vulnerable skin area, temperatures can rise by more than 1 °C. NPL has exploited this knowledge to produce a breakthrough medical imaging device, called DFIRST that generates temperature maps (thermography) of patients' feet, to provide early alerts of potential problems. Such early detection would give more than a week's extra time to take preventative action, reducing or even eliminating the ulceration and associated risk of infection.

The research is the outcome of a £1.2 million project funded by the National Institute for Health Research (NIHR) Invention for Innovation (i4i) programme in 2012. Since the project's inception we've gone on to develop four prototypes of the device and conducted two clinical trials, recording the data of hundreds of patients.

Most modern clinical decisions, from diagnoses to treatments, are based on advanced pieces of technology which take patient readings. To provide meaningful data on which life-saving decisions are made, these have to be reliable and trustworthy in their readings. Performance testing of the DFIRST device was conducted at NPL; device has been tested against rigorous standards, ensuring it is as trustworthy as possible. Aligning with the trend in home monitoring, NPL's DFIRST works fast and in a similar way to an ordinary camera, meaning it is potentially suitable for home use, empowering patients in their own care and monitoring risk throughout the treatment pathway.

NPL is also working to make sure this breakthrough in medical thermography can benefit other healthcare sectors. The technology could be deployed in many areas where monitoring and mapping temperature is key, such as Charcot foot (another serious and potentially limb-threatening lower-extremity complication of diabetes), reconstructive surgery and tackling chronic wounds.

The value of the global wound care market is expected to reach $20.4 billion by 2021. Using its innovation in DFU as a starting block, NPL is now looking to transform this market and the lives of those that live with chronic conditions.

The research was funded by the National Institute for Health Research (NIHR) II-LA-0813-20007 programme. The views expressed are those of the author and not necessarily those of the NHS, the NIHR or the Department of Health.

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IMEKO WORLD CONGRESS – 3RD TO 6TH SEPTEMBER 2018

The United Kingdom, through the Institute of Measurement & Control, will host the XXII International Measurement Confederation (IMEKO) World Congress in Belfast in 2018.

I would like to welcome you to the XXII World Congress of the International Measurement Confederation (IMEKO) which is being held in the United Kingdom for the first time in over 40 years. Belfast, the capital city of Northern Ireland is playing host to delegates from across the world, for what promises to be an interesting, scientifically challenging and busy World Congress.

This International Measurement Confederation (IMEKO) World Congress is hosted by the Institute of Measurement & Control and with active involvement of the National Physical Laboratory, the professional bodies, Universities and industry and runs from 3rd to 6th September, 2018 – this event will be very popular and it is expected that over 700 delegates from across the world will attend.

Measurement, control and the instrumentation needed are key aspects in industry that underpin economic prosperity across the world and the event will bring together leading experts from many countries to report on the latest and most exciting developments in their fields.

'Knowledge through measurement', a theme from the work of Lord Kelvin, the great scientist, engineer and entrepreneur who was born in Belfast, is the strapline for the 2018 World Congress. The Invited and Keynote speakers coming to the World Congress in Belfast in September 2018 are some of the most distinguished in their field and the many sessions held during the week will provide real insight into what is new in this most topical and economically important of fields. Among these Invites Speakers are two Nobel Laureates:

Professor William D Phillips: winner of 1997 Nobel Prize in Physics, shared with Steven Chu and Claude Cohen-Tannoudji, for their work on laser cooling, a technique to slow the movement of gaseous atoms in order to better study them. He joined the National Institute of Standards and Technology in 1978, where he has worked since, as well as being a Professor of Physics at the University of Maryland.

Professor Klaus von Klitzing: winner of 1985 Nobel Prize in Physics for discovery of the integer quantum Hall Effect, he became Professor at the Technical University of Munich in 1980 and has been Director at the Max Planck Institute for Solid State Research in Stuttgart since 1985. His research focuses on the properties of low-dimensional electronic systems, typically in low temperatures and in high magnetic fields.

In addition to these two very distinguished speakers, there will be invited contributions from UK and international industry and national standards laboratories from across the world.

Dr Pete Loftus: he has spent his long career in Instrumentation and Measurement at Rolls-Royce. He is currently Head of Measurement Engineering with accountability for ensuring the creation, maintenance and improvement of all forms of measurement capability for the company world-wide.

Professor Martin JT Milton: he is currently the Director of the *Bureau International des Poids et Mesures*. Martin joined the National Physical Laboratory from Oxford University in 1981. His early work included being a co-inventor and pioneer of the Differential Absorption Lidar technique for range resolved remote gaseous pollutant sensing. He subsequently provided scientific leadership for the Analytical Science Team and took an internationally-leading role in the application of new physical principles to the measurement of gases in the atmosphere and establishing the comparability of gas measurements around the world.

There will be a major Exhibition, which aims to showcase some of the leading developments in industry from the UK, Europe and indeed across the world.

Belfast, the host city, is situated in Northern Ireland and is a 'must see' destination. The World Congress will be held in the recently extended Waterfront Hall which has excellent facilities for the Conference, the industry-focused Exhibition and all the associated activities of the week. It is close to the city centre and a wide variety of hotels, restaurants and bars as well as being within easy reach of some of the interesting cultural highlights of both the United Kingdom and Ireland. Each year the city hosts some 8 million visitors and in 2018 the city is ready to welcome the IMEKO World Congress. Over a billion pounds has been invested in Belfast over the past decade and as a result, the city is fast becoming the destination of choice for national and international events of this type. The Financial Times recently listed Belfast as one of the Top 10 places in the world to host a conference and TripAdvisor users have just voted the city as one of the 'Top 10 destinations on the rise' across Europe. Belfast offers the best of both the UK and Ireland and is a gateway for those wishing to explore the rest of Ireland – easy by car or public transport. The World Congress venue promises easy access from the nearby airport on Belfast's waterfront and from there connections to the UK, Europe and the United States.

The World Congress will also host an exciting and diverse social programme which will allow attendees, be they from industry or academia, exhibitors or contributors to meet together and to see some of the most interesting venues in and around Belfast and after the meeting be an excellent centre to explore the beautiful countryside and historic landmarks to be seen across Ireland. The Congress Gala Dinner will be held at the Titanic

Belfast (www.titanicbelfast.com), in the Titanic Suite, inspired by RMS Titanic's opulent interiors, which creates a breath-taking setting for an unforgettable event and featuring a replica of the liner's Grand Staircase. Dinner will start with a drinks reception from 19.30pm, followed by dinner and entertainment from traditional Irish drummer band, *Steppin' Out*.

Let me summarise why you should plan to attend what will be a memorable event for the UK and for the Institute of Measurement & Control:

- Held only every three years this congress is an unmissable chance to be present with an influential and senior audience
- Association with two Nobel laureates and senior figures from industry and academia internationally
- Opportunities to meet influential figures from academia and industry worldwide, develop new customer relationships and reinforce long-term business relationships
- Face-to-face meetings with colleagues from the UK and internationally: a means to create new partnerships and generate new business
- Showcase your products and services, target new clients and stimulate interest in what you have to offer
- Establish strategic partnerships and build opportunities with existing clients and position your company as an industry leader
- Visibility at an event with high international status
- Association with measurement, the driving force behind the Internet of Things and the Fourth Industrial Revolution (Industry 4.0)

There will be a diverse and fascinating programme at the 2018 World Congress and across the four main programme days there will be a range of outstanding sessions which will take the form of lectures, workshops and round table discussions. The programme committee have worked hard to ensure the programme covers all areas of measurement ensuring there is something for everyone. We would be delighted to receive your paper submitted to the World Congress – there are more details of the style, format and dates for submission on the website. However, key dates for papers are:

- Submission of 4-Page Short Paper - 31 January 2018
- Notification of Acceptance - 30 April 2018
- Final 4-Page Short Paper Ready - 31 May 2018
- Early Bird Registration Closes - 30 June 2018

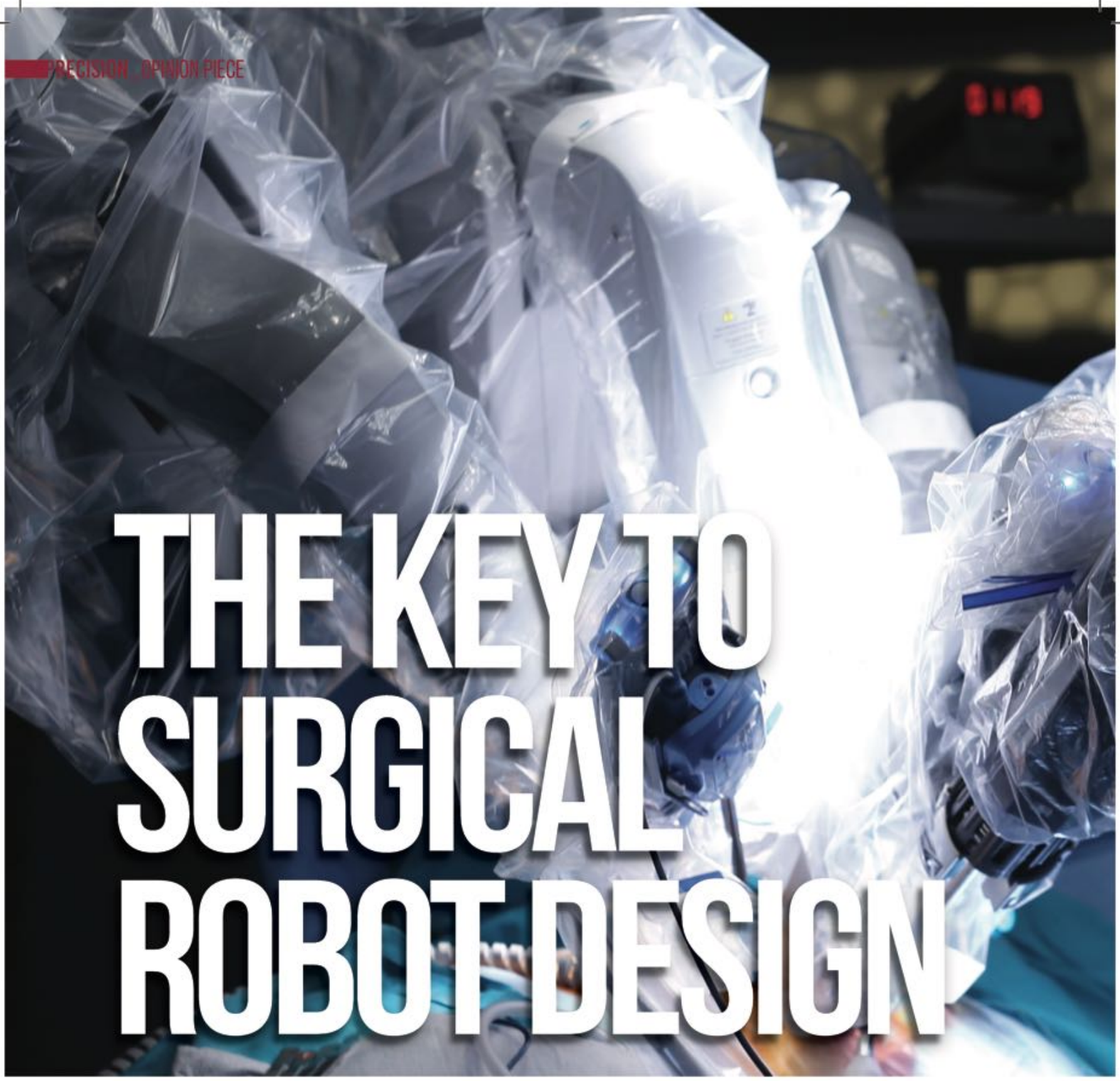
There are further details on the informative World Congress website at www.imeko2018.org where you can register to attend, submit your paper, or find out more about this unique opportunity for the United Kingdom.

On behalf of IMEKO, the Institute of Measurement & Control and the International Organising Committee, I look forward to welcoming you to the XXII IMEKO World Congress and to Belfast, the United Kingdom host city for 2018 and to what we know will an enjoyable and stimulating, but above all memorable event.

See you in Belfast in September 2018.

Professor Kenneth TV Grattan
President of IMEKO, the International Measurement Confederation

> The Financial Times recently listed Belfast as one of the Top 10 places in the world to host a conference and TripAdvisor users have just voted the city as one of the 'Top 10 destinations on the rise' across Europe.



THE KEY TO SURGICAL ROBOT DESIGN

Graham Mackrell, Managing Director of high precision gearing specialist Harmonic Drive UK, looks at the design challenges faced by medical robot manufacturers.

Many of us, if asked what we thought were the three biggest causes of death in the United States each year, would assume them to be the most talked about: cancer, gun crime and heart disease. Yet, surprisingly, the third leading cause of death is actually medical error, often during critical operations. As a result, many medical institutions are becoming increasingly interested in the use of surgical robots to assist with invasive procedures and keyhole surgery.

A recent paper from the John Hopkins University School of Medicine calculated a rate of 250,000 deaths by medical error every year in the US. This, as the medical team identified in their open letter, would account for roughly ten percent of all US deaths in 2013 — a staggering figure, especially when you consider cancer accounted for 22%. Only cancer and heart disease cause more deaths.

It is for this reason that surgical robots are becoming more widely used in hospitals. With the help of these machines, surgeons are able to operate comfortably — often from a seated position — while also

taking advantage of the improved accuracy. This makes even lengthy surgeries far easier to complete with a lower likelihood of error, while also boasting health benefits for surgeons that enable them to work into older ages. Patients also benefit from this, as robot-aided minimally invasive surgery often leads to less physical trauma.

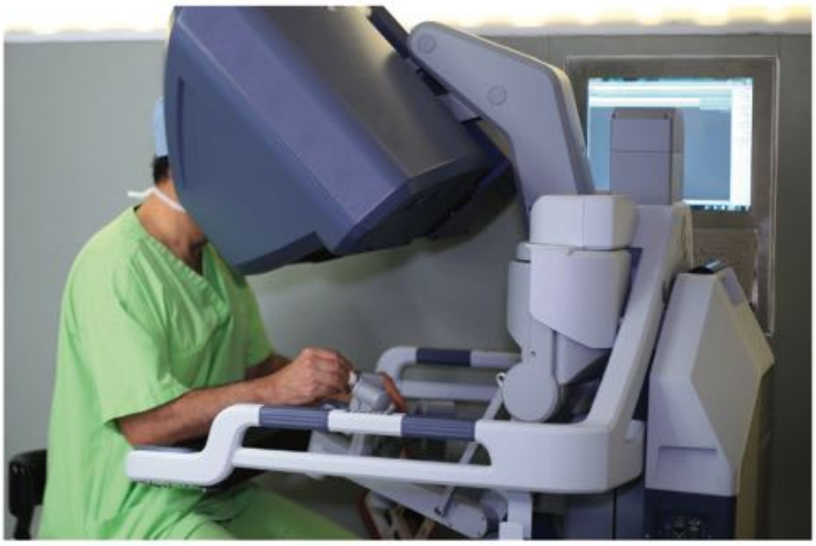
However, in order for surgical robots to be able to offer these benefits, the machinery itself must be reliably precise with proven repeatability. Delivering this involves a lengthy — and challenging — design process in which robot manufacturers must not only create detailed plans that highlight any possible mechanical problems the machine may face, but identify how they will be prevented. In addition to this, manufacturers must also source high quality components that can meet and ideally exceed the project specifications.

Foreseeing the unforeseen

Safety is the top priority during the use of any robot and, as such, it is vital that all possible faults are addressed in the initial design stages. No matter how precise the gearing, or how sturdy the steel, if there are issues with the overall machine design the robot will not be fit for use.

The first step to ensuring this safety is to identify any possible problems with the initial design. These can be broken down into three separate categories: mechanical failure, external issues and electrical problems.

External and electrical issues are relatively straightforward. Common external challenges involve the size of the machinery itself. Space in



hospitals is increasingly becoming a premium and equipment that delivers a small footprint will be given precedence. Design engineers should plan their robots accordingly and find components that are compact without sacrificing performance, a task easier said than done.

Likewise, consideration of electrical protection during the design phase can eliminate unpredictable risks further down the line. It may not come as a surprise to learn that non-medical equipment such as computers, tablets and smartphones — along with their associated charging equipment — is increasingly causing power quality issues on the mains supply. Unable to meet adequate limits of electrical insulation, isolation, impedance, creepage and clearance, these devices can cause electromagnetic interference (EMI) and radiofrequency interference (RFI), ultimately increasing the risk of electric shock during surgery. Effective electrical protection can be ensured by building in measures to tackle this during the early design stages.

Yet it is mechanical failure that is arguably the most critical, encompassing the components of the robot itself. This should come as no surprise as, if the joint in one of the arms of a surgical system were to fail, it could potentially prove fatal. Unfortunately,in most cases there is little that can be done initially to design out these faults.

The importance of identifying these risks during the planning stages is that engineers are able to source quality components that reduce all associated risks to an absolute minimum. For example, identifying the risk of power surges offers ample opportunity to use reliable power supplies with surge protection. Likewise, identifying the inadequate accuracy and repeatability characteristics in a system designed for laparoscopies, more commonly known as keyhole surgeries, allows engineers to use reliable, zero backlash gearing units with high torques and servo motor utilisation.

Fitting the build

Surgical robots used for keyhole surgery allow surgeons to be more precise in their incisions as the system handles the multiple apparatus required. Instead of a surgeon effectively juggling the laparoscope and surgical tools, the robot can handle both simultaneously for a quicker and more efficient operation.

In order to do this, the robot should include lightweight gears offering zero backlash to ensure highly accurate movement. Backlash, which is fundamental in many gears, means that they are unable to offer the smooth manoeuvrability required in keyhole surgery, so making any backlash is highly undesirable.

Combining a zero backlash gear with other functionality, such as force measurement sensors that are often integrated into gearing units for feedback control, is ideal for surgery but must be done within the confines of the system's size and weight specifications.

Fortunately, there are solutions available. Gearing specialists use years of experience in serving the robotics and medical industries to develop precision gearing units that are lightweight, compact and reliable, delivering repeatable peak torques, zero backlash and easy integration. It is by using quality components such as these that the associated risks of surgical systems can be reduced or eliminated.

A recent study showed that surgical robots led to 144 deaths in the US between 2000 and 2014, but this was across over one million surgeries and equated to 0.1 per every thousand operations. This still makes surgical robots approximately one hundred times less risky than humans, where one in every thousand procedures results in serious complications.

The figures make it clear that surgical robots lead the way in driving down the number of deaths caused by medical error. With developments in technology and careful consideration of components, this may soon be a reality. In time, we can also work to remove medical error as the third biggest cause of deaths and instead make innovative medical technology the number one life saver.

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Management of FS

- HazOp module

01 Hazard & risk analysis

01 To identify the hazards and risks to be protected against.

- ALARP module
- LOPA module
- SLOPA module

02 Allocation of safety functions

02 Allocation of safety functions to protection layers and for each SIF, the associated SIL.

03 SRS (Safety Requirements Specification)

03 To specify the safety requirements for the SIS/SIF.

- SRS module
- Process Safety Time module
- FSA 1 upload & action tracking

Design & engineering 04

04 To design the SIS/SIF to meet the integrity requirements.

- SIL Check Compliance module (PFD, HFT, SC)
- SIFED (SIF Element Database)
- Prior Use module
- FSA 2 upload & action tracking

Installation, commissioning & validation 05

05 To integrate HW & SW and validate that the SIS meets the safety requirements.

- Upload testing documents & drawings e.g. SAT, Proof Test procedures
- FSA 3 upload & action tracking

Verification

- QA Check & Approval system

Operation & maintenance 06

06 To ensure the functional safety of the SIS is maintained during operation and maintenance.

- Leading Indicators module
- Failure rate validation module
- Useful life monitoring
- Prevailing PFD calc
- FSA 4 support

- Functional safety management planning tool

LIFECYCLE STRUCTURE & PLANNING

STRONG AND STABLE M&A ACTIVITY DEFIES EU UNCERTAINTY

Perhaps in defiance of economic and political uncertainties arising from Brexit negotiations, the UK M&A market remains on course for another good year of deals with 580 completions in Q3, down slightly on Q2's figure (600) but higher than at the beginning of the year (549). In this strong and steady M&A market, most buyers say their biggest issue is in fact finding the right business to buy in the face of strong competition from other buyers and strong pricing.

BDO's quarterly PCPI/PEPI (Private Company Price Index/Private Equity Price Index) report has been tracking the multiples paid by trade and private equity buyers since 2009. This means it follows the relationship between the Enterprise Value (EV) to Earnings Before Interest Tax Depreciation and Amortisation (EBITDA) multiple (EV/EBITDA) paid by trade and private equity buyers when purchasing UK private companies.

The latest report shows gentle fluctuations in the prices paid for private companies since the beginning of 2016, with the average PCPI multiple resting at 10.2x in Q3 this year. Meanwhile, the prices that private equity investors have paid for UK companies have hotted up since early 2016, with multiples rising well above 11x. PEPI saw a slight decline in Q3 to 11.1x though PE houses still have large amounts of cash to deploy in the market.

Roger Buckley, M&A partner at accountancy and business advisory firm BDO LLP, commented: "Deal flow remains strong and we are not seeing any Brexit jitters. This remains a sellers' market and a great time to firewall a level of personal wealth, especially for business owners who carry most of their wealth within their business. We are seeing many owners exploring their M&A options and being genuinely surprised by values available and levels of interest in their business."

Test & Measurement Q3 deals: acceleration in the vehicle testing market

The test & measurement market continues to see a steady flow of transactions, with high competition in evidence for attractive businesses. UK listed Spectris plc made two acquisitions in the quarter: US-based Omnicon Group Inc, a provider of reliability design and testing services, and UK group CSA Leyland Technical Centre, a provider of test services to the commercial vehicle, automotive and off-highway sectors. The acquisition of CSA complements last year's acquisition of Millbrook, a vehicle test, validation and engineering service provider, which Spectris acquired for 12-13x EBITDA. Spectris remains very keen to make further buys in this space, and in the wake of the emissions scandal and the race towards driverless cars, such businesses are in high demand.

Further Q3 deals in the vehicle testing sector include DEKRA's acquisition of Portuguese counterpart MasterTest and Applus Services' majority stake in Inversiones Finisterre, a specialist in statutory vehicle inspections with operations in Spain and Costa Rica. Meanwhile MAHLE GmbH acquired a 20% stake in Brain Bee SpA, Italy, which manufactures electronic devices for vehicle diagnostics and emissions tests, and Renault invested in a joint venture company to further autonomous vehicle development testing. Finally, 3i-backed ATESTEO acquired straesser Automotive Testing GmbH, extending its range of road testing services and adding 280 employees in Europe.

Appetite for deals remains strong in the test & measurement sector and the race to cement strong positions in attractive markets shows no signs of abating. Certainly in the vehicle testing market, the race is on.

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Q&A

Professor Sheila Smith

This month's interviewee is Professor Sheila Smith, Assistant Head of Department, Instrumentation, Control and Chemical Sciences, within the Department of Engineering at Glasgow Caledonian University.

What was the root of your interest in Engineering?

My interest in Science and Engineering comes from my natural curiosity to understand how things work. As a child I would often be found with my nose in a book explaining an interesting fact about the world around me. I come from an agricultural background and was surrounded not only by animals but by tractors and machinery. I was always fascinated when the implements broke down, (which they often did!) to understand what went wrong and more importantly how to fix the problem.

From that natural curiosity in childhood and a love of mathematics I decided to study Applied Physics at the University of Strathclyde. This gave me an excellent grounding in the importance of measurement and an in-depth knowledge of instrumentation which has been enormously beneficial throughout my career. As part of this degree, I completed a summer project at ICL which gave me an insight into manufacturing processes within the computer industry.

On completion of my degree I decided to stay on at University and study for a PhD. This was driven by my enjoyment of experimental physics and the excitement of working in a research environment. I joined the Photophysics group at Strathclyde University where, under Professor David Birch, I worked on the development of a multichannel instrument for the simultaneous measurement of fluorescence lifetimes. This instrument was one of the first to achieve the simultaneous measurement of four fluorescence decay profiles and laid the foundations of array fluorometry. This was very much an interdisciplinary project which allowed me to indulge in my love of physics, in particular optics and chemistry within an industrial application, as my project was in collaboration with ICI Explosives Division at Ardeer on the west coast of Scotland.

Following completion of my PhD I continued to be involved in both fundamental photophysics and fluorescence instrument development which varied from investigating the fluorescence properties of diamonds to metal ion sensors for the nuclear industry.

My research interests have remained in photophysics and more recently in the development of fluorescence based sensing technologies. In the mid-nineties I joined Glasgow Caledonian University as a Physics lecturer in the Department of Physical Sciences. Since then GCU has gone through a few iterations and I am currently Assistant Head of Department in the Department of Engineering with particular responsibility for the Instrumentation, Control and Chemical Sciences subject areas.

Recent research projects have involved chemical sensor development for temperature measurement and hydrate inhibitors within the oil and gas sector, turbidity sensors for waste water monitoring and gaseous oxygen sensors for the ppm to ambient oxygen range. This later project was a KTP (Knowledge Transfer Partnership) with SST, which is a local SME, where our involvement was to help them understand the chemistry of the sensing polymer and from this improve sensor performance.

Hence throughout my career I have been closely involved with the many different industrial applications of fluorescence sensing technologies and I'm always interested to use this (and other optical technologies) to help improve British industry.

What is your vision of Engineering in Britain in 2020?

As our world becomes ever more connected to the internet and communication pathways are growing I see the importance of good measurement to be paramount. This is extremely important in all sectors of life from the advancements in medical engineering to the large scale engineering seen in the oil and gas sector.

Engineering of the future will continue to see the growth of SMART technologies and the reliance of the public on wearable technologies is increasing at an astonishing rate. This will put a strain on our reliance on power so I do see a growth in battery storage technology and also the ability to recharge our wearable technology wirelessly while on the move. After all, in the modern world, we need to stay connected and running out of battery power is a catastrophic event for many.

However, while there is a growing reliance on our connected world through the internet I think we would be foolish not to stop and consider the impact this is having on our more traditional modes of communication – the spoken word.

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

The current shortage of engineering graduates is a serious concern to all within the sector. The work needs to start within the schools so that children are encouraged to ask the most difficult question of all - WHY? I believe that in order to encourage children to enquire about the world around them it is important to have inspiring teachers from all disciplines.

In particular, young children need to learn through play that science and engineering are exciting areas in which to work and that engineering has many hats – after all there is an engineering career for all! A lot of good work is carried out here through the many outreach initiatives and Science Centres around the country. Sustainable funding here is paramount to the growing success of science and engineering for future generations.

The current government initiative, the Degree Apprentice programme, is an excellent way of upskilling the UK workforce. It will also open up excellent engineering opportunities to young people who want to work while they learn and I really hope that this scheme is successful... but ultimately curiosity starts young.

What do you do in your free time to relax?

Coming from Scotland I play the 'Roaring Game' during the winter months. For those of you not familiar with the term, its curling, that game on ice where you throw stones down an ice rink. During the summer (and often in winter too) I enjoy gardening, cycling and walking in the countryside. I still live on a farm so my continued affiliation to the farming community and animals is never far away.

Given one wish what would that be?

Globally this would be for us to live in a tolerant world where everyone is respected. However, I do realise that this is against the laws of human nature.

On a personal level my wish would be to have more time to enjoy the great outdoors and relax in the Scottish countryside.

From a professional point of view I am really passionate about ensuring that young people are given every opportunity to succeed in their chosen field and my wish would be that they are given the support they need to follow their dream, whatever that may be.

As our world becomes ever more connected to the internet and communication pathways are growing I see the importance of good measurement to be paramount.

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CONTROL SYSTEMS FOR WAVE ENERGY CONVERTERS - SPRING 2017

The Scottish Government-funded organisation, Wave Energy Scotland (WES) has already invested **£15M** in **51** separate collaboration projects. These were funded from its **3** previous technology innovation calls for Power Take Off, Novel Wave Energy Converters and Structural Materials and Manufacturing Processes.

WES opens a call for **Control Systems** on **5th April 2017**. Organisations from sectors such as Robotics, Electrical Engineering, Aerospace, Automotive, Mining, Offshore and Sub-Sea vessel stability & manoeuvring could all make valuable contributions. Up to **100%** of project costs, via a contract for Engineering Design Studies, are available under this call.

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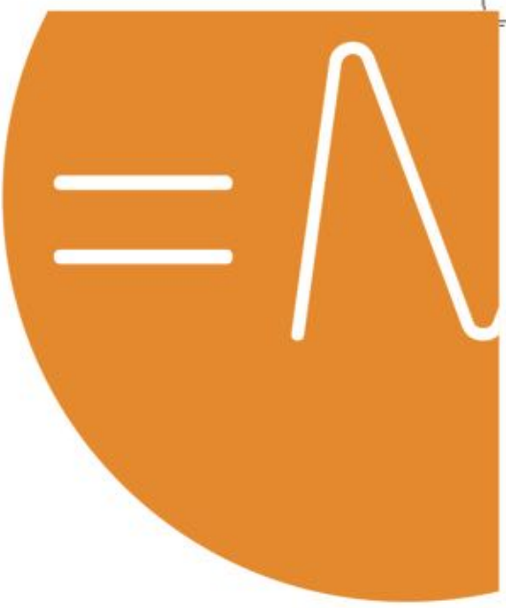

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