



THE LIMITATIONS OF LOW-COST AIR QUALITY

FEATURES//

THE INSEPARABLE TWINS OF
"MEASUREMENT" & "CONTROL"

RADAR LEVEL SENSOR

REMEMBERING RON FISCHBACHER

FUTURE LEADERSHIP PROGRAM (FLP)

SPECIAL INTERVIEW//

WILLIAM HEATH

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ON SCALE



In his essay, “On being the right size” Haldane (1927) establishes early on the essential consequences of scale:

“You can drop a mouse down a thousand-yard mine shaft; and, arriving at the bottom, it gets a slight shock and walks away. A rat is killed, a man is broken, a horse splashes”.

Though I doubt if any direct evidence was collected to verify these observations, they did serve to establish one of my own research strands in the 1990s. At first it

was just an academic thought experiment – how can we represent physiological phenomena that occur at different spatial scales simultaneously?

Eventually, the initial thought experiments were replaced by model-based simulations that produced behaviour traceable to real-world physiological phenomena that the model represented. The increased understanding of multi-scale behaviour became possible due to the combination of researchers with the right capabilities interacting with the availability of modelling tools at each level of scale investigated, and crucially their integration via well-formed information models (ontologies). The clinical transfer of the increased physiological understanding was established by a French paediatric cardiologist and his team of geneticists. From initial thought experiment in 1995 to recognition of the impact has taken 20 years; the trick now is to use the process knowledge gained in research cycles, innovation pipelines, and clinical transfer to accelerate the research of whatever comes next.

My current thought experiment remains in multi-scale measurement.

In his foray into biology, Erwin Shrodinger’s “What is Life?” (1944) used the cell as his basic building block. At that time it was known there was some form of inheritance molecule; known now as DNA (indeed it is part of the central dogma of biology together with RNA and proteins). We also know that the helical chains of DNA are made up of four ‘bases’, and in turn they are made up of atoms. Since the ‘confident’ discovery of the Higgs boson in 2012 we also know that the standard model of particle physics is complete. So, the question I now pose, “Is a quantum level description of biology/physiology purposeful?”.

Clearly this is an exciting time to be an engineer, with aspects such as measurement, control, instrumentation, modelling and automation all playing a role to uncover the elusive understanding of quantum-level phenomena. Note that the second part to my thought experiment is just as important – is it purposeful? Watch this space for an answer!

Ron Summers

Master, Worshipful Company of Scientific Instrument Makers

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ANOTHER RECORD YEAR FOR MERGERS & ACQUISITIONS IN THE TEST & MEASUREMENT SECTOR

2017 was another record year for M&A in the Test & Measurement sector, with deal volumes up by 11%. The sector has seen strong interest from both trade investors and private equity, with heady valuations reflecting the robust potential of T&M technology and the unquenchable demand for TIC services.

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PRECISION

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THE INSTITUTE OF MEASUREMENT AND CONTROL IS PROUD TO ANNOUNCE THAT IT WILL BE HOSTING THE NATIONAL FESTIVAL OF MEASUREMENT

The Festival will start in September 2018 at the IMEKO World Congress and run until World Metrology Day 2019.

On 20th of May 2019, all the SI units will finally be based on measurable physical constants and the last remaining measurement artefact (the kilogram) will no longer be needed.

To celebrate this change, InstMC wants to spend the time leading up to the SI redefinition highlighting the importance of measurement in all areas of life.



Festival of
MEASUREMENT

THE INSEPARABLE TWINNS OF “MEASUREMENT” AND “CONTROL”

Graham Machin
elected President
of the Institute
sets out his
agenda



Reliable Measurement and Control are at the heart of a modern society. In fact the process of Measurement and Control these days is so slick and effective that hardly anyone notices it happening, except when it goes wrong. When you go to a supermarket and buy your food you just assume that the weights given for products are correct, don't you? When you go to a fuel station to buy fuel you just assume that the amount dispensed is correct, don't you? And if you require medical treatment then you would just assume that the radiotherapy dose was correct, wouldn't you? These are just very minor examples of where Measurement and Control are in action in our daily lives and we don't even notice. Over the entire range of human endeavour Measurement

and Control has amazing importance; in trade and commerce, in health and medicine, in industry, in fact wherever one looks you find the need for reliable Measurement and Control.

Given the vital importance of Measurement and Control I am very honoured to be elected as the President of the Institute and I very much look forward to representing and promoting the Institute's activities and objectives during my term, not least because this is an exciting time of change for the discipline of Measurement and Control.

Let me give just four examples of what I mean. Firstly, for the first time for over 40 years, the UK plays host to the International Measurement Confederation World Congress (IMEKO 2018) 3-6 September 2018 (www.imeko2018.org). This is a tremendous opportunity to learn from the leading experts in the field of measurement and also for UK manufacturers and suppliers of measurement devices and services to showcase their wares to the world. In addition the Institute will take the opportunity afforded by the World Congress to launch a "Festival of Measurement" to run from September 2018 to May 2019.

Secondly a momentous change is happening at the highest level of measurement with the international system of units (SI) on course to be redefined. The current SI system is a heterogeneous mixture of classical and fundamental constant definitions, however from World Metrology Day, 20 May 2019 onwards the SI will be defined through a coherent set of fundamental constants. This change was described in a series of articles I edited (Measurement and Control, 47, Dec 2014. "The new SI"). One of the purposes of the redefinition is to separate the realisation of the units from their definition so that in future the definitions themselves will not need to change, allowing for improved realisations as technology advances. Much more information on the redefinition (and a great deal more about measurement in general) can be found on the International Bureau of Weights and Measures (BIPM) website (www.bipm.org/en/about-us/).

Thirdly it is a truism that, to facilitate reliable process control there needs to be reliable measurement. Unreliable measurements lead to poor products, inefficient energy use and larger carbon footprints. Although now, with the beginnings of in-process calibration, there is the real possibility that within the next 10 years, at least for some measurement quantities, traditional

off-line sensor calibration will no longer be required. Instead in-process calibration allowing for "always on and always right" capability will mean that key process control parameters will be traceable to the SI and always within the tolerances required. An impossible dream? I don't think so, this is one of the objectives of the recently launched EPSRC Future Metrology Hub at Huddersfield University (<https://research.hud.ac.uk/institutes-centres/fmh/>). In addition, work is underway at National Physical Laboratory (NPL) in the dimensional and thermometry groups to develop in-process self-validating sensor systems. Such developments will in fact be essential with the rise of autonomous robotic production to allow factories to run effectively with little human intervention. This means the role of the company metrologist will radically change. No longer will the company metrologist be relegated to the laboratory calibrating sensors for control systems off-line but actively involved in the production process. In fact the role of metrologists will become critical in this "brave new world" of autonomous manufacturing because they will become key to ensuring production continues effectively.

And, fourthly, this leads on to the issue of "big data". Although an overused term it is clear that for reliable robust autonomy, be it self-driving vehicles or autonomous factories, one needs reliable sensor data and certainly measurement redundancy as well. This means a huge amount of multi-sensor information needs to be taken and processed in real time and autonomous decisions made about how to drive a vehicle safely or how to control an industrial process optimally. The control will also need to take into account the uncertainties associated with the sensors (yes even if they are self-validating they will still have an associated uncertainty) which adds to the complexity of the control that is required. To help address these

issues the Institute is planning to establish a "Digital Transformation - Special Interest Group" this year, whilst the recently established Cyber-Security - SIG is looking at promoting best practice to this crucial aspect of our modern economy.

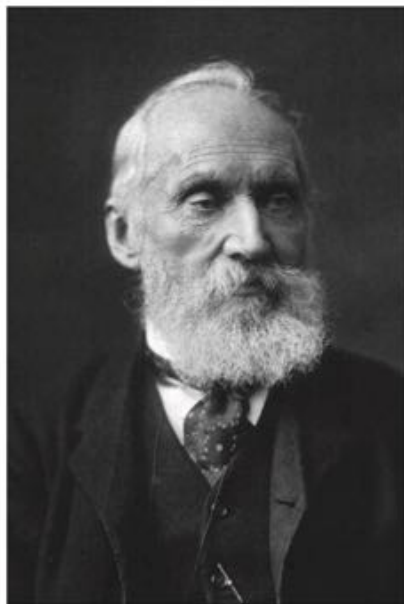
In all this change the role and objectives of our institute, dedicated to Measurement and Control, are even more important. For example the necessity of good measurement practice has been highlighted in the recently launched UK Government's "Measurement Strategy", whilst reliable Measurement and Control will be one of the essential core requirements to delivering on the UK Government's "Industrial Strategy". Both these strategy documents are available at: www.npl.co.uk/news/the-uk-measurement-strategy-launched-to-support-uk-industry.



One of the purposes of the redefinition is to separate the realisation of the units from their definition so that in future the definitions themselves will not need to change, allowing for improved realisations as technology advances.



“All this goes to prove the adage of one of the founders of NPL, and one of Britain’s greatest scientists, Lord Kelvin when he said “If you cannot measure it, you cannot improve it”.



All this goes to prove the adage of one of the founders of NPL, and one of Britain’s greatest scientists, Lord Kelvin when he said “If you cannot measure it, you cannot improve it”. Although he said that over 100 years ago even then he saw that effective and efficient industrial production was inextricably linked to reliable Measurement and Control.

I would like to close this introductory article with some of my objectives during my presidency.

Firstly the Local Sections of the Institute are its essential foundation, if they thrive, the institute will thrive. It is my objective to visit all of the UK Sections during my presidency. I want to engage with local Section members, learn of your plans, support your endeavours, wherever I can, to promote the discipline of Measurement and Control and especially discuss how best to promote to work of the Institute. I also want to hear your concerns so that I am better able to represent you, both on council and on the board of trustees.

Secondly it is clear that the objectives of the Institute and NPL, and more broadly the National Measurement System (www.gov.uk/government/publications/national-measurement-system) are in some aspects co-aligned and intertwined. All of us want to make sure that measurements are performed reliably in the UK for the good of industry and our quality of life. As president, I want to make sure that

we exploit those strong synergies for the mutual benefit of all, and that we work together to raise the profile of the discipline of



Measurement and Control so people are more aware of the vital role these inseparable “twins” play in modern society.

To that end I am delighted that, during my term as president, we, as an Institute, are going to lead on a “Festival of Measurement” in the

period between the IMEKO World Congress and the redefinition of the SI. Its objectives are to raise the public awareness of the importance

control. So, after the dust has settled on the introduction of the redefined SI, it would be good to consider an event focused on the institute's Control interests in 2020.

Thirdly, the Institute should be the natural leader in promoting Measurement and Control as a valid, indeed valuable, career choice.

I see the establishment of the Institute's Measurement – Special Interest Group (M-SIG) in helping facilitate this aim. Indeed within the M-SIG there is already discussion about how to improve the status and recognition of Measurement and Control as an important discipline in its own right (which of course we all know to be true!).

Finally I want to end with a few words about myself. I have worked at the NPL for more than 25 years. I am an NPL Fellow and Head of the Temperature and Humidity Measurement Group. Besides being responsible for providing world leading temperature measurement capability for the UK over the years, I have worked on a wide range of industrial temperature measurement problems in for example the space, aerospace and nuclear sectors, as well as led EU programmes on improving industrial thermometry. For anyone interested to find out more please have a look at my profile www.npl.co.uk/people/graham-machin. I look forward in the coming months to meeting and working with you to reach out, grow and strengthen the Institute. This is

important not just for the long term future of the Institute but also, given the vital role reliable Measurement and Control plays in a modern society, will be good for the UK as well.

of measurement, to re-emphasise to industry the benefits of effective measurement and calibration and to promote metrology as a career. Of course measurements are not just an end in themselves but are required to facilitate effective and efficient

As president, I want to make sure that we exploit those strong synergies for the mutual benefit of all, and that we work together to raise the profile of the discipline of Measurement and Control so people are more aware of the vital role these inseparable “twins” play in modern society.



Radar level sensor is offering a safe solution for chemical storage for a UK-based waste-to-energy plant.

Cory Riverside Energy is a waste to energy plant, near London, which utilises waste to provide a safe, secure, affordable and sustainable energy supply. As one of the largest operations of its kind in the UK, the facility generates around 525,000 MWh of electricity each year from processing 750,000 tonnes of waste.

The energy from waste combustion process presents many challenges - from bulk handling of the incoming waste streams to the monitoring and control of the outputs to the environment.

At various stages chemicals are also used on the purified water systems. These chemicals are stored in tanks at strategic points across the plant, in one such area there are four polypropylene plastic chemical tanks containing Sodium Hydroxide (Caustic Soda) 32% and Hydrochloric acid 32% - each product utilising a ground floor bulk storage vessel and a smaller 'day' tank' on an upper floor, used

for the process-critical dosing and neutralisation.

Accurately monitoring the level in these tanks became a headache for engineers at the plant. All of the tanks had been originally supplied fitted with low-cost 'back pressure' level systems that failed due to corrosion and build up. With fumes and vapours escaping through the housings, they were unreliable, inaccurate and unsafe.

Any sensor used in such applications needs to be properly specified. It needs to be made of the right materials and of the right construction. During fitting or removal, both the sensor and process also require containment, isolation and decontamination, as well as requiring comprehensive PPE for those undertaking the task. This often results in mandatory closing off an area of the plant while any equipment installation or removal is taking place on the vessel. These necessary health and safety procedures incur extra safety risks and cost.

Stored chemicals - especially those that are highly acid or alkali - can leave residues and can give off vapours and fumes which can result in a hazardous environment for personnel.

At Cory, these chemical products needed to be carefully monitored and accurately measured to remove any risk of overflow, and ensure the process

has ample supply.

"We wanted to find a new level system that would avoid any repeat of the issues experienced with the original sensors, ideally eliminating process contact and any risks experienced with the previous technology," explained a Cory instrument engineer. The use of contactless radar sensors, mounted above and outside the vessels looking through the vessel top to measure the liquid level inside was proposed.

Contactless measurement

For liquid level measurement of chemicals, a sensor generally requires a process connection into the vessel to get its 'sensing part' to connect into the process - even when using a top mounted 'non-contact' device - it could be a rod, cable or diaphragm. To measure any process variable completely, without contact, therefore provides many benefits; from longevity of operation, protection from chemicals and the process, and increased safety through reduction or elimination of exposure to harmful substances. Radar has the ability to measure the level of a liquid through an opaque plastic vessel top or window on a nozzle, completely from the outside.

More companies today are specifying plastic vessels and tanks for chemical and bulk liquid storage. They are quicker to make, are generally more cost-effective and

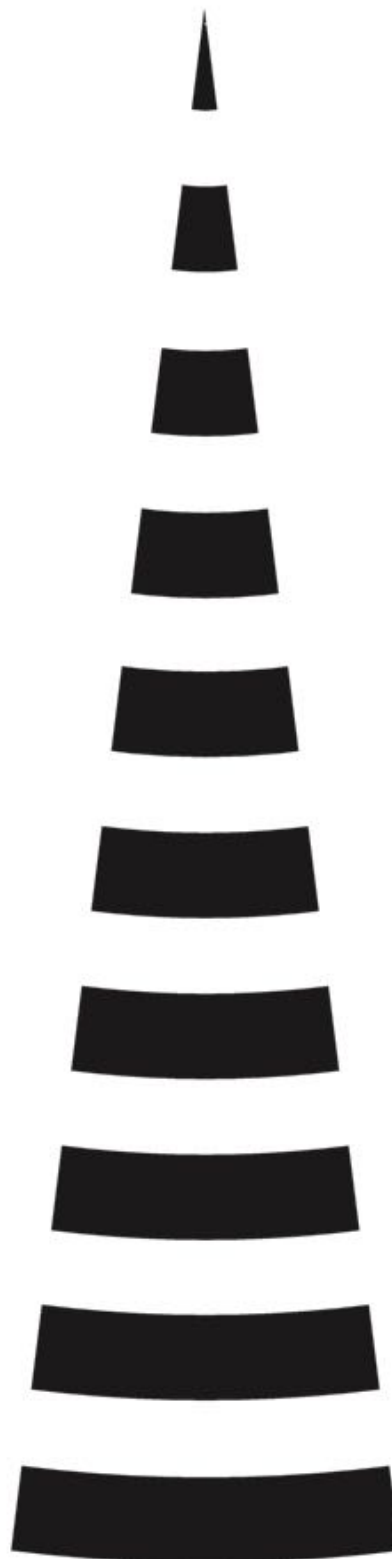
RADAR LEVEL SENSOR

have good chemical resistance. They can also offer a longer lifespan and lower maintenance than equivalent steel painted, lined or coated vessels. Many even come with 'integrated bunds' for overflow or overspill protection. Plastic IBC's are now also one of the most common vessels for bulk transport of intermediate quantities of liquid. Radar technology can be used to measure liquid level through the top of all these vessel types.

How does it do it?

Radar uses microwave technology so is able to transmit signals through plastic and other non-conductive materials (like glass and ceramic) and reflect back off a liquid level inside. With a good dynamic range (sensitivity) it can also deal with any condensate or sublimation on the inside of the vessel roof.

Using 80 GHz radar offers several benefits. Firstly, the higher focusing means it achieves good penetration through the plastic vessel roof, it also offers more mounting position options and is less likely to pick up any unwanted false signals. It also offers wide measuring range capabilities, from very small to very tall vessels, up to 30m high. It also offers high dynamic sensitivity to handle condensation and build up caused by fumes or sublimation from the products inside the vessel. It can even measure low reflectivity, oil-based hydrocarbons in some applications.



Installation best practice

Installing the radars above the tank on a suitable bracket perpendicular to the liquid surface is essential. A small gap between the sensor and the vessel top is vital. A sloping roof-top is ideal for a microwave sensor to look through, as any unwanted signal reflected back by the roof is deflected away from the radar. If this is not possible and the roof is flat, such as with an IBC, the sensitivity of the radar should easily be able to overcome any reflection. If a tank is outside, a cover is necessary to stop snow forming directly beneath the sensor and the sensor needs to be positioned so that water does not pool directly beneath the sensor. However, rainfall down a sloping roof tank situated outside should not affect sensor performance.

Cory Riverside Energy now has its first radar successfully working through the roof of the bulk chemical tank, mounted on simple 'unistrut' frame and a radar bracket that attaches to them. "The sensors are simple to use and the Bluetooth communication for set up via smart device App or with a PC and PACTware makes it so much easier," said the Cory engineer.

Figure 1

Bulk chemical storage tanks for acid and caustic storage



Figure 2

Radar mounted off 'unistrut' bracket above the bulk storage vessel looking through the top to measure Hydrochloric acid level inside



Figure 3

Radars are mounted above each of the smaller acid and caustic day tanks measuring the liquid level from outside the vessel, for ultimate safety



““
 With fumes and vapours escaping through the housings, they were unreliable, inaccurate and unsafe.
 ””



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OBITUARY

RON FISCHBACHER — PAST PRESIDENT AND PREVIOUS HONORARY TREASURER OF THE INSTITUTE

Ron was born in Glasgow in October 1924, the eldest of seven children. His parents were engaged in business and Ron inherited a strong work ethic.

After secondary school in Jordanhill, Ron went on to Glasgow University where he graduated with a first class BSc Hons degree in electrical engineering. His talent was spotted early and he was "fast tracked" through the course so that he could be employed by the Admiralty to work on the use of radio and radar for the war effort.

After some time, Ron was posted to Portsmouth naval base and it was there that he met and ultimately married his wife, Doreen, a nurse. Their son, Alastair and daughter, Trina were born in Portsmouth. Three years later the family moved to Orpington in Kent to allow Ron to take up a new role for SIRA (Scientific Instruments Research Association) where he ultimately worked his way up to become Deputy Director, before moving on to GEC/Elliott in Lewisham in 1975.

Ron retired from GEC in 1983 and this opened up new opportunities. He worked as an industry consultant for around five years visiting countries as diverse as Malta, Albania and South Africa. He was

a keen member and supporter of the Institute of Measurement and Control, having become a member in 1957. He became a Fellow in 1975 and was elected President in the same year serving his term in 1975/76. He became Honorary Treasurer in 1989 and began making regular trips into London to help the Institute on its database, sharing this work with his friend and colleague, Colin Howard, who today is serving as the current Honorary Treasurer. Ron was awarded an Honorary Fellowship of the Institute in November 1993 and continued his association with the Institute until he was 88!

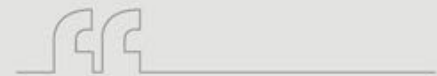
As Colin remembers, "his wise counsel, support and advice throughout that period and afterwards was invaluable to me. It is largely as a result of Ron that I am now in the role of Honorary Treasurer, a post that he so ably occupied all those years ago. I certainly have had a giant to live up to as my role model. In recent weeks I have been thinking about him as the Institute has been commissioning a new computer system for the membership records, replacing a system that Ron developed some 25 years ago and which has served us very well in the intervening years. I have been using



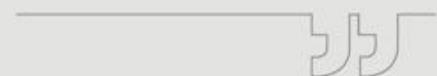
the system he developed as the benchmark against which to validate the operation of the new CRM system, so his contribution to the Institute has continued throughout his life".

Ron was quiet man, who was happy with his own company; a gentleman, who was kind and caring to others. A thoughtful, dependable man who lived a full and happy life. He will be sorely missed by all who knew him.

Graeme Philp
Honorary secretary



...his wise counsel,
support and
advice throughout
that period and
afterwards was
invaluable to me.





JOIN THE InstMC AND GAIN A COMPETITIVE EDGE

What are the benefits of becoming a member of the InstMC?

- ▶ Official recognition of your skills and expertise
- ▶ Special Interest Groups to connect with like-minded professionals and grow your network
- ▶ Programmes, local and national events to build your skills
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THE IMPORTANCE OF UNDERSTANDING LIMITATIONS OF LOW-COST AIR QUALITY

Dr Richard Brown, Fellow in Chemical Metrology, NPL

Poor air quality is an increasing concern in urban areas. The Royal College of Physicians states that, annually, “inhaling particulates causes around 29,000 deaths in the UK, which ... may rise to around 40,000 deaths when also considering nitrogen dioxide exposure.” These associated health effects have led members of the public to take action to reduce air pollution, through initiatives such as Clean Air Day, as well as monitor air quality and their exposure for themselves.





While government-run monitoring stations provide valuable data on the air we breathe on busy streets, it is impossible to have them on every corner. Therefore, entrepreneurs are working to cater to this market, offering consumers the ability to track their exposure to air pollution wherever they go with portable air quality sensors. These low-cost sensors are increasingly heralded as a way for governments to add to their existing network of data points and assess what difference their policies are having on the environment. However, different sensors often give different readings in the same location, even if

manufactured by the same provider. Moreover, the sensor data quality can deteriorate over time. Unlike traditional air quality monitoring stations that contain large, expensive instrumentation, these sensors are not subject to any ongoing checks of their performance and accuracy once they are in use, meaning users cannot determine whether they are still working. It was the knowledge of sensors and data quality able to advise government, academia, industry and the public about how to draw conclusions from the data produced by air quality sensors. As such, we are working to highlight the importance of the public understanding the limitations and benefits of using low-cost sensors to monitor their exposure to air pollution, and subsequently make decisions or alter their behaviour. There is currently no compelling scientific evidence that these sensors are able to give absolute measures of concentration over extended time periods that could be used, for instance, to predict health effects.



However, air quality sensors are not the only items of measuring equipment used by consumers that fall in this realm. You may ask why should the public believe their bathroom scales, for instance, but exercise caution with air quality sensors. Firstly, air quality sensors are new compared to bathroom scales, so the limitations of the technology are less well understood. Secondly, bathroom scales are not affected by interferences, while air quality sensors can give different readings of the same pollution levels if, for example, the weather conditions are different. Thirdly, while we can judge whether our bathroom scales are starting to give the wrong result, sanity checking air quality sensors is incredibly difficult, as the quantity of pollution being measured is very small. Even in urban areas, sensors are measuring around one unit of pollution to 100,000 units of clean air. Relative to our weight, this is like

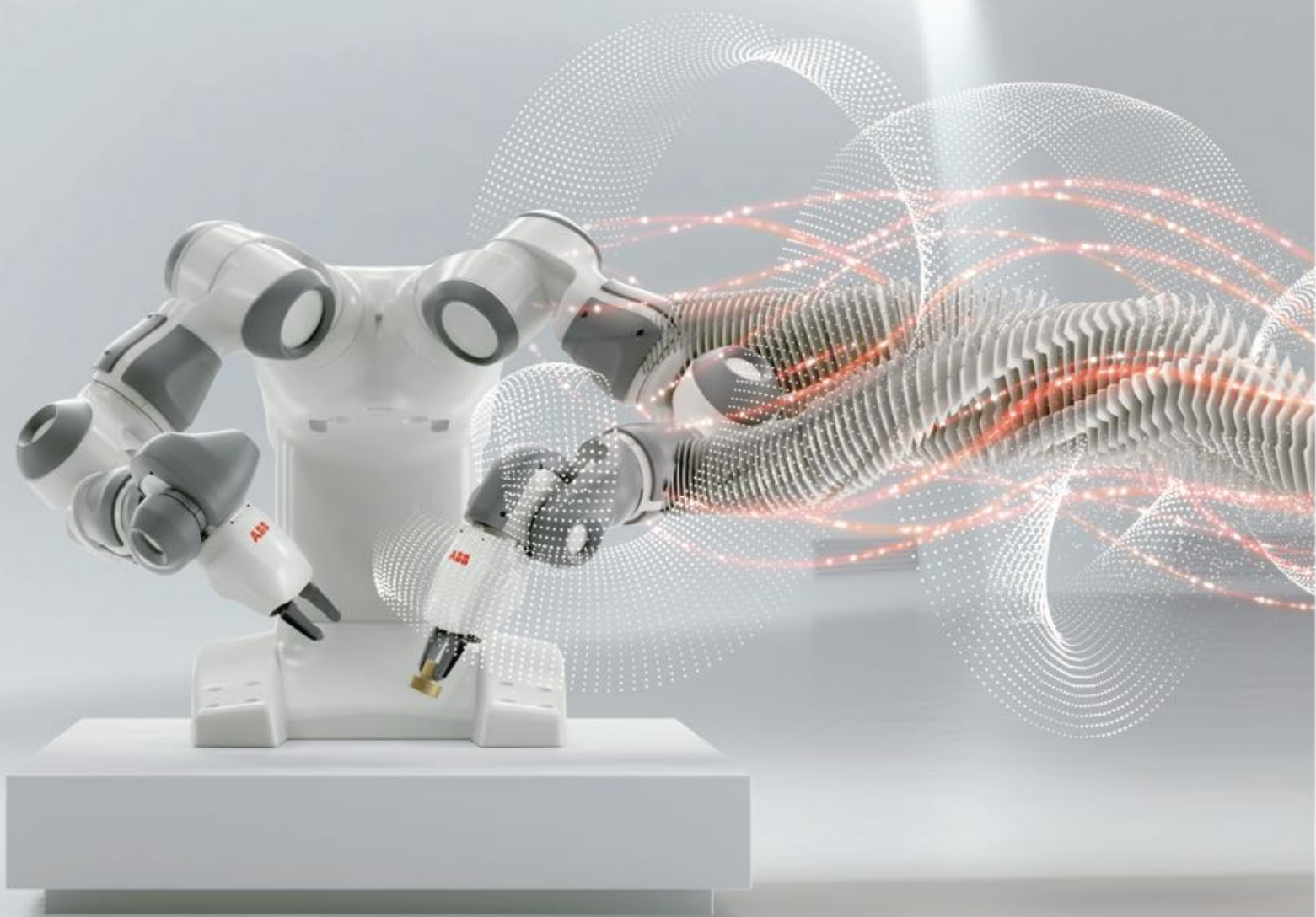
trying to detect a difference of one gram on bathroom scales. The job of sanity checking is made even more difficult with pollution being mostly invisible to the naked eye.

Low-cost air quality sensors have the potential to help consumers measure personal exposure, increase the data we have about air quality in many different locations, and help us better understand the links between pollution and health. However, their use should be restricted to applications where research has demonstrated that they are fit for-purpose. NPL is working closely with industry to overcome these challenges and introduce standardisation, which will ultimately help low cost sensors to meet their potential in accurately monitoring air quality.



Unlike traditional air quality monitoring stations that contain large, expensive instrumentation, these sensors are not subject to any ongoing checks of their performance and accuracy once they are in use, meaning users cannot determine whether they are still working.





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DEVELOPING INDIVIDUALS WILL SHAPE THE VALVE INDUSTRY AS A WHOLE

FUTURE LEADERS PROGRAMME (FLP)



“The FLP is possibly the most rewarding activity of my career.”

This ringing endorsement – and there are many – comes not from the programme’s delegates on this occasion, but from the British Valve & Actuator Association’s Director & CEO, Rob Bartlett.

“The BVAA Future Leaders’ Programme has had an amazing effect on all those involved in it,” says Rob. “I believe we all instinctively knew it had terrific potential, but all my colleagues have been blown away by the successes of the first cohort, and the tremendous impact it is having on the second in 2017.”

What is the BVAA Future Leaders Programme?

In 2016 BVAA launched a new programme specially designed to develop a small group of future leaders for the industry.

Eleven individuals were identified by their employers as having the right qualities and potential to become leaders within their own organisations. This first cohort was put through a range of exercises and activities designed to help them fast track their experiences within the industry and ramp up their personal skills and knowledge, all without having to change employers, which many of us had to do in order to advance ourselves. Such moves are of course very disruptive for the employers, and involves a significant element of risk for the employee.

Company Knowledge-Transfer Days

The 'FLP' as it has become known comprises a series of days set at each one of the candidates' own premises. There, the host and their colleagues educate their cohort in a particular specialism, activity or area in which their company excels. Delegates also receive short lectures on product types, systems, and facility to increase their understanding of the wider valve industry.



Cohort 2's Valve building exercise at BEL Valves.

Personal Development Days

In addition to the dozen or so company days, BVAA provides the group with a series of personal development courses to help round the individuals. The breadth and depth of this element has been substantially increased for the 2017 intake, such as the positive feedback from the first cohort. This now includes TQ Psychometric testing and attributes wheel assessments, helping generate a composite team profile – particularly important as the group works so closely together over the year.

Guest lecturer and Personal Development Consultant Dr Martin Haigh MBE (Latitute 7) commented, "It has been an absolute pleasure and privilege creating and delivering the learning and development interventions for the FLP. I have witnessed some amazing breakthroughs from cohort 1 and was really impressed by their confident and seamless presentation at the BVAA AGM. Before we started the personal development training for the second cohort, I carried out a psychometric test on the delegates. This gave us a good steer on where to focus our leadership efforts. More importantly, the team profile from the psychometric instrument indicated that all the primary work preferences were covered and that we have a really well-balanced group. So it has been proven because I have seen how well the team has gelled together and how their complementary strengths are driving strong outcomes. Like the first cohort, the second group of leaders is applying the PD principles in the workplace and making things happen. I look forward to the remaining sessions this year and helping to make a difference to this rapidly-developing team!"



The 'helium stick' challenge at Rotork Gears.



BVAA Networking & Technical Training

Throughout the programme, BVAA has provided opportunities for the cohorts to expand their personal network of contacts, and offered free-of-charge technical training courses from BVAA's extensive portfolio. All delegates enjoy a life-long discount on BVAA courses thereafter.

Experience Days

Another feature is the 'experience days' organised by BVAA at the behest of the cohorts, to suit their learning needs. Cohort 1 for example visited a valve casting facility – witnessing first-hand a valve pour, something many of us had to wait a lifetime to see. The group also spent a day touring the Advanced Manufacturing Research Centre (AMRC) at Sheffield, which included AMRC Castings, Nuclear AMRC, AMRC Design Centre, The Welding Institute, AMRC Training Centre and the inspiring AMRC 'Factory 2050.'

Beyond FLP

At the end of the programme, each cohort makes a presentation

to the BVAA membership at the Association's AGM. The Cohorts are also encouraged to think beyond the life of the programme. As Rob Bartlett explains, "You drive, we assist' is very much part of the philosophy of the FLP. Some of Cohort 1 were very keen to extend their programme to include a Level 3 Mentoring qualification, under the auspices of Institute of Leadership & Management. Working with Martin Haigh this was delivered in spring 2017 and I'm delighted to say they finished the taught programme recently and have been mentoring Cohort 2 delegates as part of that course requirement."

"We are also encouraging the groups to stay connected – not just through the BVAA committee structure which several have joined - but also through reunions, additional training and an alumni social networking strand. I'm sure it is a programme that could easily be repeated across British industry."

Father of the project, and BVAA vice-Chairman Colin Findlay has the last word, "When the BVAA's small working group comprising myself,

Tim Guest and Rob Bartlett got together to kick around our Board's outline proposals, we had a clear vision that we wanted to not only advance the individuals, but also the industry as a result. I think it is clear that, with this programme, we are sowing the seeds of our industry's continued success and many of the individuals are already enjoying personal career advancement. We have to thank our members for giving up a lot of time and energy to the visits and in rolling out their top guns to support us. It really is what we hoped for and appreciate on these very useful days."

"The delegates post-event reports to their CEOs show that each day was different, building up their knowledge and offering new ideas that will benefit the future leaders of the industry for decades to come."

The Future Leaders' Programme is sowing the seeds of our industry's continued success such is the popularity of the BVAA programme, the association already has a waiting list for cohort 3.



Photo courtesy of Latitude70



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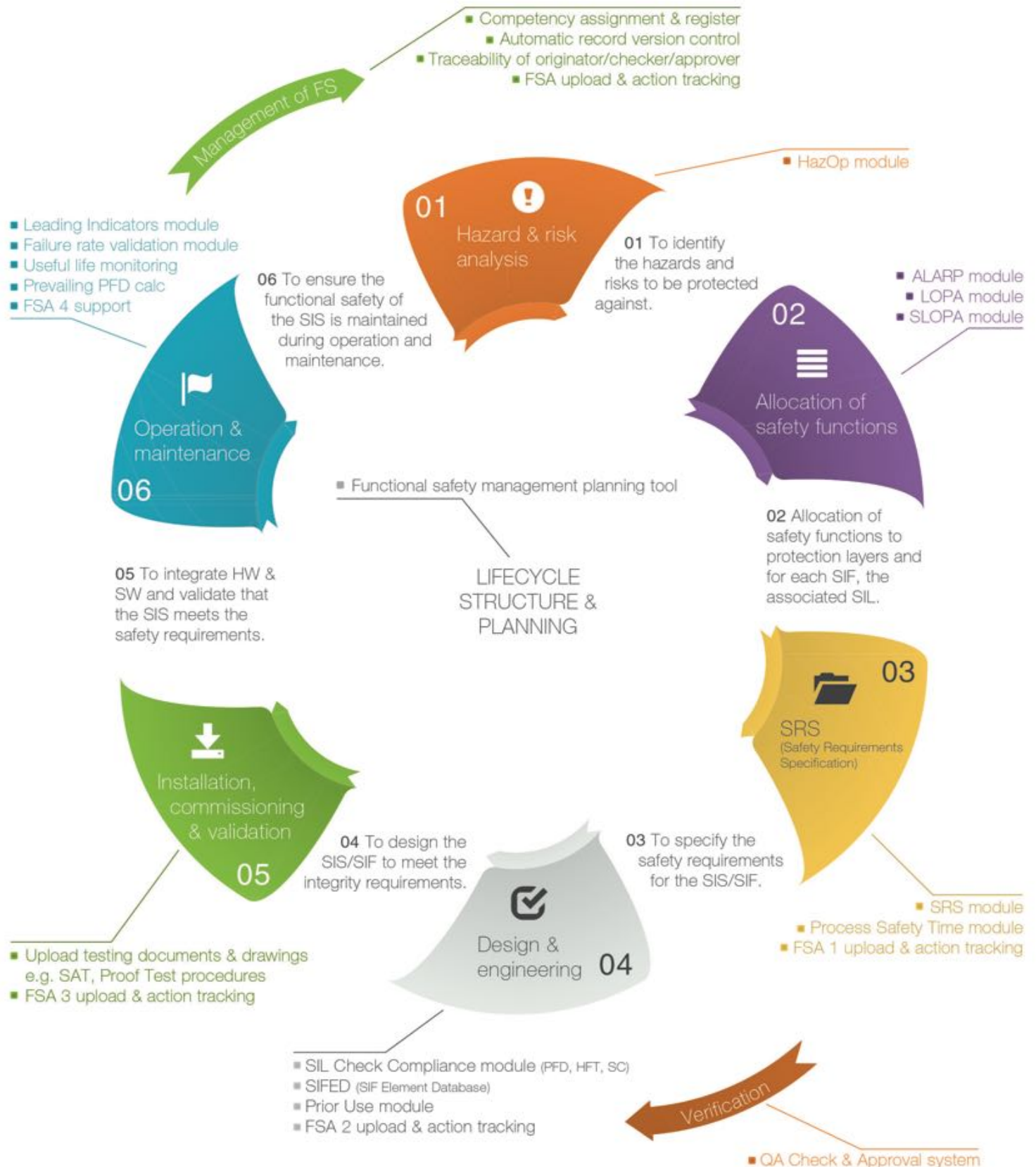
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ANOTHER RECORD YEAR FOR MERGERS & ACQUISITIONS IN THE TEST & MEASUREMENT SECTOR

2017 was another record year for M&A in the Test & Measurement sector, with deal volumes up by 11%. The sector has seen strong interest from both trade investors and private equity, with heady valuations reflecting the robust potential of T&M technology and the unquenchable demand for TIC services.

The sector has seen double-digit growth in transaction volumes year-on-year since 2014, leading to 357 deals completing in 2017. Deal volumes increased most notably in Europe, which saw an incredible 39% hike in activity levels in 2017. UK businesses featured in 23% of all transactions in 2017, confirming the country's long-held position of strength in the global T&M market, but it is North America which continues to dominate the landscape, with 148 transactions completed in the year.

Cross-border transactions have increased year-on-year, and now account for half of all deals, confirming the increasing global importance of the sector. In the UK market this figure increases substantially, with 60% of all UK transactions involving an international party on the other side of the deal. 31 UK businesses were sold to overseas acquirers, while UK acquirers bought 19 overseas targets in 2017, underlining the sustained appetite to transact, in spite of Brexit negotiations and the economic and political uncertainties.

Sales of UK-based businesses to overseas acquirers include Environmental Scientific Group's sale by 3i to Socotec France SA, and Exova Group plc's sale to Element Materials Technology NV, for a consideration of £620m, implying an enterprise value of approximately 12.5x Exova's adjusted EBITDA.

Private equity investors remain a firm feature of the market, with key transactions including Inflexion's secondary buy-out of Cawood Scientific, NVM Private Equity's backing of Thyson Technology, Limerston Capital Partners' buy-out of Crawford Scientific, and the agreement by OMERS Private Equity to acquire a majority stake in Trescal SA from Ardian for €670m, implying a valuation of 14.9x EBITDA.

But despite the high levels of PE cash available to invest, a key barrier to completing deals is the vigorous competition from trade investors, who are willing to pay high multiples to secure attractive products, services and reach. For example, Halma plc acquired Mini-Cam

Enterprises in October 2017 for a total consideration of up to £85.1m, equivalent to 16.4x EBIT. Halma gains access to a leading pipeline inspection solutions business, serving waste water systems in the UK and internationally, which is highly complementary to the technologies held within its Environmental & Analysis division.

On the technology side, Hexagon AB and Trimble Navigation Inc were also profuse acquirers in 2017, completing 9 and 6 deals respectively. Hexagon, the Swedish provider of measurement software and services completed the \$834m acquisition of MSC Software, a game-changer in Hexagon's mission to realise its smart connected factory vision.

Roger Buckley, M&A Partner at BDO LLP commented: "When an attractive business comes to market there is a strong appetite from both trade and PE investors. We have seen a resilient 'business as usual' ethos from investors and trade buyers who actively seek deals to deploy capital or drive market opportunities. T&M companies continue to outperform the market; over the last 3 years we have seen a 65% increase in our T&M index, compared to 29% growth in the S&P 500 and 14% growth in the FTSE 100. The outlook for 2018 remains positive, with impressive valuations holding firm. Like the T&M market, BDO has seen a significant increase in M&A deals: we completed over 1,200 transactions in 2017."

Q&A

William Heath

This month's interviewee is William Heath, Director of Teaching and Learning for the School of Electrical and Electronic Engineering, and Chair of Feedback and Control

What was the root of your interest in Engineering?

Having studied mathematics as an undergraduate I wanted to apply it to something useful. I enrolled on an MSc in Systems and Control at UMIST not knowing quite what to expect, and loved every minute. What began as a utilitarian venture quickly became a passion.

At the time, I was surprised by the diversity of analytic tools needed for goal-oriented tasks such as control system design. Mastering such tools is fun! But mostly I still find it thrilling when simple mathematics can explain some rich structure in the physical world. As an example, I was once given a tour of a paper mill by the parent company's Director of R&D. He pointed to the swirling pulp on the forming wire, and said something along the lines of "Just imagine the curl on that! This process is highly nonlinear and almost surely chaotic. You'll need neural networks if you're going to crack it." Yet it turned out the phenomenon we were discussing could be explained (and controlled) using only simple linear algebra.

As a control engineer I've been lucky to work on a wide variety of applications and I love the breadth of the profession. My current applications range from nan positioning to process control. I have worked on engine control, water management, food processing, paper making, plastic film extrusion, steel making, nuclear decommissioning. I've been employed in the UK and Australia, and worked in several European countries. With every new application I've encountered talented specialists with fresh insight and knowledge. The same goes for academia where I'm lucky enough to collaborate with brilliant people both on my doorstep and internationally. Meanwhile I have had the opportunity to foster the early careers of talented students.

My PhD students alone have come from four continents.

What is your vision of Engineering in Britain in 2020?

The rate of change in today's society is so fast that I hesitate to predict anything, even for 2020. Nevertheless engineering is part-and-parcel of such change. I'm sure the UK will continue to play a key role in this, both developing new products and addressing the various global challenges. Working at a leading university gives a fantastic insight to the many ideas and opportunities for British Engineering.

I'd like to see more women in the profession. Happily I don't think I'm alone in this, and perhaps at last there is sufficient momentum building to make a real change. That said, we clearly have a challenge and the root cause of the problem is not so clear. Why is there near gender equality in some countries and some disciplines, but not ours? The best analogy I've heard is the leaky pipe, whereby possibly small factors make it more attractive for talented women to leave the profession than to continue. If this is right then we must all play a part to make the engineering environment more attractive and inclusive, and to address any impediment we find, however small.

At the same time, we need to both normalise the profession in society (how many soap opera or sitcom characters are engineers?) and get across the excitement of what we do. I don't think there's been a time when the skillset required of engineers has been so diverse, nor when an entrepreneurial attitude has been so necessary. Nevertheless Roland Barthes' observation about cars (I guess if he were writing now it would be mobile phones), still seems spot on. Roughly translated: "I believe that cars are today's near enough equivalents of the great gothic

cathedrals: I mean to say great creations of the era, conceived with passion by unknown artists, consumed [...] by an entire populace which appropriates them as perfectly magical objects.” How is it that we sometimes fail to convey this inspiration?

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

My (possibly unpopular) view is that it's actually companies' responsibility to address this; if they find there is a shortage of engineers then they should raise salaries.

But this isn't to absolve UK government from responsibility. Neither manufacturing nor education has a level playing field in the UK. Decisions are made for

the short term and petty politics ascends strategic thinking. Rules for the banking sector seem to be quite different to the rules the rest of us have to play to.

Ultimately, I'd like to see both a return to high investment in education (and primarily by that I mean secondary schools) and a much larger presence of engineers in governance. To turn it round again, it's up to us to make that happen.

What do you do in your free time to relax?

We live on the edge of the Peak District and I love cycling in the hills. On the occasions when the clouds lift, “God's own country” is truly inspiring. I don't get Facebook or Twitter, but Strava is a neat tool for socialising with like-minded cyclists. Unfortunately I'm sufficiently old

that my time up Long Hill gets slower (you can check this online), just as I have to drop gear ratios, year-on-year.

Given one wish what would that be?

I wish I could properly understand measure theory.



“

But mostly I still find it thrilling when simple mathematics can explain some rich structure in the physical world.

”

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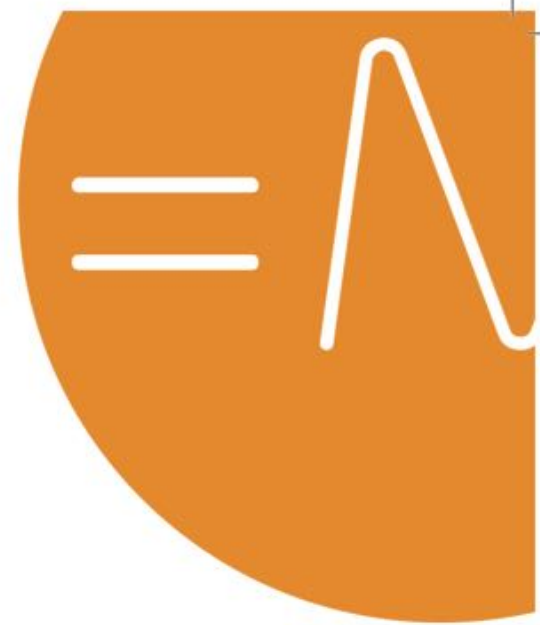
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