

RISE OF THE COBOT



FEATURES//

NEW ULTRASOUND TECHNIQUES
SPOTLIGHT ON ABB INSTMC COMPANION COMPANY
SMART SENSORS FOR SELF-CARE

SPECIAL INTERVIEW//

DR GRAEME PHILP
CHIEF EXECUTIVE OF GAMBICA

APRIL_2017_ISSUE ONE **PRECISION** MAGAZINE

INNOVATION CALL:

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.

Find out more:

www.waveenergyscotland.co.uk



A NEW LOOK IN A CHANGING WORLD

Welcome to the first pilot edition of Precision, the Institute's new magazine for members.

We are introducing this change for three reasons – member preference, Institute promotion and young generation appeal – as elaborated below. We are working to a 12-month timescale for the changeover, so you will continue to receive regular issues of Measurement and Control throughout 2017, but you will also receive four issues of Precision, of which this is the first.

The purpose of these pilot editions is to enable us to get the long-term format right, and your views will help with this. You can send your feedback on this and future issues to precision@instmc.org

From the start of 2018, Measurement and Control will cease to be printed as a hard-copy journal. However, the technical articles it features will continue to be published online, with free access for members.

The overwhelming majority of the members we contacted through Council would prefer to receive a coffee-table style magazine. You told us you would like articles describing exciting and challenging applications of control and instrumentation technology written in a journalistic style. When needing to consult scientific papers on a specific subject, you displayed a preference for access on the web via a searchable database.

As well as appealing to members, we want Precision to serve as a shop window for the Institute and the industries it serves. We hope non-members who come across it will catch a flavour of the areas that define our community. We would like them to realise the huge importance of measurement and control in everyday life as well as in unusual and demanding situations. If these readers become active Institute members, that will be a measure of success.

One group we are keen to reach is younger practitioners, whether students or early-career professionals. Precision will be accessible online and as an app, and we want to stimulate the interests of a new generation of engineers and scientists, and encourage them to consider careers in our field.

We hope you enjoy the magazine and do let us know what you think.

Patrick Finlay PhD CEng
Chief Executive Officer

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PRECISION

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NEWS

MEASURING AND CONTROLLING BREXIT

As Professional Engineering Institutions consider the impact of Brexit, Patrick Finlay, CEO of the Institute of Measurement and Control, presents key points.

On 23 June 2016, the UK narrowly voted to leave the EU, and the Prime Minister has announced her intention to launch this process by invoking Article 50 in April this year. Whatever our personal and corporate misgivings, Brexit is going to happen, with a completion target of April 2019. There is no point in arguing for a change of this decision, but there is certainly an opportunity for influencing the negotiations to ensure that damage is limited and benefits maximised.

In a rare display of unanimity, the 35 UK Professional Engineering Institutions, including InstMC, recently produced a report that identified the key engineering priorities for Brexit negotiators. Unity has paid off, and the UK Government has indicated its interest in an ongoing dialogue with us, through the Royal Academy of Engineering (RAEng), as exit negotiations begin.

The RAEng report, Engineering a future outside the EU, identifies that engineering contributes £280 billion to the UK's gross value added accounts for half of all exports, and employs 5.5 million people in the UK, of whom 450,000 are represented by professional institutions. UK science and engineering companies invest £9.5 billion per year in R&D, at least three times as much as central Government.



62% of companies said that the ability to employ EU citizens was the most significant impact of the EU on their business.



Much of the report's findings were based on a survey across the engineering sector. The major sectors represented include energy, transport, defence and oil and gas. 31% of the responding companies had turnovers of more than £100 million.

62% of companies said that the ability to employ EU citizens was the most significant impact of the EU on their business. When asked about concerns on leaving the EU, major items highlighted were availability of labour, free movement of goods, R&D networking, and standards and regulations. Benefits cited for leaving the EU included lower exchange rate and fewer regulations.



Major findings and recommendations from the report are:

Engineering skills and major projects

Brexit could present a major challenge to the supply of skilled engineers from the EU, who are essential to maintaining the world-class quality and success of UK engineering companies and universities. In academia, engineering has proportionally more staff originating from the EU (15%) than across all subjects as a whole.

Uncertainty about the status of EU workers in the UK and further risks to the supply of skilled engineers are likely to result in delays to major infrastructure projects such as HS2, Thames Tideway and Hinkley Point C, which will face recruitment difficulties and increasing costs if demand for labour outstrips supply.

In response to these potential challenges, the report calls on Government and the engineering community to work together to take decisive action on the engineering skills crisis, as well as to develop

a Shortage Occupation List for engineering positions that cannot be filled domestically in the short term. It advocates straightforward solutions such as temporary visas for skilled engineers from EU countries with the specialist skills that the UK lacks.

The report also calls on the UK Government to extend procedures for intra-company transfers to cover EU citizens, as many companies require their engineers to move freely to support and fulfil contracts.

Impact on research and innovation

Innovation is critical to the UK's economy and productivity, as sectors with high concentrations of graduate engineers report greater than average levels of innovation activity and innovation-related income alongside greater productivity.

The UK has a globally excellent and highly productive research and innovation base, to which EU support and collaboration has significantly contributed. The report warns, however, that losing access to EU research and innovation funding programmes would pose a considerable risk to the quality and quantity of UK research and innovation, and in turn to UK GDP. Evidence suggests that EU collaboration with UK researchers is already being put on hold or has been scaled back since the referendum, and if European project funding becomes less available, the UK is likely to become a less attractive destination for the brightest and best students and researchers.

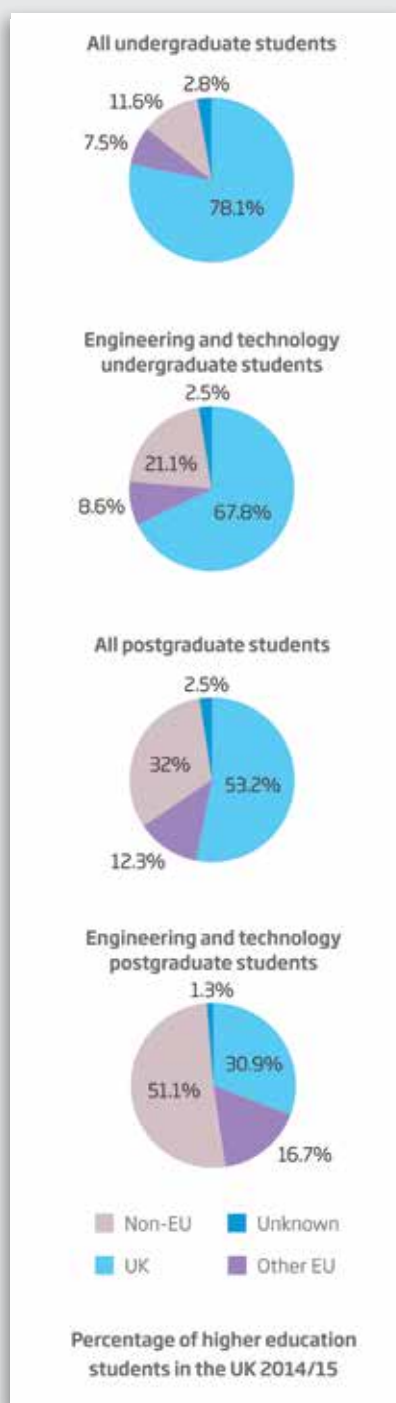
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In recognition of the importance of European funding streams and collaboration frameworks to UK research and innovation, it recommends that Government seeks the closest achievable association with relevant EU programmes, and if needed develop long-term funding streams that complement current funding by encouraging international mobility and collaboration, particularly between industry and academia.

Industrial strategy: an opportunity for global leadership

Throughout the consultation process, one opportunity was pointed to repeatedly - the development of a new industrial strategy, in partnership with academia and industry, as a route to enabling engineering to maintain and increase its contribution to economic development and social progress after the UK leaves the EU.

Engineering A Future Outside the EU highlights the UK's strengths in attracting foreign direct investment (FDI), including a relatively open attitude to foreign ownership of assets and a flexible labour market. It calls on the Government to continue to create the conditions for the UK to attract a high level of FDI by developing policies and frameworks that are designed to lower the costs of doing business and make the UK an attractive place to invest in.



Standards and legislation are recognised in the findings as non-tariff barriers that are crucial to strong trade relations, with the UK's continued leading role in developing European and global standards seen as being particularly important. The report emphasises the need for data protection and cyber security laws to be closely comparable to EU law in order to avoid barriers to trade, and that frameworks must be introduced that allow the UK to continue to collaborate in the digital single market. The internet economy contributes 8% of the UK's GDP, a greater contribution than in any other G20 country, and policy changes that limit ongoing collaboration in the sector would undermine the UK's leadership.

The consultation also found that the UK energy industries would benefit from continued membership of the European Energy Community. Remaining a member would help foster security of supply, ensuring that the UK can continue to influence regulation and deliver economic benefits.

Overall, the report calls for an industrial strategy that presents the UK as forward-looking, open for business, and an active and welcoming partner for the international research, innovation and business communities.

To read Engineering a future outside the EU produced by the Royal Academy of Engineering in October 2016 visit www.raeng.org.uk/publications/reports/engineering-a-future-outside-the-eu



REVIEW TEAM BEGINS WORK

The Industrial Digitalisation Review, part of the Government's new Industrial Strategy, meet for the first time in February. Chaired by Juergen Maier, CEO Siemens UK and Ireland, the review is set to assess how the UK can benefit from the accelerated adoption of digital technology across advanced manufacturing.

The review leadership team will engage with academia and large and small businesses to see how the design, development and deployment of digital technologies can drive increased national productivity.

Technologies in scope include automation, robotics, industrial machine processes and the Internet of Things.

FLOW METROLOGY STANDARDS CLOSER

2017 has already seen significant progress on the development of a wide range of standards linked to flow metrology.

'This demonstrates the importance of the UK's role in delivering the underpinning research and work necessary to develop standards and guidance to support trade and industry,' says Glasgow-based NEL Group Manager Mark Roscoe.

'One of the highlights of this work has been the excellent progress made in developing the draft of the new multiphase flow measurement standard (ISO/TR 21354),' he continued. 'This was identified as an industry need at last year's North Sea Flow Measurement Workshop held in St Andrews.'

NEL is also working on ISO/DTR



The Sylvac Scan F60, available from Bowers Group, UK, can increase productively with a significant reduction in inspection time on cylindrical parts including shafts, turbine blades, camshafts and associated components.



15377 (differential pressure devices),

ISO/WD 5167-6 (wedge meters), ISO 11631 covering fluid flow measurement and is involved with the ISO/TC 30/5 committee which oversees mass and velocity meters. Team members are conversing on ISO/DIS 2714 (positive displacement meters) and ISO/DIS 2715 (turbine meters) to ensure that the meters are satisfactory for all liquid flows, and not just oil.

For information on standards, email Michael.Reader-Harris@tuv-sud.co.uk

OPTIMAX GAINS UKAS ACCREDITATION

Optimax, Market Harborough, has been granted the UK's first accreditation for the verification of coordinate measuring machines (CMMs) equipped with imaging probing systems against the ISO 10360-7 standard by the United Kingdom Accreditation Service (UKAS).

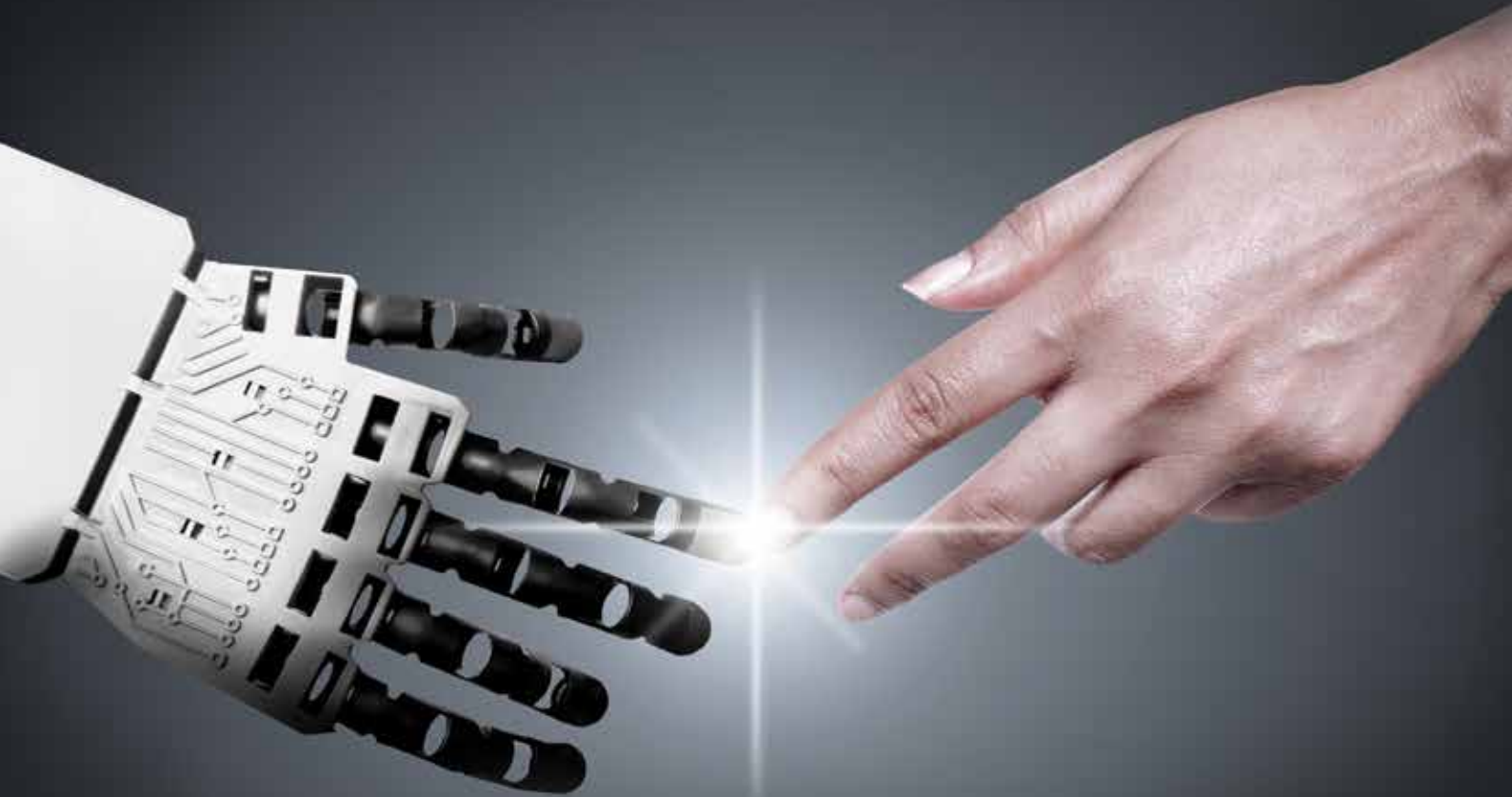
ISO 10360-7:2011 specifies the acceptance and re-verification tests for confirming the manufacturer or user's stated performance of Cartesian CMMs equipped with imaging probing systems (often referred to as vision or video measuring machines).

PRECISION SHAFT MEASUREMENT – SYLVAC SCAN F60

A new optical measuring system for the non-contact measurement of cylindrical turned parts features a new camera and optics for superior image processing, speed and quality.

The Sylvac Scan F60, available from Bowers Group, UK, can increase productively with a significant reduction in inspection time on cylindrical parts including shafts, turbine blades, camshafts and associated components.

With a cycle time of less than three seconds on full sized parts and a measuring range of 60 mm diameter and 300 mm in length, the system has a helix tilting system enabling sensors to tilt to a 30 degree angle. This ensures that measurements taken for threads are precise, taking data on the flank, thread and root with ease.



RISE OF THE COBOT

Suzanne Gill takes a look at the cobot, and how safety can be assured as man and machine work together.

Ever since Isaac Asimov's Three Laws of Robotics we have been concerned that creators will lose control of their creations, but as more and more collaborative robots (cobots) emerge, man and machine are learning to work together.

While traditional robots cannot work in an operator-occupied workspace without safety fencing, cobots are

cage-free and designed to work side-by-side with humans on shared or separate tasks.

Andrew Armstrong, Sales and Marketing Manager at FANUC UK, states 'Although collaborative robots do not eliminate the need for workplace risk assessments, the increased adoption of peripheral safety devices is enabling robots and

humans to work in close proximity to each other, eradicating the fear of interrupting production or worse, an accident.'

To work safely with humans cobots are equipped with force sensing to limit their power and force. In any situation they can 'feel' or detect an abnormal force and stop their motion immediately. Although they still cannot avoid a crash, they can reduce impact and avoid incidents such as crushing accidents.

Safety standards

In 2013, the first safety standards for collaborative robotics, ANSI/RIA R15.06, were published. More recently, the ISO/TS 15066 standard was published in March 2016, specifically outlining guidance for and the requirements of collaborative industrial robot systems, such as contact forces and pressures that can be applied to different regions of the body.

'To ensure that humans are not exposed to unacceptable risks when working collaboratively, the current standards describe four separate measures that can be used to provide risk reduction. It is required that at least one of these is fulfilled, in addition to having visual indication that the robot is in collaborative operation,' said Armstrong. The four measures are:

- 1. Safety-rated monitored stop:** when it is detected that a human has entered the collaborative workspace, the robot should stop. The stop condition should then be maintained until the human leaves the workspace.
- 2. Hand guiding:** the human can guide the robot by hand. Additional requirements for safety include safe-limited speed monitoring and a local emergency stop.
- 3. Speed and separation monitoring:** the robot must maintain a specified separation distance from the human and operate at a pre-determined speed. This measure requires careful risk assessment and needs to take account of safety distances.

4. Power and force limiting by inherent design or control: the power and force of the robot actuators need to be monitored by safety-related control systems to ensure that they are within limits established by a risk assessment.

Ford adopts cobots

Ford is one company using cobots for vehicle manufacture. The robots are being used to help workers fit shock absorbers to Fiesta cars, a task that requires pinpoint accuracy, strength and dexterity. Employees work hand-in-hand with the robots to ensure a perfect fit every time.

The trial at Ford's assembly plant in Cologne, Germany, is part of the company's investigations into Industry 4.0. Feedback was sought from more than 1,000 production line workers to identify tasks for which the new robots would be best suited.



'Robots are helping make tasks easier, safer and quicker, complementing our employees with abilities that open up unlimited worlds of production and design for new Ford models,' said Karl Anton, Director Vehicle Operations, Ford of Europe.

Metre-tall robots work hand-in-hand with the line workers at two work stations. Rather than manipulate a heavy shock absorber and installation tool, workers can now use the robot to lift and automatically position the shock absorber into the wheel arch, before pushing a button to complete installation.

'Working overhead with heavy air-powered tools is a tough job that requires strength, stamina, and accuracy. The robot is a real help,' said Ngali Bongongo, a production worker at Ford's Cologne plant.

Sensors on the robot will stop it immediately if an arm or even a finger is detected in its path. Developed over two years, the robot programme was carried out in close partnership with German robotics manufacturer, KUKA Roboter GmbH. Ford is now reviewing further uses for collaborative robots.



The robots are being used to help workers fit shock absorbers to Fiesta cars, a task that requires pinpoint accuracy, strength and dexterity.



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Du-Aro launch

Following a Japanese launch for its Du-Aro Collaborative robot in 2015, Kawasaki Robotics has introduced its cobot to the UK market and it is currently being installed into several operational systems.

Du-Aro is a two-arm collaborative robot designed to function as a quickly and easily installed co-worker to meet fluctuating production demands.

Where production runs are limited in volume, justifying costly dedicated assembly or packaging tooling can be difficult. Finding operators to integrate on production lines at short notice, and for limited periods, can be an even bigger problem, so having a co-worker robot that can simply be wheeled into position when needed is a natural progression for manufacturing automation.

Two SCARA (Selective Compliance Assembly Robot Arm) configurations share the same central pedestal to allow Du-Aro to provide the same working envelope as a human operator. Controlled by a single unit, coordinated arm movements can be programmed easily either by 'lead through' or by using a tablet or robot teach pendant.

Low-power motors and speed reduction helps Du-Aro to co-exist with its human operators and in the event of a collision or contact with any object or an operator, collision detection sensors immediately stop all motion.

'The concept of Du-Aro is based around the need for ease of integration and flexibility,' said Ian Hensman, UK Sales Manager at Kawasaki Robotics. 'Integrating it onto a production line conveyor with other operators simply requires it to be wheeled into position and the arms to be physically guided through the required motions. Of course, sensors are required to provide inputs to the controller but even this area has been simplified with the inclusion of optional vision cameras.'

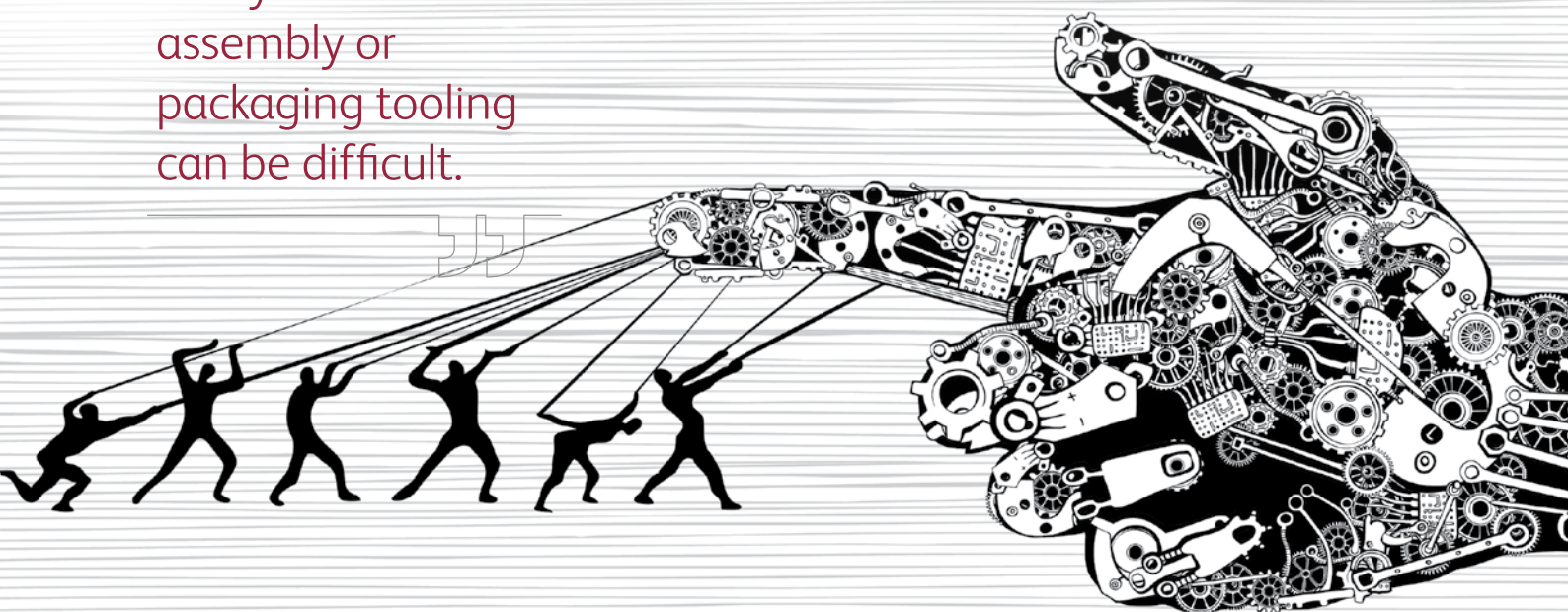
The Du-Aro's controller can also be supplied with embedded vision processing software. A range of application-specific cameras, light sources and grippers can be simply plugged into the robot's arms.

'We believe we have made the whole process of programming very straightforward from program routines and sensing, through to simulation of the working area and operation,' concluded Hensman.

A version of this article was first published in Control Engineering Europe, October 2016.



Where production runs are limited in volume, justifying costly dedicated assembly or packaging tooling can be difficult.





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ABB

FIGHTING CANCER WITH ULTRASOUND

Bajram Zeqiri from the National Physical Laboratory's (NPL) Ultrasound and Underwater Acoustics Group showcases the latest innovations being moved from lab to industry with the help of NPL metrology.

As a technique for diagnosing and treating cancer, ultrasound has been around for decades, and for as long as it has existed, it has been necessary to define how it should be used. What protocols ensure that patients get the best, most accurate diagnosis possible? Are there dose levels that shouldn't be exceeded? And in what circumstances are these appropriate?

NPL has worked to answer these questions for many years to ensure the safety of the technique, and is now supporting new, better diagnosis and treatment methods using ultrasound.

Better diagnosis of breast cancer

It has long been known that tissue has acoustic properties including sound speed and attenuation that are correlated with different breast pathologies such as cystic masses, tumours or fibroadenomas. Ultrasound is therefore better than X-ray mammography in distinguishing between cancers, resulting in tissue of increased density, and naturally occurring dense breast tissue encountered in younger women.

Ultrasound Computed Tomography (UCT) is being investigated as a next-generation clinical technique for detecting onset of breast disease, driven by its potential low-cost, safety, comfort and operator independence. With Innovate UK funding, NPL is leading a consortium comprising Precision Acoustics, Designworks and a clinical partner, University Hospitals Bristol, to design, develop and test a next-generation UCT system for whole breast imaging.

The system is based on a novel thermal detector, pioneered at NPL. The detector is phase-insensitive and, since the 1980s, it has been known that UCT images from such detectors are much less susceptible to errors such as image artefacts that arise using phase-sensitive detectors.

These issues arise because different tissues have different sound speeds. This modifies the direction of an ultrasound wave travelling through tissue, spreading out the arrival time of the acoustic waves at the detectors and, in extreme cases, leading to signal cancellation. Errors in the reconstructed tissue maps are



Ultrasound energy can be focused onto a region as small as 1 mm² to thermally ablate (destroy) cells with minimal damage to the surrounding tissue. This is called High Intensity Focused Ultrasound (HIFU).



produced when using conventional phase-sensitive detectors, which are sensitive to arrival time of the acoustic wave.

The new phase-insensitive detectors respond to acoustic energy and are therefore immune to this effect. Under a project funded by the National Institute of Health, NPL proved this by showing that UCT images generated by the new detectors are much less susceptible to such artefacts, albeit for images generated on simple test objects. The Innovate UK project will develop an imaging system to examine the whole breast immersed in water, with the detector opposite an array of 14 transducers generating sound at 3.2M Hz. The detector-transducer array pair will rotate around the breast, gathering the data required to reconstruct an attenuation image.

The target is to complete a scan in a specified plane in four minutes. The imaging system has been built and is currently at NPL for performance evaluation and optimisation. The overall project objective is to demonstrate the clinical potential of the technology for identifying breast cancers and, in mid-2017,

the system will be deployed at the clinical partner, Bristol Breast Care Centre, Southmead Hospital for testing on a small number of volunteers and be compared with conventional technologies.

From lab to hospital

The last decade has seen many promising new therapeutic uses for ultrasound emerge, including the use of extremely high power levels. Ultrasound energy can be focused onto a region as small as 1mm² to ablate (destroy) cells with minimal damage to the surrounding tissue. This is called High Intensity Focused Ultrasound (HIFU).

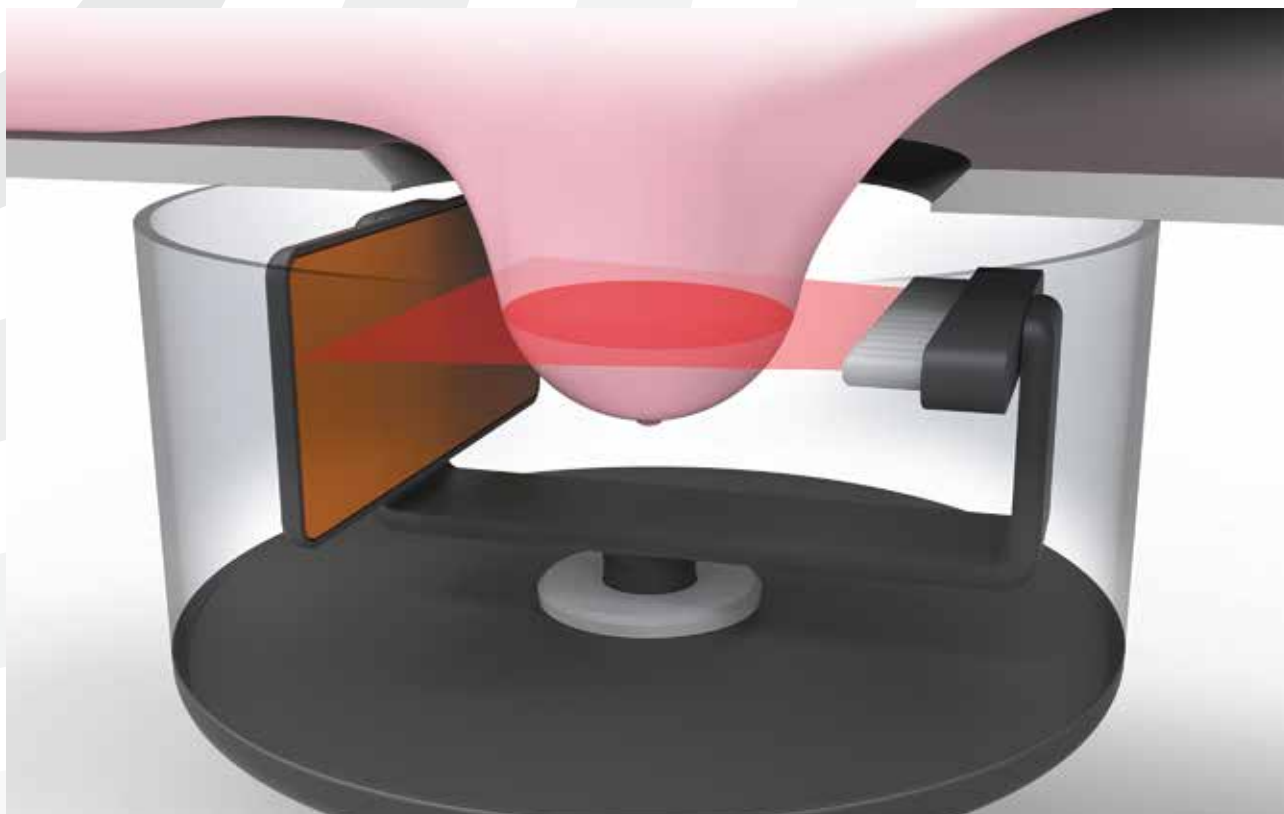
Tissue damage can be accurately controlled and ultrasound waves can be directed using magnetic resonance or ultrasound imaging. More than 8,000 patients were treated commercially or in clinical trials worldwide with HIFU in 2014. To date, nearly 90,000 patients have undergone this treatment for a range of serious medical conditions.

HIFU has been approved to treat 19 medical conditions in regions around the world, such as prostate and liver cancer. But there is not yet a metrological infrastructure for this

treatment in place, meaning that doses given to patients cannot be traced back to an agreed standard or treatment plan. This can result in over- or under-treatment and harm to the patient, or mean that valuable new treatments are not taken up because they are too inconsistent.

NPL first started working on HIFU in 2003 and we have worked closely with clinical colleagues to put in place standards for its use. Working with the Institute for Cancer Research (ICR), NPL created a report reviewing the measurement needs for HIFU and identifying the international standards that would be necessary to ensure HIFU is used correctly.

Continued on next page...



This report was subsequently adopted by the International Electrotechnical Commission (IEC) and has led to three new industry standards. One of these standards is about the measurement of total power output – something of key importance, but which could not previously be measured accurately above 20 W. With power above several hundred watts often needed for clinical treatment, NPL developed better targets and a new measurement method based on thermal expansion to monitor the power levels. These are now used by leading manufacturers of HIFU sources for quality control of their products.

International collaboration is essential to developing such standards in medical areas. Two EURAMET-funded projects, on External Beam Cancer Therapy and Dosimetry for Therapeutic Ultrasound, have resulted in better laboratory measurement standards, the definition of basic exposure and dose quantities and enhanced computer modelling, as well as the development of transfer standards for use in the clinical environment.

It is not just cancer treatment that is benefiting from this development of standards in diagnosis and treatment. There are also exciting developments in the treatment of brain disorders such as Parkinson's disease and neuropathic pain. This work will improve patient quality of life, benefit the medical manufacturing industry and give healthcare providers optimised treatment planning methods.

Ultrasound may have been around for decades, but improvements to its efficacy are being made every day. Its future as a treatment is bright.



There are also exciting developments in the treatment of brain disorders such as Parkinson's disease and neuropathic pain.



Bajram Zeqiri

Biography

Bajram Zeqiri is the Lead Scientist for the Ultrasound area in the NPL Acoustics group. His current research interests relate to a number of areas of ultrasound metrology.

www.npl.co.uk

A version of this article appeared in Insights magazine, Issue 10, 2016.



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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.

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- ▶ 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.



THE SMART WAY TO VISUALISE HAZARDS

John Martin explains what needs to be considered when preparing a bow tie analysis – a diagram that visualises risk in a single, simple graphical format.

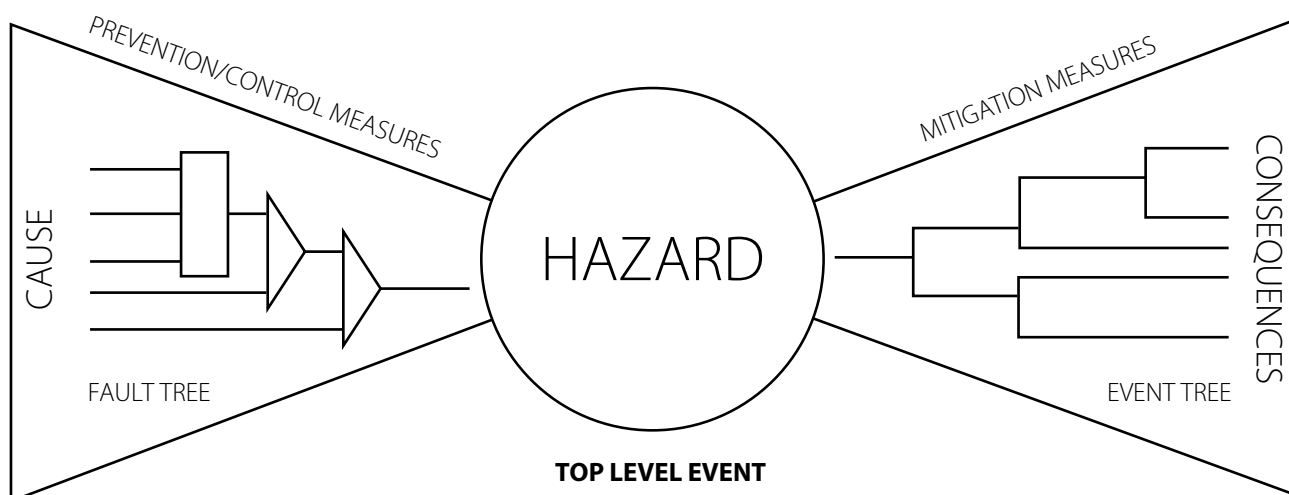
Bow tie diagrams are already widely used in the oil and gas industry and are becoming increasingly popular within the chemicals sector too, forming a useful part of the armoury of tools used in the journey to avoid the realisation of hazardous scenarios.

There is much talk about bow tie analysis. However, the real value of bow ties comes from using the diagram as a visual representation of the analysis which should already have been carried out prior to construction of the diagram. The centre of the bow tie diagram is the 'top level' event, the significant event that needs to be avoided – the hazard. Examples might include overfilling of a gasoline storage tank or the occurrence of a runaway reaction. On the left hand side of the top level event are the initiating events which begin the journey towards the hazard. These are often referred to as 'causes'. In between the causes and the hazard are the preventive barriers which, if successful, will interrupt the journey from cause to hazard and if unsuccessful will allow that journey to proceed. In effect this side of the diagram is a fault tree without numerical data. On the

right hand side of the diagram are the 'consequences' and in between the hazard and the consequences are the mitigation barriers which, if successful, interrupt or mitigate the journey from the hazard to the consequence. This half of the bow tie diagram is effectively an event tree without numerical information.

Bow tie diagrams are flexible and can be used anywhere in an industrial setting that a visual representation of risk and barriers would be beneficial. It allows important information to be quickly conveyed to people from different backgrounds and disciplines. The bow tie can quickly demonstrate when pathways have very few barriers or, for example, when all the barriers in a pathway rely on human intervention. It is also possible to display the effect of certain barriers becoming impaired or failing.

Bow tie diagrams are flexible and can be used anywhere in an industrial setting that a visual representation of risk and barriers would be beneficial.



Producing bow tie diagrams is not without challenges and there will be times when a fault or event tree with quantitative data is required to allow decisions to be taken. It is important to consider how much information is displayed in the bow tie diagram – the benefit of visual impact can be lost if the structure becomes too complex or if too much annotation is added so that the diagram becomes unwieldy and cumbersome.

Bow tie success

Bow ties are best constructed once the input data has been generated using a recognised and structured methodology for the identification and assessment of process hazards. In the process industries HAZOP and PHR are widely used for this purpose. Process Flow Diagrams (PFDs) or Piping and Instrumentation Diagrams (P&IDs) are divided into sections and considered by a suitably qualified team using guidewords under the leadership of a competent chairperson to identify hazards, initiating events, ultimate consequences and barriers.

Failure to use a structured methodology can result in ineffective hazard identification and may lead to key data not being present in the

bow tie diagram. Once the hazard identification study is complete the bow tie author selects hazardous events to be considered and must concentrate on presenting the data in a clear, understandable and useful diagram. Proprietary software can be useful for the construction of the diagrams as this provides a consistent and professional appearance.

Bow ties should be used to clearly and broadly communicate the key hazards and controls on site. It might be possible to construct too many bow ties so that either quality suffers and/or the majority of diagrams are never used and key information not communicated.

Before investing time and effort in the construction of the diagrams it is important to consider how the diagram will be of assistance on that journey. One approach could be to develop bow tie diagrams only for the most serious hazards. Here it would be beneficial to have used a recognised hazard identification methodology as this can include risk scoring which will assist in identifying those hazards associated with the most severe consequence or the greatest risk.

John Martin works for ABB Consulting.



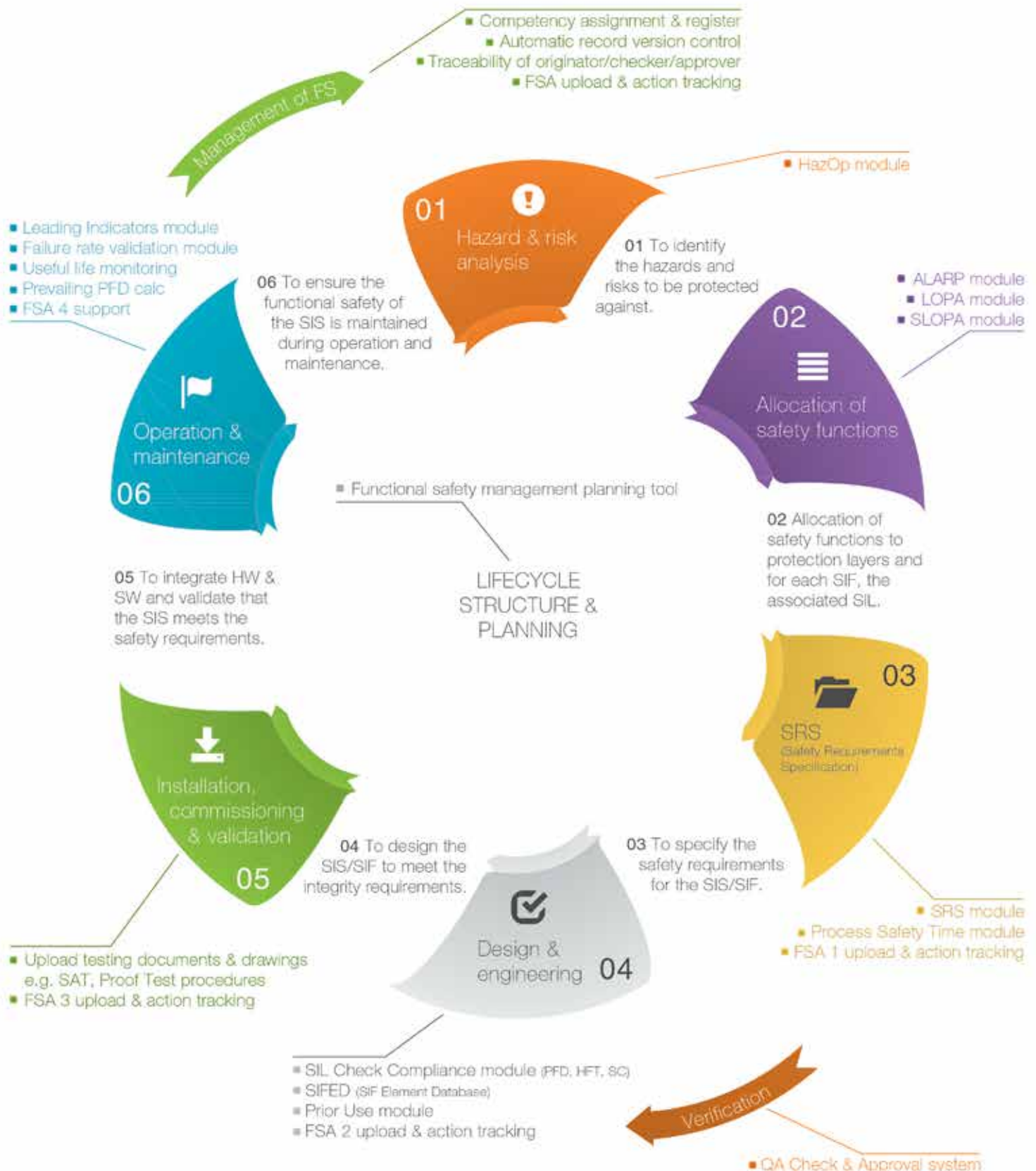
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SAVING THE NHS WITH SELF-MEASUREMENT AND CONTROL

Each day we hear news cautioning of an NHS crisis. Jeremy J Ramsden, honorary professor at the University of Buckingham, UK, considers the causes and the role of sensors in managing chronic disease.

Every 10 years the NHS has been carefully scrutinised and thoughtful, constructive reforms have been put forward by authorities such as the British Medical Journal in 1998 and Financial Accountability & Management in 2009. We are still over a year before the 70th anniversary, but presently one of the most prominent and actively debated matters of national concern is the perceived crisis in the NHS.

Under the present organisational regime, there is simply not enough money to run all the services that, it is felt, should be run. For example, taking the country as a whole, A&E services are severely overstretched. The drastic solution now being proposed is to reduce the number of A&E units, as the ultimate way of discouraging overuse.

The primary cause of the healthcare funding crisis is, seemingly ironically, the great success of the NHS. Aneurin Bevan,

the principal architect of the 1946 NHS Bill, foresaw the withering away of the service as the general health of the population improved. So it has, but the result has been increasing life expectancy – largely due to improvements in housing, sanitation and diet as much as to advances in medicine – yet without rejuvenation.

The elderly need proportionately more care, and their numbers are growing rapidly. Furthermore, small families, smaller houses and general household financial pressures have discouraged many families from looking after their elderly members at home, resulting in the enormous growth in the demand for social care, which has so greatly outstripped its availability that many hospital beds are occupied by those who no longer need to be there, but would be vulnerable if sent back to their homes without some provision for social care.

False economies

At the same time, the UK's national debt now stands at a very high level — between 80 and 90% of GDP and the Government is determined to reduce it. Even if there were very good evidence for increasing healthcare spending, it is not presently politically opportune to do so. Nevertheless, it is worth pointing out a number of interesting facts in this regard.

Firstly, the UK is one of the lowest spenders, expressed as a proportion of GDP, on healthcare in the developed world. Secondly, there is a clear lack of correlation between the quality of health outcomes, such as life expectancy, and healthcare spending.

Finally, the National Institute for Health and Care Excellence (NICE), the body that determines whether to authorise spending from the public purse on drugs or treatments, despite its purported use of “evidence” to underpin its decisions, is actually overly frugal and, therefore, denies drugs and treatments even though they would be beneficial in monetary terms. The root of this discrepancy seems to be undervaluation of the quality of life. If the J-value approach is used, as presented by P J Thomas, in the Proceedings of the Smart Sensor Systems for Self-Care Symposium held by the InstMC on 18 January 2017, it allows the appropriate level of spending to be determined in terms of objective parameters such as income and life expectancy, and application of this approach to healthcare clearly reveals the false economy of many of NICE's decisions.

Clinical costs

Another factor contributing to the present difficulties of the NHS is the growing cost of medicine — drugs are ever more expensive to develop, and high-value capital equipment (such as tomographs and functional magnetic resonance scanners) are more expensive than ever before. There have been attempts to develop low-cost open-source



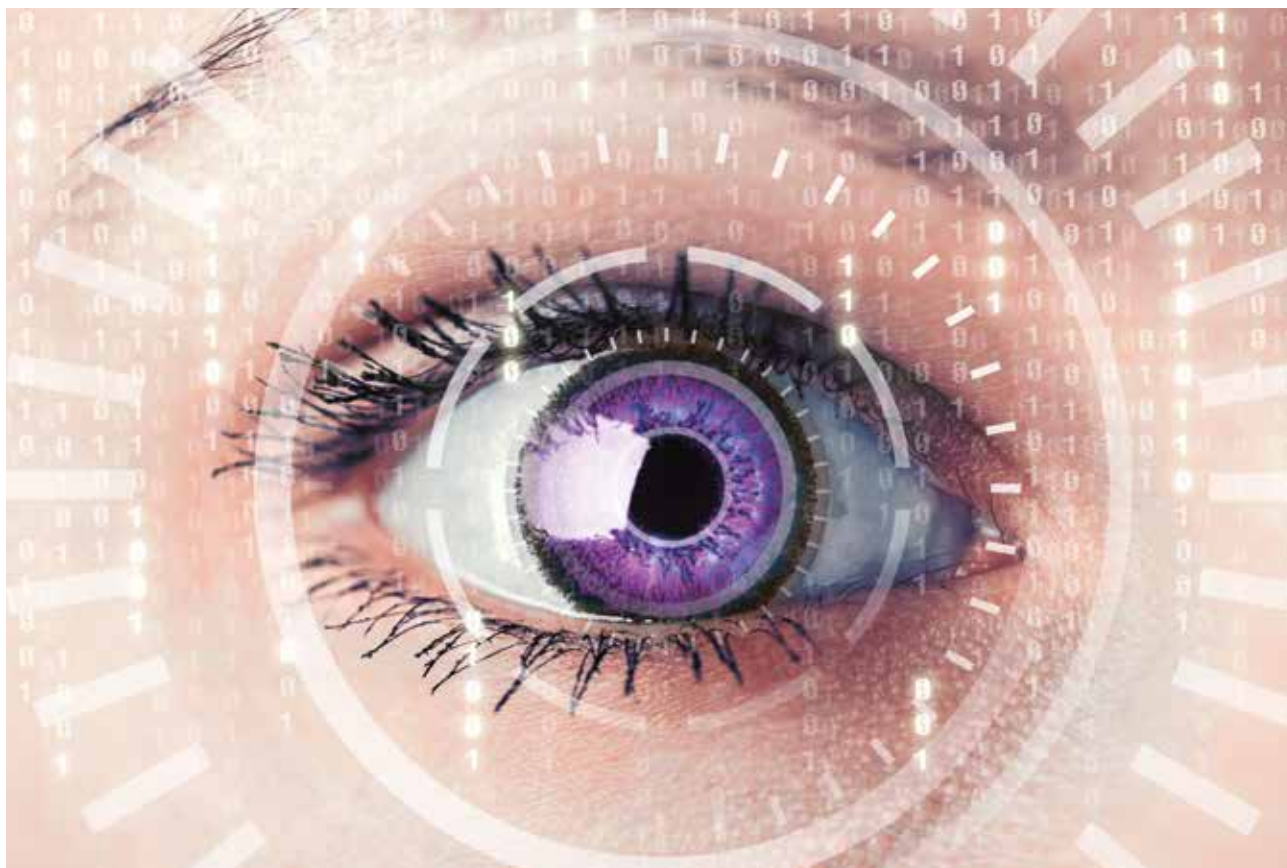
Professor Philip Thomas speaks at the InstMC Smart Sensor Systems for Self-Care Symposium held on January 18th 2017

hardware instruments, but these efforts seem to have largely petered out.

Then there are global factors, such as the emergence of antibiotic resistance in bacteria. Britain is doing quite well in keeping this under control compared with many other countries, but with international travel being relatively cheap and easy, there is always the risk of importing resistant bacteria from elsewhere. Yet another problem is the burgeoning bureaucracy of the NHS, fulfilling Parkinson's law in common with any large organisation. Few, if any, analyses and proposals tackle this fundamental aspect.

There are also exciting developments in the treatment of brain disorders such as Parkinson's disease and neuropathic pain.

Continued on next page...



Finally, there is the problem of lifestyle. Healthcare manuals written in the 1820s recommend walking or running about 20 miles a day whereas official recommendations nowadays suggest walking for 20 minutes, about one tenth the amount of exercise. Similarly with diet — Albert Szent György, who discovered vitamin C, believed that man’s natural intake of fresh vegetables would give him about 1g of the vitamin per day — official recommendations suggest about one tenth of that amount.

Furthermore, we eat a great deal of processed food rather than buying fresh ingredients and preparing them ourselves, and this implies, usually, less fibre and more preservatives. Some prominent healthcare practitioners, such as Lord Darzi, who has been a prolific writer of reports and articles in recent years, strongly advocate behavioural changes to combat “lifestyle diseases” such as type 2 diabetes, including more exercise and improved diet.

Behave yourself

The previous Government set up the Behavioural Insights Team

(now a social purpose company) to explore the practical application of behavioural science. This goes back to the work of J B Watson about a hundred years ago, which B.F. Skinner then developed into ‘operant conditioning’, or behaviourism, a central tenet of which is that the individual’s behaviour is a function of its consequences (not intentions or goals). Hence, positive and negative reinforcements and punishments are used to achieve desired behaviours. In the commercial sphere, especially among exploiters of digital technologies, B J Fogg’s ‘behaviour design’ has become popular and quite successful.

The Behavioural Insights Team is attempting to tackle matters such as smoking, organ donation, teenage pregnancy, alcohol consumption, obesity, type 2 diabetes, food hygiene, physical activity and social care. But while the goals are laudable, these ‘nudging’ activities may be inappropriate.

In 1944, Von Mises remarked, ‘Many doctors describe the ways

in which their fellow citizens spend their money as utterly foolish and opposed to their real needs. People, they say, should change their diet, restrict their current consumption of intoxicating beverages and tobacco, and employ their leisure time in a more reasonable manner. These doctors are probably right. But it is not the task of Government to improve the behaviour of its “subjects.” Neither is it the task of businessmen. They are not the guardians of their customers. If the public prefers hard to soft drinks, the entrepreneurs have to yield to these wishes. He who wants to reform his countrymen must take recourse to persuasion. This alone is a democratic way of bringing about changes.’

‘Nudging’ is surely a kind of persuasion, not the brainwashing that one associates with totalitarian states. We are all at liberty to ignore the nudging completely. Only if it starts to become coercion must we invoke the old maxim *quis custodiet ipsos custodes?* (who will watch the watchmen?)



If the NHS is to maintain its fundamental principle of free treatment at point of care, paid for out of general taxation, a degree of social responsibility is required. Last year, the Vale of York Clinical Commissioning Group proposed that if overweight people did not lose weight they would be prevented from undergoing surgery for up to 12 months while smokers would be forced to wait for six months if they did not quit. The proposals triggered outrage among those who believed they violated “patients’” fundamental right to treatment’.

Evidently the NHS is an exceedingly complex system, and must be treated accordingly. Despite health being as much about prevention as cure, the NHS has very much evolved into a cure-oriented organisation and is not itself interested in inexpensive measures, such as accident prevention, which could enormously reduce the burden on A&E units.

Self control

Lying somewhere between prevention and cure is the upcoming generation of advanced, miniature sensors able to monitor health parameters at the point of care — a GP’s surgery or even at home.

Progressive GPs are already encouraging patients to find out as much as they can about their condition — from books or the internet — before their standard 10-minute appointment. Empowering them by supplying them with sensors able to measure vital parameters, even DNA sequences, is the next step along this path. It could be especially valuable

for managing chronic diseases, which presently consume well over half the resources of the NHS.

Artificial intelligence, despite the vaunted imminence of its introduction into NHS advisory services, does not yet seem to be sufficiently advanced to be able to deal with the interpretation of the data generated by the new generation of sensors, but this may well come.

In 1974, Austrian philosopher Ivan Illich considered that the post-Second World War industrial system for health improvement, epitomised by the NHS, was actually counterproductive, not least since that type of medical science created new needs for health care — hence the unstoppable demands placed on a service like the NHS.

Although the sensors are themselves the product of an industry, is it possible that they could be deployed in such a way as to help once again restore acceptance of the essential features of our humanity, including the capacity to bear pain, accept ageing, and face death with positive equanimity, rather than simply considering ourselves as a unit to be cybernetically optimised?

Bio

Jeremy J Ramsden is member of the Systems Management Panel at the Institute of Measurement & Control.



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NEWS FROM THE INSTITUTE

New logo



The Institute's new logo was launched on 27 February 2017. With a contemporary professional engineering look, we hope it conveys what we do and what sort of people we are. The design incorporates reference to measurement and control via the stylised scale and flow-symbol motifs. The format is chosen to be clean and uncluttered, with a bold graphic that suggests an established and authoritative voice. We have changed our typeface to one with a modern image and improved legibility.

This new logo, along with a number of other changes to Institute media, will form a new look for the Institute during 2017, which we hope you will enjoy.

Website changes

The new Institute website was launched in 2015 and while the look and feel is much improved, there are some functions to be added, such as a members only area. Recently, the ability to pay subscriptions online was introduced and several additional functions are planned. To provide these new website capabilities, the Institute is currently looking to acquire a Customer (Members) Relationship Management system (CRM). This new system will allow members to login and gain access to additional information. This will also allow personalisation of the way the Institute communicates with members, as well as allowing each member to join Special Interest Groups or 'communities of interest'.

Changes to publications

During 2017 you will receive four issues of Precision, this new members' magazine, as well as ten issues of Measurement & Control (M&C). From January 2018, the M&C journal will move to an online-only version and the new members' magazine will be the primary printed publication for members.

If you would like to advertise in Precision magazine, please contact Danny Henderson on +44 (0)20 7387 4949 Ext 3 or email precision@instmc.org



JOIN THE InstMC AND GAIN A COMPETITIVE EDGE

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

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- ▶ Special Interest Groups to connect with like-minded professionals and grow your network
- ▶ Programmes, local and national events to build your skills
- ▶ Opportunity to engage with other professionals to influence national strategy
- ▶ Advice from experienced members and mentoring programmes designed to develop your career
- ▶ Access to relevant technical publications and information
- ▶ Discounts on a range of services essential for today's engineers.

Q&A

We interview
Dr Graeme Philp,
Honorary Secretary
and Trustee of
the InstMC and
Chief Executive of
GAMBICA.



What was the root of your interest in engineering?

My dad has to take most of the credit. His father owned a garage in Carlisle and spent his life fixing cars. My dad helped from an early age but was more interested in aircraft. He began in national service in the RAF in the late 1940s and came out to become an airframe technician at Napier's at Luton Airport in the mid 1950s. For as long as I can remember, he encouraged me to use his tools to build things, starting with the inevitable soapbox go-karts, then moving onto flying model aircraft – another of his passions. I even built a rocket powered monorail in our back garden with his help.

Then came the motorbikes and rust-bucket cars that many young kids went through at that time. He would encourage me to strip down engines and gearboxes to component parts and service them and put them back together. Between us we kept cars going mechanically long after their bodies had decided to give up the ghost.

I got into electronics in my mid teens through an equally inspirational uncle who had started his career as a TV repairman. There was no way I was ever going to be anything other than an engineer.

What is your vision of engineering in Britain in 2020?

The UK has a proud track record for innovation and continues to produce some of the most free-thinking and innovative engineers in the world. It also produces some of the best project managers and, through the accident of birth that gives us world class skills in – the global language of science and engineering – English, we are also called upon to chair many of the influential working groups that codify engineering through standards and legislation.

We have all the right ingredients to make the UK one of the most influential locations for engineering – just as we have become for banking and financial services, but in terms

of commercialisation of these skills and making them count for the economic wealth of our citizens, we have consistently punched below our weight since the end of the 1950s. There are examples of brilliance – ARM is one, Rolls-Royce continues to be another. But the political struggles that Rolls-Royce has had in its past, to stay alive in a world of eye-watering development costs and long development cycles, is a great metaphor for what we need to put right in the UK to turn our potential into reality.

We need to become less short-term and more knowledgeable about technology at government and company boss levels – investing in the right things and not just leaving everything to the markets. Markets are good at reacting to what is put in front of them and notoriously bad at predicting what they want in the future. With longer-term thinking we'll invest in training, apprenticeships and promising innovation, continue investing in development through the 'chasm of death' and won't sell out to multinationals just as we start to be successful. Instead, we'll have the vision and the confidence to become one of those multinationals ourselves. That's the way we'll make engineering appealing again to young people. That's what I hope for 2020 and beyond.

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

Engineering is one of the few professions a young person can enter that really can make a meaningful contribution towards solving social and environmental challenges. It really shouldn't be a difficult sale to people considering their careers. But somehow we have failed to get this message across to parents, teachers and politicians and the result is that a career in engineering remains one of the UK's best kept secrets.

Government has a part to play in addressing this issue but cannot do it all. It is up to us in the profession to get our 'marketing' right and show the general public what a great career in engineering and technology offers. Government has done some good work on apprenticeships recently and, after much lobbying from our industry and others, has extended these to also apply to the 40% of school leavers who go to universities – a great step forward.

Now the Government needs to



Engineering is one of the few professions a young person can enter that really can make a meaningful contribution towards solving social and environmental challenges.



become much more technology savvy and begin to understand the engineering industry and how important it is for wealth creation in the UK. It needs to stop insisting on quick wins and sound bites and see that its job is to understand at a deeper level what engineering and technology can do for the UK. In particular, it needs to wake up fully to the contribution that instrumentation control and automation can make to productivity, wealth creation and safety and job satisfaction in the UK.

What do you do in your free time to relax?

I sail. I think this is quite a popular pastime amongst engineers. Something about the elemental forces and the maths necessary to sail the boat safely and get it to where you want to go. As the CEO of a public company for 13 years, it was also a pastime that was all-consuming – I could relax without my brain free-wheeling, because when it did that, I could guarantee that I would find myself thinking about work.

What would your one wish be?

More vision in politics and industry.

RECORD YEAR FOR MERGERS AND ACQUISITIONS

Accountancy and business advisory firm, BDO LLP, took a look at merger and acquisitions activity in the test and measurement sector during 2016.

The test and measurement sector is a dynamic industry that has been growing strongly. The sector remains highly fragmented, but 2016 proved to be another record year for mergers and acquisitions (M&A) with deal volumes increasing by 15%. In total, 322 deals were reported in 2016 compared to 281 in 2015.

The global outreach of the industry was confirmed with cross-border deals accounting for 38% of transactions in the year. There have been increases across all geographies, but it is the North American and UK markets that have fuelled growth. North America was involved in 43% of all M&A transactions in 2016, having more than doubled the volume of activity since 2014. Deal volumes in the UK market also saw a significant increase with a 27% rise in 2016, and steady quarter-on-quarter increases through the year.

41% of the UK targets sold in 2016 were cross-border transactions, demonstrating how international investors continue to be attracted to the UK market, despite uncertainty surrounding the UK's future international trade agreements. The lower value of the Pound Sterling and the surfacing of better-than-expected economic data are also supporting investors who believe in the long-term prospects for attractive UK businesses.

Recent examples of sizeable cross-

border deals into the UK market include Australian ALS Ltd's acquisition of ALControl UK Ltd, a provider of food and environmental analytical services for AU\$66.7m, and the acquisition of e2v Technologies plc by US-based Teledyne Technologies Inc for £620m.

Private equity volumes have also steadily increased. Recent deals include Battery Ventures' buy-out of Michell Instruments Ltd to support investment in Michell's proprietary technology and in complementary acquisitions, and the MBO of Thyson Technology Holdings Ltd backed by NVM Private Equity, which will spur entry to new markets and international growth.

Roger Buckley, M&A Partner at accountancy and business advisory firm BDO LLP, said, 'We expect another strong year of M&A activity within the test and measurement sector in 2017.'

Buckley continued, 'The shadow of high-profile scandals will spur regulation and increase the outsourcing of non-core functions by businesses and governments. We also predict an increasing emphasis on environmental monitoring as pollution, air and water quality rise up the political and public agenda.

Smart, wireless and automated technologies will proliferate, and there will be increased efforts to harness the associated big data

to streamline processes, gain efficiencies, implement controls and improve safety. Furthermore, the growth of global brands and political rhetoric around protectionist policies will create

an increasing need for brand protection, leading to increased supply chain scrutiny.'

Against this backdrop, a number of larger businesses in the sector are repositioning themselves, aligning with client needs and future-proofing for long-term growth. Examples are Spectris plc, which manufactures instruments and controls, and has been making acquisitions to shift its emphasis towards complete solutions, combining products, software and service. A further example is Exova plc, which made a number of acquisitions and disposals in 2016 to realign its business towards more technically demanding services in sectors such as fire, transportation, aerospace, industrials and infrastructure.

A full report on 2016 M&A Highlights can be downloaded here: <http://bit.ly/2kKbx8r>



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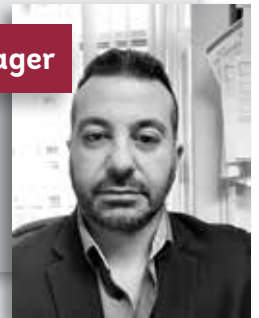
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