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New beginnings *We are working and living in a time of increasingly fast-paced change. Against a backdrop of political uncertainty, Deborah Ritchie says investment in home-grown talent and innovation is vital to economical and commercial success*

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Innovation in the UK

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New beginnings

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Earlier this month, a team of students from the University of Edinburgh's engineering, informatics, economics and business schools showcased a prototype for the potential future of the safe, efficient and sustainable transportation of people and goods. 'Hyperloop' is a sealed tube or system of tubes where a pod can travel free of air resistance or friction. First used to describe a concept released by Tesla and SpaceX, Hyperloop has since been explicitly open-sourced to encourage the advancement of the technology. The latest prototype is just one of an exciting array of innovation currently in development up and down the country; and the UK government sponsored Innovate conference, where the Edinburgh students were showcasing their design, provided a platform for dozens of others.

Readers of this magazine will quickly be able to tease out the opportunities and risks associated with a number of the innovations on show in the sprawling Birmingham conference centre – from Internet of Things solutions for security, safety, sustainability and smart cities, to nanostructuring for aero, solar batteries, supercapacitors, implants, as well as sensors and GNSS-enabled products and services for safety and security applications. The potential collective societal, commercial and environmental benefits of some of the technologies and solutions put forward are many and varied.

Other innovations, focusing on the use of robotics and artificial intelligence, demonstrate just how innovation-rich the UK is. And what better time to be looking closer to home for these pioneers? Such work will make an important contribution to the UK economy's ability to weather the turbulent waters of Brexit. As it prepares to leave the EU, the UK is facing the most complex challenge of the post-war period. On top of that, we face the challenges brought about by the economy slipping from the fastest growing in the G7 to the slowest in just three years.

When it comes to dealing with economic threats, the companies most at risk are unlikely to be big businesses which have the option to restructure or even move divisions of their business abroad; rather it is SMEs, who are the drivers of innovation. As Google's CEO, Sundar Pichai, remarked in a recent interview with the *Guardian*: "Pretty much every great thing gets started by a small team."

The very formation of these teams is among the risks associated with Brexit, as the potential removal of some £730m in research and development funding a year from the European Union (EU) looms. To prevent the emergence of a black hole in funding, public sector funding will have to plug the gap. Failure to do so could mean a further drop in the UK's 23rd place ranking on the OECD's global R&D expenditure table.

In the private sector, R&D collaborations between UK businesses and universities are currently worth in excess of £3.5bn in knowledge

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exchange income alone (ie. not measuring derived commercial benefit). The money injected into advanced research by universities is itself derived, in large, from the EU and this funding has a significant impact on the UK economy: university spending generates more GDP per unit of expenditure than any other sector including health, public administration and construction.

Supporting innovation

Besides the work carried out at Innovate UK, there are a number of other important hubs supporting the bid for British technological innovation. Among them the Centre for Process Innovation (CPI), where expert scientists collaborate with universities, SMEs and large corporates to help overcome innovation challenges and develop next generation products and processes.

The CPI was originally established to support the UK process manufacturing industry. It now operates across a broad range of technologies and supports a sector which currently exports almost £50bn a year with a contribution of over £15bn a year to the UK's GPD. To the CPI, risk assessment is core to its commitment, running new products and processes through its own risk mitigation model.

The National Physical Laboratory (NPL), meanwhile, is the UK's National Measurement Institute, and is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available. NPL maintains a wide portfolio of internationally visible research programmes that advances measurement science. It also has a commercial division, in which consultants and project managers combine to enable innovation and secure competitive advantage.

At the funding and training end, the Engineering and Physical Sciences Research Council is the main UK government agency for funding research and training in engineering and the physical sciences, investing more than £800 million a year in a broad range of subjects – from mathematics to materials science, and from information technology to structural engineering. With around 230 staff, EPSRC is a non-departmental public body principally funded through the Science Budget by the Department for Business, Energy & Industrial Strategy (BEIS).

These are just some of the centres of excellence for innovation in the UK – each making valuable a contribution to innovation efforts. But there is more work to be done, and at a difficult time economically. Ahead of the Autumn Budget, the Confederation of British Industry (CBI) urged the Chancellor to send signals that the UK is open for business and committed to supporting entrepreneurs and ambitious firms to thrive in all parts of the UK.

The CBI hopes the Budget will be treated an opportunity to "back the basics of a strong market economy" and show how good government in partnership with responsible business can improve lives, regardless of the outcome of the Brexit talks.

Director-general of the CBI, Carolyn Fairbairn, urged the government to greenlight large and small infrastructure projects, implement the ground-breaking T-Levels programme and make good on their commitment to provide practical support for innovators.

"Brexit planning must not be allowed to crowd out vital action at home. With this Budget, the government needs to set its eyes on the horizon, not the next few yards. The only sure way to raise living standards and provide sustainable public services is to solve the UK's productivity problem," she urged.

Among the priorities in the CBI's Budget submission are a pathway to reach an investment target of 2.4 per cent of GDP on R&D by 2027 and increase Innovate UK's funding for collaborative R&D. Innovation remains the bedrock of the country's productivity growth, and unlocking public and private investment in R&D to catch up with international neighbours will enable the ongoing investment the UK's innovators need to keep the country at the forefront of technological advances throughout Brexit and beyond.

In pursuit of Innovation: CBI recommendations to government

- Set an interim target for public investment in R&D by the end of this parliament as part of commitment to hit R&D spending equal to 2.4per cent of GDP by 2027
- Increase grant funding through Innovate UK to help meet the above target. This should focus on 'crowding-in' business investment via collaborative R&D and continued support for catapult centres
- Fund pilots to improve adoption of tried and tested technologies and management practices to improve productivity.

Redefining the future

A rare combination of innovative spirit, creative drive and scientific know-how are behind one of the most exciting developments in infrastructure security and management in recent years. And the timing could not be better...

Measured, stoic, polite: adjectives often associated with Britons. Yet, rarely do we hear others credit us for our innovative spirit. This is curious given the UK's long and voluminous history in pioneering technologies that have redefined human behaviour: the internet, the telephone, the electric motor, the steam locomotive, the light bulb – all outputs of Brits imbued with a creative spark.

We would also be mistaken to think of British technological ingenuity as a feature of some bygone era. As a nation, in spite of relatively marked underfunding in R&D, our universities and businesses continue to advance the state-of-the-art and provide ever more remarkable solutions to increasingly complex economic, social and political conundrums. Last year, Britain's scientists helped the UK claim half all Nobel prizes on offer.

So, what does this innovative spirit look like in the modern era? Where is to be found? As we wade through the murky waters of Brexit, where are we to look next to find the company pushing the technological envelope and driving change for a better world?

The Datatecnics Way

Birmingham seems as likely a place as any in the UK to find a company which takes innovation not so much as a practise but as a litany. In the city that gave birth to the Industrial Revolution, computer scientist and Datatecnics CEO, Mohammed Zulfiquar, leads a small, aspirational team of engineers and operational staff. Established in 2011, the company was created after Zulfiquar noticed the dearth of innovation in infrastructure security.

"It's a curious thing that the UK has not focused in any detail on how we protect the assets upon which we are most reliant as human beings: water, oil and gas; we take them for granted in a developed economy and yet, beneath the surface, all is not well and has not been for some time."

Though ominous in tone, Zulfiquar's caveat rings true. Every day, 25 per cent of the nation's supply of potable water is lost through leakage – enough to fill 1,300 Olympic-sized swimming pools.

"The hardware that's currently being deployed for leak detection is quite rudimentary," Zulfiquar explains. "Meanwhile, our software has become incredibly advanced; we're now able to use algorithmic techniques such as deep, feed-forward neural learning for artificial intelligence and predictive analytics. But, this type of software analysis requires advanced hardware, capable of creating meaningful data, and the existence of that hardware was lacking until we noticed the gap in the market and set about developing our technologies."

Since the company's inception, Datatecnics has set out on a mission to revolutionise asset management through the most advanced developments in machine learning, nanofabrication and printed electronic sensors. These technologies culminate in Datatecnics' flagship product, the Critical Infrastructure Pipeline Protection System (CIPPS), an architecture of ultra-low-cost printed electronic sensors embedded within a pipe wall to provide real-time, broad-spatial oversight of entire infrastructure grids.

Zulfiquar highlights the relevance of the challenge in the water sector, one of Datatecnics' target markets, where companies still beam radar signals into the ground in the hope of detecting pipe leaks.

"This is akin to pressing a cup against a wall and attempting to listen to a conversation in the adjacent room: always muffled and liable to misinterpretation. Our aim is simply to break down the wall altogether – to provide immediate, direct access into what is currently poorly understood. Our team are experts in materials science and engineering and they're using emerging technologies so we can observe our buried infrastructure just as well as our above-ground infrastructure."

As the CIPPS architecture harnesses printed electronics, the flexibility

in the system is unique – operators in the water, oil and gas sectors can specify which metrics they would like to monitor and the company can, in turn, print proprietary sensor systems for their clients. As the assets are then transported through the grid, CIPPS constantly interprets and learns pipeline behaviour from the cluster of sensors.

For water operators, valuable data include how pipes expand and contract, what their range of temperature is and how flow varies during night and day time – to name only the most salient.

For oil operators, changes to pH levels and pipe wall thickness are vital to understanding the effects of corrosion. Constant monitoring allows operators in all industries to not only gain a better understanding of their pipelines but to predict pipe failure. This is the holy grail as pipeline bursts often result in stark environmental damage, business interruption, state penalties and, not uncommonly, loss of life.

Though the idea is straightforward enough – making inert pipes 'smart' – the innovation required to realise this ambition has been far from it. Zulfiquar recalls conversations throughout the company's infancy in which fellow scientists argued that his idea of printing sensor arrays inside pipes was not feasible. "We were told that plastic pipe porosity would damage the electronics, that powering the system wouldn't be practical, and that the undertaking was too great to take on, but, here we are, a year away from product roll-out." Zulfiquar's persistence won him investment from the then government Technology and Strategy Board (now, Innovate UK) and Birmingham's Regional Growth Fund. These grants have served as the company's lifeline, enabling it to focus entirely on product development.

"Working through complex problems is part and parcel of innovation. You're not doing anything new if there's no friction between ideation and realisation"

The culmination of these efforts are summarised in the remarks of an Innovate UK evaluator who highlighted that CIPPS could have a "highly significant impact in the water industry globally".

Having seen how the scepticism of his peers has given way to avidity over the years, Zulfiquar is eager to stress that "working through complex problems is part and parcel of innovation. You're not doing anything new if there's no friction between ideation and realisation." And with Wx, the first CIPPS line designed specifically for water utilities, nearing roll-out, Datatecnics' drive to innovate and to create something novel and with wide environmental and commercial benefit, seems to have paid off. The company were lauded for the 'Best Use of Technology in Risk Management' at CIR's 2015 Annual Risk Awards by a panel of independent judges, beating both Google and Network Rail. In 2016, a new panel of judges awarded Datatecnics with CIR's 'Environmental Initiative of the Year'.

Redefining the future

When CIPPS is installed on water operators' networks for the first time in 2019, it aims to redefine best practice for an industry rapidly adopting new innovation to deal with increasing legislative and financial pressure. Southern Water's chief executive, Ian McAuley, recently remarked: "I think this is the biggest time of change that I have ever seen in the water sector in the UK, and I have been in the sector for 35 years. I think it's the biggest ever change for a variety of reasons – the scale of technology for example and its capability."

And yet, with CIPPS just on the cusp of commercialisation, Zulfiquar has already set about working on other product lines.

"The reality is that even when you're leading the pack, you're constantly watching your back. We know we need to keep pushing the boat out further and further. Some of those gambles will work, some won't. But if we don't try, we're only guaranteed failure."

This thirst for innovation is clearly apparent in the company's extensive IP portfolio: some 30 patents filed to-date with a further 20 pencilled for 2018. When asked to expand on some of these, Zulfiquar treads carefully. "Obviously, we can't speak too freely on some of the developments still in their infancy. That said, two projects the team are working on that really excite me are related to explosive particle detection and solar energy harvesting. And no, they're not related!" he jokes.

Datatecnics' constellation of technologies may not, however, be entirely disparate - rather they seem to be united by a company that takes problem-solving, curiosity and creativity as a philosophy for growth. Indeed, this philosophy serves as a reminder of the creative spirit that has served Britain so assiduously for generations past.

As the spectre of Brexit looms large, what is certain, in the pool of unknown unknowns, is that small and medium enterprises like Datatecnics – creators of truly novel solutions with potentially global impact – will be vital to Britain's ongoing, long-term prosperity and competitiveness.

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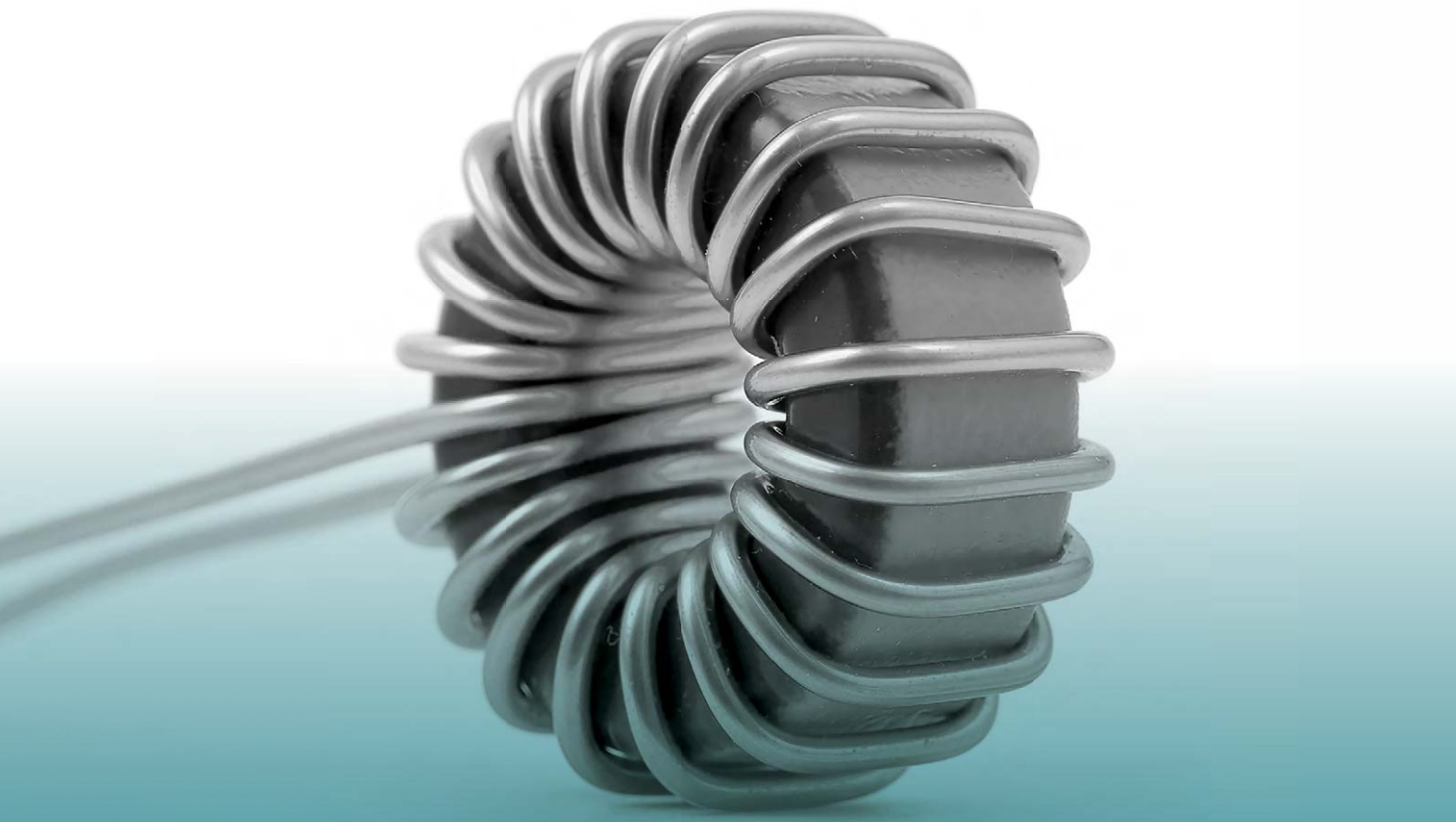

Driving change for a better world

At Datatecnics, we don't just innovate; we innovate to better lives and better environments. Our cutting-edge technologies are inspired by a desire to protect and drive positive change.

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winner
Best Use of Technology in Risk Management

CIR Risk Management AWARDS 2016
winner
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