NewStatesman

Spotlight

EMERGING TECHNOLOGIES: MAKING INNOVATION WORK

Alan Mak MP / Eben Upton / Iain Wright MP

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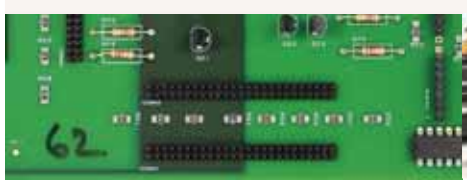

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Are we still innovating?

Every generation, it seems, is told it's living in an age of greater technological wonders than the last. Is this still true? The huge increase in the volume and dispersal of information over the last two decades has disrupted everything from pizza delivery to taxis to mattresses – but is the modern world as inventive as it used to be?

It's certainly true that the vast shifts in quality of life experienced by previous generations are hard to match. In the early years of the 20th century, it was relatively unusual for a household to have running water or electricity; within decades these conveniences had become ubiquitous. In 1911, the average life expectancy for a man in the UK was 51; by 1951 it had risen to 66.4. For all the disruptions the internet has wrought since its inception in the 1980s, they look insignificant in comparison to fresh water, light and 15 extra years of life.

But surely innovation is contributing more to the economy than ever? Perhaps not: in 2006, researchers from MIT and Northwestern University found that the economic contribution of an American R&D worker in 1950 contributed, on average, seven times as much to productivity as an R&D worker in 2000. Innovation has become harder, and less effective, because with each advance it becomes more complex.

There is more than one answer to this conundrum. Certain events – war, for example – force the pace of innovation to increase. In more stable times, though, the answer is to innovate well, rather than more quickly: to apply advances smartly; to invent with one eye on the things we already have; to develop with good intentions, not just because we can. Rather than begrudging the complexity of our advances, we should treat them as a resource. We should appreciate the view we have when standing, as Newton described himself, "on the shoulders of giants".

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COVER ILLUSTRATION BY SAM FALCONER

Britain must lead the fourth Industrial Revolution

Our financial future depends on our ability to innovate, says Alan Mak MP

The Chancellor, Philip Hammond, was right to put the future economy and the fourth Industrial Revolution at the heart of government policy during his party conference speech this month. While the "4IR" as it's sometimes dubbed, is still a relative unknown outside of specialist circles, mastering it holds the key to Britain's continued economic success this century.

In Birmingham, Hammond described how "quietly and unnoticed" a growing group of entrepreneurs and scientists from home and abroad have been "turning Britain into a hub of tech innovation". In recent years these leading minds have been operating under the radar; London-based DeepMind Technologies led the world in artificial intelligence (and became prominent only later when acquired by Google), while the University of Manchester quietly pioneered graphene, the ultra-strong, ultra-light wonder material.

This new technological age, characterised and accelerated by artificial intelligence (AI), hyperconnectivity and mass-automation, was the theme at the World Economic Forum's annual meeting in Davos this year, underlining its global significance.

In Westminster, interest in the 4IR is growing, too. In September, I led the first House of Commons debate on the topic, drawing cross-party interest. Rising stars Peter Kyle and Stephen Kinnock were among those who spoke from the Labour side. In the coming months, I will launch a new all-party parliamentary group (APPG) on 4IR, to allow MPs and peers to deepen their engagement with key industry figures and ministers as we set out on our mission to ensure Britain leads the way.

Fortunately, the signals from government have been positive. New business minister, Jesse Norman, responding for the government during my backbench debate, committed the UK to being at the forefront of 4IR; a few weeks later, the Chancellor cited 4IR as a way of "future-proofing the economy post-Brexit". He committed additional funds for science and technology so we don't miss what he called a "once-in-a-generation opportunity for Britain to cement its role as a leader in tech innovation". While all of this certainly sows the seeds for mastering 4IR, we need to continue building a free enterprise, pro-innovation economy that backs our entrepreneurs, start-ups and new industries. In doing so, we can look to our history for inspiration, for Britain has a strong record of leading the world through technological change.

Dyson is the blueprint for how SMEs can become bigger

Around 250 years ago Britain led the first Industrial Revolution, as engines and factories powered by coal and steam changed the world's economic landscape. Britain's manufactured goods were exported around the world, fuelling the nation's economic growth at home and establishing our reputation as innovators abroad.

During the late 19th and mid 20th century, Alexander Graham Bell and Tim Berners-Lee respectively continued our tradition as the home of innovation during the subsequent two industrial revolutions, driven first by electricity and then the internet. More recently our leading entrepreneurs such as James Dyson continue to prove we still have the talent to produce world-class products based on innovative technology. Dyson is the blueprint for how SMEs can become bigger businesses and help Britain lead the fourth Industrial Revolution by driving economic growth. His radical ideas were initially shunned by mainstream retailers keen to hold on to existing relationships in the multimillion pound vacuum cleaner industry. But after winning over consumers Dyson has now morphed into a company which generated more than £1.5bn in revenue last year and employs 7,000 people, many of them in Malmesbury, Wiltshire.

Through my role as chairman of the APPG for entrepreneurship, I meet many businesspeople who aspire to follow the success of Dyson. It is these men and women who could be the British Bill Gates, Sergey Brin or Mark Zuckerberg. One of the functions of the APPG is to facilitate dialogue between entrepreneurs and government officials. This month, David Gauke, Chief Secretary to the Treasury, set out his views to APPG members on the role entrepreneurs and technology play in our economy. The government should continue its backing for innovation hubs such as TechCity and Canary Wharf's fintech-focused Level39.

The Catapult network of regional innovation centres has also been a great success. These physical centres allow the very best UK businesses, scientists and engineers to work side by side on late-stage research and development projects, transforming high potential ideas into new products and services to generate economic growth. We need more of them across the country, including at least one in every strategic region of the UK. The Solent area, which includes my Havant constituency, is home to 1.3 million people and, according to figures from the Federation of Small Businesses, an estimated 50,000 companies, but has no Catapult Centre.

Similarly, Innovate UK, the government's innovation arm, can also be given a stronger role to help foster more 4IR businesses. It is already doing an excellent job, helping to create 55,000 jobs since its launch in 2007. Better infrastructure will also help new firms to flourish especially in areas where traditional manufacturing is in decline. The government has already committed to "targeted public investment in high value infrastructure", and is spending £13bn on transport improvements, including on high-speed trains as well as promising that 95 per cent of the country will have super fast broadband by 2017.

These will all be points that I will include in my forthcoming policy pamphlet for the Free Enterprise Group of Conservative MPs, backed by the free-market think tank, the Institute of Economic Affairs. We have more work to do in order to make Britain the capital of the new 4IR world, but the Chancellor quite rightly pointed out in his speech that we have a number of strategic advantages, including a trusted legal system, an advantageous time zone, the English language and access to finance which put us in a strong position. Moreover, our universities are some of the most respected in the world and continue to be the place where innovation thrives. We also have the lowest corporation tax in the G20, making us more attractive still.

We must make the most of these considerable assets as we develop our 4IR economy, and build on our early success, rather than adopting an inward looking, anti-innovation approach. Throughout history, Britain has adopted a pro-innovation attitude to technological development. From farming mechanisation and domestic labour-saving devices to the City's Big Bang, we did not allow fears about the future to stunt our economic and social progress. We soon realised the folly of requiring drivers of early cars to be preceded by a man carrying a red flag. We must adopt the same, forward thinking approach when it comes to the fourth Industrial Revolution.

Hammond himself warned that "this explosion creativity and innovation" could easily be "snuffed out by government policy". So, as the new revolution accelerates, we can be confident that if we follow the lessons of history and have the support of government, Britain has the entrepreneurial spirit and talent to master the fourth Industrial Revolution in the same way in which we mastered the first.

Alan Mak is the Conservative MP for Havant and chairman of the APPG for Entrepreneurship. Follow him on Twitter: @AlanMakMP

IN BRIEF

What can we expect from 4IR?

The fourth Industrial Revolution is the current trend of automation and data exchange in a wide range of technologies and industries. It includes cyber-physical systems and remote access through cloud storage. Breakthroughs and new products in fields such as artificial intelligence, advanced robotics, driverless cars, drones, 3D printing, the Internet of Things and nanotechnology, to name just a few, have captured the imagination of the public and the attention of policymakers.

Our industries need to work together and share developments in order to exploit the enormous potential of new technologies, writes the new president of the IET, Professor Jeremy Watson

The fastest innovation moves sideways

Ahead of the curve: the "race-bred" equipment developed for Formula One has been applied to transport incubators at St Mary's Hospital in Manchester

The Institution of Engineering and Technology (IET) and the Motorsport Industry Association (MIA) joined forces earlier in the year to address the current lack of widespread exploitation of "horizontal innovation" in the business technology community.

The UK is internationally renowned for its creativity, research and innovation, but often it seems that new technologies or processes can get locked into one sector, an industry, or even one specific company. As an industry and as a society, we don't tend to work together to fully exploit the potential of new technologies – which means that we are genuinely missing out on the rewards that they could bring.

The IET's horizontal innovation initiative is about addressing the barriers to sharing ideas and ensuring that more of our innovations are used where they are needed, and not just in the sector in which they are created. The effective transfer of knowledge and technology from one sector to another could deliver huge economic and societal benefits.

There are already some outstanding best-practice exemplars of horizontal innovation – but there is a great opportunity to find and encourage more.

We have also seen how Formula One technology is benefiting neonatal care. The Greater Manchester Neonatal Transport Team at St Mary's Hospital, Manchester, conducted a project into the effects of transporting critically ill newborn babies between hospitals using an innovative, "race-bred" piece of equipment which was secured to a transport incubator. The data logger uses an accelerometer combined with GPS technology to provide an electronic movement profile of the whole transfer.

The study compared how the speed of the ambulance, G-forces and vibration

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experienced by the baby related to the stability of vital signs such as heart rate and blood pressure. Premature and sick babies needing intensive care transfer are at increased risk of brain injury. A better understanding of the physiological effects of movement and vibration, at a critical stage in their lives, will enable technological improvements in ambulance and incubator design and real-time driver feedback to improve long-term health outcomes, when these journeys are unavoidable.

Williams Advanced Engineering has collaborated with UK start-up Aerofoil Energy to develop a new device that can significantly reduce the energy consumed by refrigerators in supermarkets and convenience stores; a new retrofit aerofoil system keeps more of the cool air inside the refrigerator cabinet, which will result in significant energy savings. Sainsbury's, the UK's second largest supermarket chain, has been testing the product at a number of its stores, with impressive benefits for their carbon footprint and costs.

As an interdisciplinary organisation, the IET is ideally placed to promote horizontal innovation between industries and is encouraging more sectors to get involved. This is a genuine opportunity to drive growth, create jobs and opportunities for future engineers – and most importantly make sure that solutions that already exist are used to address some of our greatest challenges.

Engineers and technologists really should strive to share information and think about how to transfer knowledge and technology from one sector to another; the IET can help by creating connected communities where we can foster knowledge exchange and generate new solutions with existing technology and know-how.

Commercial and business innovations have begun to merge with consumer electronics know-how and trends to push technology in new directions. These combinations are capable of developing something incredibly powerful and new, but we need to create even more opportunities to share ideas.

That's why the IET launched a new "horizontal innovation" category in its annual Innovation Awards. We have received an overwhelming number of entries, have drawn up a shortlist and the winner will be announced later in the year. The awards will be presented at a ceremony in December.

We've also invited SMEs to apply for our funded R&D programme to make their innovation a reality and solve healthcare challenges.

As the UK healthcare sector is an area that can greatly benefit from technology development in other sectors, we launched this programme to support a UK technology business in solving some of the NHS's current challenges. It offers one SME the opportunity to have access to its state-of-the-art manufacturing centre in Coventry to develop and adapt an existing technology for commercialisation in the health-care sector.

Once accepted on the programme, the SME will gain access to the MTC's flexible factory capabilities and use some of the most advanced manufacturing equipment in the world, as well as receiving support in business planning, product design, IP protection and engineering expertise.

If we are to effectively drive this horizontal innovation transformation forward, we need to reach out beyond the engineering world to the people who are experiencing the problems and challenges that we, as engineers, are trying to solve, and include them as an integral part of this new horizontal innovation initiative.

Through this long-term partnership we want to raise awareness and drive wider take-up of the successful transfer of technology from one sector to another across the UK.

Closing the gap between concept and commercial success

The High Value Manufacturing Catapult was set up to help manufacturers bridge the gap between innovation anad commercialisation. Chief executive **Dick Elsy** gives his views on the future of manufacturing

How would you describe the current state of UK manufacturing?
The UK is the ninth-largest manufacturing nation in the world. Manufacturing makes up 10 per cent of our GVA, accounts for almost half of our exports, employs over 2.7 million people and provides over two-thirds of our research and development investment. Many of the innovations developed for manufacturing subsequently find their way into other sectors.

So why does the government need to get involved? Can't industry look after itself?
All nations want a rich seam of advanced manufacturing value in their economies. All are offering to help companies to invest, through direct assistance or though the provision of supported research and development. In the UK, we have some of the best technological research in the world, so it makes sense to exploit this and offer an attractive, stable and supportive place to innovate. The conventional way of taking small steps to make continuous, gradual improvements is no longer enough in a world offering lower labour and energy costs than the UK. Industry – if left unsupported – would continue to improve, but not at the speed and scale required and would inevitably focus on lower-risk, more "vanilla-flavoured" innovations. We need high-risk, disruptive technology.

How does government know where to invest in order to best support industry?
The UK has an excellent network of collaborative business groups – such as the Aerospace Growth Partnership and the Automotive Council – where the main players come together to define which technologies need to be developed to keep us competitive. The

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government's proposed Industrial Strategy aims to build on their input, as does Innovate UK's Manufacturing and Materials Investment strategy, which will be launched on 2 November. It will stimulate innovation and adoption across all sectors of the UK economy by enabling UK businesses to develop transformative, flexible and resource-efficient manufacturing.

The High Value Manufacturing Catapult has a big role to play in delivering the strategy, by helping industry bridge the gap between concepts and commercial exploitation.

There is a good reason why companies – if unsupported – may not turn their innovations into manufactured products. It is often very expensive, requiring investment in equipment and expertise, without the guarantee of success.

The HVM Catapult removes those risks. Companies of any size and based anywhere in the UK, can access our equipment (we have over half a billion pounds worth of assets), our expertise (we employ over 1,900 engineers, technicians and scientists), and our networks for collaboration. Our set-up also enables us to take technologies that are tried and tested in one sector and help implement these in others.

In 2015-16 we worked with over 3,000 industry customers, over half of whom were SMEs. Collectively, they contributed over £70m to our total income, a clear sign that businesses are keen to access – and pay for – what we have to offer. We have a successful formula, offering technology capabilities ranging from composites materials to biologics, from additive manufacturing to printable electronics, and from metal forming to digital manufacturing.

How do you see Industry 4.0 impacting on UK manufacturing?

Industry 4.0 is best described as software-defined manufacturing. It is a digital revolution that introduces a new level of automation and cyber-physical systems that will disrupt manufacturing and other sectors, creating exciting opportunities for businesses that engage.

Cloud and mobile technology now allows us to access data anywhere and any time. New developments, such as 3D printing, virtual and augmented reality and advanced materials, help us make things in ways impossible before.

VR and AR enable collaborative design and allow us to test products virtually, before producing physical prototypes. The capture of product data means different design iterations draw on user experience analysis. The production process may change, too, as traditional manufacturing processes are replaced or complemented by new technologies such as additive manufacturing.

Even the sales process is changing as manufacturers now often seek a long-term customer relationship by offering through-life engineering services. Rather than buying a product, the customer buys the product's performance.

Industry 4.0 even affects how we manage a product's end of life, as advanced technologies minimise waste by recycling most materials.

So how does the HVM Catapult account for these profound new ways of working?

We work with a wide spectrum of universities and industry players at the very cutting edge of technology and it puts us in a unique position to see what the next trends in innovation will be. We are then able to invest in manpower and equipment ahead of the curve.

Our Energy Innovation Centre at the WMG Catapult Centre, for example, works with industry and leading academics on the development and scale-up of innovative battery solutions for domestic appliances, the automotive industry, the grid and other applications. It is the only centre of its kind in Europe, as it not only focuses on battery chemistry, but also on the actual manufacture and testing of battery cells and packs.

Our National Netshape and Additive Manufacturing Centre at the MTC works with industry on the UK's first Additive Manufacturing Strategy, exploring how different sectors can exploit this technology to their benefit.

Our National Biologics Manufacturing Centre in Darlington helps clients in the biologics sector to accelerate the commercialisation of new processes and technologies in areas such as new cancer therapies.

Our revolutionary, fully reconfigurable Factory 2050 facility at the AMRC houses the latest data-driven assembly technology, with initial projects including a programme to take aerospace manufacturing technology into the construction industry.

Through a new Industrial Strategy, the government plans to put the UK in a prime position to exploit global market opportunities through leading technological development. Equipped with the right tools to achieve this aim with the national resources of the HVM Catapult, it is no wonder that we are seen as the go-to authority for advanced manufacturing needs.

Augmented and virtual reality technologies have a future outside the entertainment industry; Inition chief executive Dr Adrian Leu tells Rohan Banerjee about the possibilities

Virtual reality: from game to game-changer

You could be forgiven for thinking that augmented and virtual reality (AR/VR) are technologies largely confined to the entertainment sphere. It is within this that there have been the most obvious signs of advances – stereoscopic films, motion-sensing video games, the ability to go deep-sea diving from the comfort of your living room; and admittedly, it all sounds pretty cool.

Cool, though, is an ultimately transient term. As Dr Adrian Leu, the chief executive of Inition, a leading AR and VR production company, puts it: "Cool will only take you so far. People have short attention spans and after the initial novelty has worn off, they'll be asking what can this new technology do for me? How it can it enhance my life? How can it make it better?"

Those questions, Leu explains, form the core tenets of Inition's broad church. The London-based firm, which is equipped with a 2,000sq ft underground demo studio, specialises in variety. It was founded in 2001 and has since gone on to embark on a range of ground-breaking projects not just in enhancing entertainment but applying AR and VR technologies to such areas as education, art, sport, travel, charity and medicine.

These ventures have included the first 3D broadcast of a rugby match to 40 cinemas around the UK, in partnership with the BBC; a 360-degree VR catwalk show for Topshop, which allowed audience members to watch remotely from the shop floor; a flight simulator for Nissan; virtual showrooms for an assortment of companies wanting to market products too big to transport; and working with the London Philharmonia Orchestra, Inition also turned the foyer of the Royal Festival Hall into a VR access point for people to view and listen to the performance in complete surround sound and vision– a first for that venue.

These considerable achievements so

In 2012, Inition worked with Nissan to produce a virtual flight simulator

far, Leu insists, are just the tip of the iceberg. Still, as with any emerging technologies, AR and VR are not without their challenges and beyond the obvious hurdles of cost or complexity, Inition is trying to make sure that the pair's introduction to the mainstream is not simply seen as an indulgence in possibility but rather as a necessity. "We have to be careful not to fall into this trap of technology for the sake of it," Leu says, "which is why at Inition we adopt a very consultant approach. We try to understand what the client wants and discern the scalability of the project. We ask what they want to achieve. Then we propose a solution that uses the latest technologies. In any case, the scope of AR and VR doesn't stop with entertainment; that's just the start."

"Let someone see what you see or feel what you feel"

Leu's own ambitions are worthy of a Bond villain, even if his altruistic motivations are not. The son of a surgeon, what interests him in particular is the application of AR and VR in healthcare and medicinal training. From using interactive holographic diagrams of human organs to haptic and sensory equipment to help understand panic attacks, Leu believes that AR and VR can offer unprecedented insights into the treatment of a host of physical and mental conditions. "You can use VR for surgical training or to give less experienced doctors a more realistic education. Previously, we helped make something that is interactive, and recreated a hospital bed with a virtual patient; you can see the influence of the drugs through their body.

"There is also the opportunity to treat phobias or different forms of anxiety with exposure therapy, with patients being guided through imagined scenarios designed to help them overcome their problems."

The main advantage of any AR or VR technology, Leu suggests, is in its ability to improve the communication of ideas. "Not only is it important for technology to have a purpose by design, but we need clients to understand why AR and VR represent the best strategy for them. Why should they use these rather than anything else? What can they do that couldn't be done or couldn't be done as well before?"

Empathy, Leu stresses, is at the centre of this communicative drive. "Often it's hard for us to describe things. To be able to let someone to see what you see or

Motion capture and sensory technology are at the heart of VR

feel what you feel, that's where these technologies can bridge a gap. For example, we've worked with a number of NGOs and charities in trying to improve this. Nowadays, whether for better or for worse, we seem to be quite a bit immunised to the two-dimensional news reports and data we're getting on TV. Putting someone in the thick of it, in that situation themselves, that will help them to fully understand what other people are going through."

Of course, a difficulty in describing something is not limited to our emotions. Sometimes, seeing is believing and what Leu calls "virtual showcasing" is paving the way for space or time efficiency in various industries. "If you are in the property industry," he offers, "you might allow clients to see 50 houses in VR. They probably won't make a decision from the headset, but they might filter 20 from the 50, so it will impact the bottom line.

"I can also see VR being used in retail, perhaps in the preparation of a new product line. You can recreate the retail store in VR, reducing operating costs with remote presence. Say you were a car manufacturer: you can show off your latest model abroad without having to transport it."

Virtual showcasing will change retail forever

With Leu's charm offensive in full flow, AR and VR's potential undoubtedly sounds exciting, but how will we know when they've actually succeeded? "Well, a lot of VR is driven by marketing at the moment; as a point of entry, it will be used to go after the low-hanging fruit. There is nothing wrong with that, obviously, but any project will have to have great content, not to see any wires, be invisible, to have a clear purpose, an application and, ultimately, a sustainable model for mass adoption."

So, what comes next? Leu refuses to rule anything out. "Touch? Smell? The ability to blend the physical with the virtual, perhaps." Isn't that dangerous? Leu rejects the Icarus implication. "Blurring the lines between fantasy and reality is always going to have its critics, but at the end of the day it's the users of the technology who comport the risk, not the technology itself. We're talking about technologies capable of letting people who can't walk, have the opportunity to. Is that really so wrong?"

AR and VR, Leu predicts, are on the brink of multiple breakthroughs and the pan-technological Inition is at the vanguard of any progress.

To find out more about AR and VR visit www.inition.co.uk

Bristol & Bath: building the smart city of the future

From programmable urban infrastructure to driverless cars to real-time immersive 3D data visualisation, Bristol & Bath is a testbed for emerging technologies, writes **Matthew Cross**, head of Inward Investment at Invest Bristol & Bath

Innovation has always been key to increasing quality of life for people in cities. With urban populations constantly increasing, placing extra demand on transport, energy and internet connectivity, it is only by embracing the latest technologies that we can make the cities of the future as smart, adaptable, efficient and pleasant to live in as we want them to be.

Cities around the world have begun to understand the importance of collecting, sharing and acting on the data generated by city processes to help them run more efficiently, but Bristol & Bath is working to make "smart cities" a reality.

Programmable cities

Bristol Is Open is a collaboration between the public and private sector that aims to create the world's first "programmable city". Combining high-speed networks with Internet of Things sensors to record, capture and share information such as traffic and pollution data, the project will produce an open, shareable data set that could change how the city works.

The project has already attracted other cutting-edge collaborative tech projects to use its high-speed 5G networks and distributed sensors. This infrastructure creates a testbed for other smart-city initiatives.

Driverless cars

VENTURER – another collaboration between industry and academia – will lay the foundations for autonomous driving. It will use the high-speed connectivity offered by the Bristol Is Open network to test the efficiency and safety of cars that move around cities by themselves.

Meanwhile, the "data dome" – an immersive, 180-degree domed screen connected to a supercomputer which can show off complex data sets in 3D overhead – has already been demonstrated with city data, with an AI chatbot being used via voice commands to control and interpret the data being shown.

So why is this happening in and around Bristol & Bath? The region is home to many major tech players including Oracle (specialising in cloud development), Cray Inc (global supercomputing giant), GCHQ and a network of collaborative tech startups, all of which are pushing the boundaries of tech in various fields. What's more, the infrastructure and data being created will help to create more tech startups in the region, which is why it was named as one of two leading smart cities (London being the other) in the UK by the Smart Cities Index.

Open data and tech opportunities

Much of the innovation in Bristol & Bath is built on open-source principles. Its projects are accessible and available to businesses and other organisations for their own research and applications.

Both new and established companies can take advantage of the information being produced and analysed by projects such as the Bristol Is Open network to find monetisable solutions to the problems that can crop up in metropolitan life. So while Bristol & Bath is a network of smart city technology, it is also a business network of tech companies, collaborating together to seize the opportunities it is offering up, and in the process making Bristol & Bath and beyond a better, more accessible and more fulfilling place to live.

For more information, visit www.bristolandbath.co.uk

The future of work in a nutshell

In the new world of 'citizen developers', employees can bring not just their own devices but their own apps too, writes **Vicki Hayward**

The widespread proliferation of technology has transformed the manner in which employees communicate and collaborate. Traditional approaches to work are becoming increasingly redundant as the lines between professional and personal lives continue to blur.

Noting this change, key industry leaders have started to implement new ways of working. Greater focus is now being placed on employee satisfaction, in order to successfully foster an environment for growth.

These new workplace behaviours have enabled employees to become their own arbiters for change, particularly with regards to the adoption of technology. There is a greater requirement for time consuming and labour intensive business processes to be streamlined and with this in mind, employees are becoming increasingly able to solve problems to their evolving needs by being the driving force behind the creation of solutions to these barriers.

As technology continues to permeate industry, the demand for more communication tools in the workplace has increased. Keeping employees engaged and connected, through the provision of such tools, has successfully stimulated the development of employee-driven initiatives such as Bring Your Own Device. Encouraging access to corporate tools and information via mobile devices, and making those accessible from anywhere in the world, has led to the widespread need for enterprise mobility strategies.

This is at the core of the concept of the digital workplace. The streamlining of processeses encourages innovation and inspires employees to forge productive business relationships, beyond their natural work group. What's more, the

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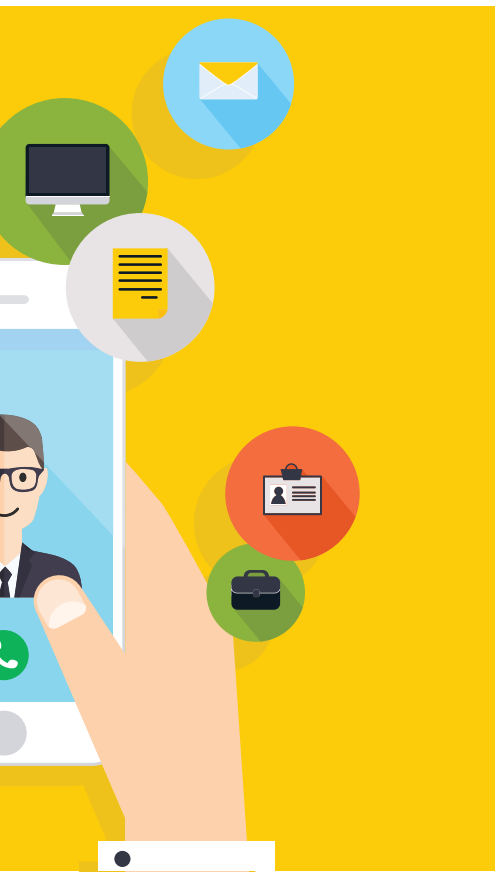

successful implementation of an enterprise mobility strategy has been proven to increase employee satisfaction. By giving employees autonomy over their roles, they are able to carry out tasks beyond the confines of a traditional office environment. Enterprise mobility is gaining traction throughout a vast array of industries, and the future of work will ultimately depend on its effective implementation.

At Nutshell, we have a solid understanding of the importance behind the delivery of a unified digital workplace, aligned with business strategies and employee needs. We know that the business demand for technology is only going to continue, meaning that there needs to be a readily available solution ahead of the curve.

By bringing every element of existing mobile enterprise application platforms together, Nutshell helps place mobile technology into the hands of the end user. Moreover, it successfully delivers initiatives that encourage employee innovation and experimentation, by involving those who would ordinarily be excluded.

The advent of citizen development has given rise to a new generation of software engagement, and Nutshell allows clients to solve long-neglected problems within enterprise by relinquishing the control of app development and redistributing it to our clients and their respective teams. This is made possible because Nutshell is the only zero code mobile development platform available that aims to empower entire workforces to automate and improve their existing workflows. Using the drag-and-drop builder and user-friendly interface, Nutshell doesn't just reinforce the ideologies behind citizen development, but encourages employees to take control and streamline the process of app development itself.

As a result, more organisations are now adopting Nutshell as their entire end-to-end mobile strategy. By helping clients create feature-rich apps that are quick to design and develop, a well as incredibly easy to test and launch, Nutshell doesn't just offer software as a service, but redevelops mobile into a management tool that adapts seamlessly to existing databases. In short, the results gained from using Nutshell reveal truly bespoke, polished and professional apps that are putting an increasingly large number of companies at the forefront of the digital workplace.

Our most recent project saw the development of an app created in conjunction with Northumbria Police and local government. Initially piloted in Blyth, the aim of the app was to streamline communication between citizens, Northumbria Police and local government. Since its release, the app has successfully altered the efficiency of how citizens in Northumberland report problems in the area, increasing productivity and response times of local government when issues are reported. Police time spent on non-criminal issues has been reduced by five hours, allowing them to refocus on solving crime in the area. This exemplifies the transformative potential of Nutshell and shows that our platform caters to the digital workplace by offering results to business process issues that affect industry as a whole.

Furthermore, Nutshell reduces the millions of pounds per year spent on consultants, whose job it is to find areas in which companies are spending too much money, by being a cost effective solution that redistributes these responsibilities to frontline staff, teams and departments who understand their processes and where the main problems lie. Nutshell gives employees this opportunity and empowers them, not only to provide a solution, but to build it themselves.

Nutshell has already made a massive impact on a wide selection of industries in a short frame of time, and while the platform is definitely powered by sophisticated codebases, we remove that element of the software development process for our clients. This means their main focus can be on initiating positive change within their processes, while Nutshell takes care of the potentially intimidating technical aspects of mobile app development.

Nutshell is an entirely unique proposition and seeing the impact of our dedication to technology every day, makes us believe that the future of work will rely heavily on the continued ingenuity and innovation of those within the digital workplace. For Nutshell, this begins in the north-east – the heart and home of all things digital.

Ultimately, Nutshell is an increasingly integral element of the future of work; and as we continue to remove the complexities of software development from enterprise mobility, we are taking our groundbreaking platform global, to convey how seamless adapting processes to the Nutshell platform can be.

For more information visit our website www.nutshellapps.co.uk, call us on 0191 499 8507 or follow us on social media @nutshellapps

Why the government can't be a venture capitalist

Will Dunn speaks to Eben Upton, whose Raspberry Pi computer was denied government support – and went on to become the most successful British computer ever made

On 25 June 2009, Eben Upton received a reply from the East of England Development Agency. He and his colleagues had recently applied for a loan guarantee to start a new company making a very small, very cheap computer that would help people learn programming. The response was not encouraging.

"Thank you for your application," it read. "Given the widespread availability of 'proper' computers, the rationale for . . . a device that reverts to the early days of computing is not persuasive. The panel also noted that the demand for application programmers has fallen since the last decades of the 20th century, and it was felt that the number . . . is unlikely to rise to previous levels." The email then added that "the National Curriculum does not specifically mandate programming skills".

This letter is tech's equivalent of Decca Records' declaration, when declining to sign the Beatles in 1962, that "guitar groups are on the way out". Despite the doomsaying of the East of England Development Agency, Upton's Raspberry Pi computer quickly became the biggest selling computer Britain has ever produced, with more than ten million units sold in under five years. Better still, it is – unlike almost every other computer on the market – made in Britain, and its popularity in schools has led to a demonstrable increase in the number of people applying to study computer science. Why does its creator think the government is poor at spotting promising emerging technologies?

"Large organisations struggle to allocate money to the right things," Eben Upton says. "We know that central planning doesn't work, for a variety of reasons. There's an information problem – it's hard to get information into the centre about what's going on at the edges – and it's also difficult because of politics.

"Resources tend to flow towards people who are good at playing the game. If you're good at playing the game of Get Resources, you get more resources and more power and more experience of getting resources. The wrong things get funded. That's true of government, and it can also be true of large companies. It can be true of any large, centrally

The Raspberry Pi 3 is a small, powerful desktop computer that costs £30

"It's a struggle to allocate money to the right things"

planned organisation – corporations are little mini Soviet Unions, they're miniature centrally planned economies. But corporations have a way out – they can buy other corporations.

"Over the last 50 years, we've seen a gradual de-emphasising of the idea of research and development, or at least internal R&D, towards – I've heard it called research and acquisition. Rather than trying to develop new technologies or products yourself, you as a corporation focus on trying to do the things you're already doing really well. And you rely on the little nimble guys to run around discovering new things to do, then make sure you've got a good enough radar to spot them while they're still small, and you snaffle them up and apply your big-company economies of scale to make those things work. That's the established private-sector solution to the problem.

"On the startup side, you see a lot of companies that are starting up really with the intention of being acquired. So both sides co-evolve towards each other – and you see this in pharmaceuticals as much as in the tech sector. It leads to a profusion of small companies that might never turn into large, self-sustaining businesses, but that's not the point. It works, it delivers growth. The annoying thing is, I'm not sure anyone has a plausible story as to how the public sector can learn from this experience."

Examples of the misguided attempts by government to participate in the private sector's ecosystem of research and acquisition are dismayingly easy to find, but the most resounding clanger of recent years must be Impossible.com, the "gift economy" website that was awarded £200,000 of government funds at around the same time as Upton was launching the Raspberry Pi. Described by the *Spectator* as "disastrously vacuous" and *The Register* as "a website that replicates the 'Help Needed' pages of Craigslist and Freecycle", Impossible.com is reported to have lost around £250,000 per year since it launched. The crucial difference in securing funding was not the validity of its premise, but the fact that it is the brainchild of the supermodel Lily Cole, who at the time had a personal wealth estimated at £7m.

Upton says a more effective way for government to stimulate innovation can be to invest at scale, over time, and with the goal of creating regional centres of excellence. "In 1978, the government, through the National Enterprise Board, invested £50m in a company called Inmos, based in Bristol. They built memory and processors, including the famed transputer, which was innovative but never became a commercial success. The business never became profitable, and after consuming more than £200m of government funding was sold to the French-Italian company SGS-Thomson in 1989; it was a failure. But if you go to Bristol now, the place is crawling with chip companies, and in fact the chip we use in the Raspberry Pi 3 was largely designed in Bristol. When industrial policy investments work, it is often in this sort of non-linear way."

One of the key differences in the way the public and private sectors successfully invest in technology is duration. The staying power of public-sector investment is its unique selling point: "Inmos was there for more than a decade. Throwing some money ▶

"Academics are good at reviewing proposals"

in, letting it burn up in two years and then it dries up and blows away – that's very different from putting money in for something that's going to exist for ten years."

Magnify this kind of investment, says Upton, and you can explain the success of the biggest and most lucrative centre of innovation in the world: Silicon Valley.

"People draw completely the wrong conclusion about Silicon Valley. Why is Silicon Valley where it is today? The answer is, about a trillion dollars in defence spending. The federal government spent an enormous amount of money over a long period with giant aerospace companies such as Lockheed and Westinghouse: that's where a lot of the smart people came from. And often, those people had kids, and their kids didn't go to work for Lockheed. The kids went to Stanford, and then founded tech companies, and those companies were able to hire from a pool of talent that was already in place.

"The mistake that governments make, a lot, though, is to try to build copies of Silicon Valley as it is now, rather than looking at where it came from. A long-term investment in something, even if it fails, can have the side effect of pulling lots of clever people into one place."

Counterintuitively, then, it may be that the most successful policy for fostering innovation is to look for the things that seem likely to fail, and which have no obvious commercial application.

"They have the Defense Advanced Research Projects Agency [DARPA] model in the US, where they spend money on 'moonshot' ideas that might turn into something, with one or two very notable successes – one of which was the internet.

"DARPA will pretty much fund ideas in proportion to their outlandishness – the internet is a very weird idea – where the East of England Development Agency was only able to fund things in direct proportion to their conformity to existing ideas."

Should the government, then, be in the business of funding "moonshot" ideas? "In my view, the right thing to do is actually to fund basic university research better. We already have a system for doing moonshots: university researchers. If you work in the government and you're tempted to be a venture capitalist, quit and try to get a job as a venture capitalist. We know that the government is good at funding universities, and academics are good at reviewing each other's grant proposals to allocate that funding effectively. So, we have a working system there."

"It's worth bearing in mind that the government activities that have really helped Raspberry Pi have been very traditional ones.

"The provision of free education, which created our workforce, the promotion of foreign direct investment, which led to the construction of the Sony factory in South Wales where we build the Raspberry Pi, and then reform of the computing curriculum, which was also to our massive advantage – this is pretty conventional stuff. It's always been this way. Look at the BBC Computer Literacy Project, which gave us the BBC Micro: the government simply gave grants to schools to buy computers, which again is very conventional, but the long-term impact on UK industry was transformative – much more so than any speculative investment in an individual start-up."

For Upton, while there are many questions to be asked about funding at the surface level, the broader perspective is that he and many other successful technologists have been aided over the decades by the education, the infrastructure and the economic environment that the UK government has provided for them.

"I think our government's quite good at what it does, actually. It's been there for hundreds of years, and has an enormous depth of experience. We've got this very capable machine for doing traditional government things, and as long as we can keep it focused on those then it has the potential to bean incredible source of competitive advantage to our country."

Driverless cars: are we ready for a revolution?

Driverless cars are the future, and they're almost here; or so the big technology companies would have you believe. But there's still plenty of work to be done, writes **Gunwant Dhadyalla**

Driverless cars are the future, and they're almost here; or so the big technology companies would have us believe. They offer an exciting vision of cars so intelligent they'll take you to your destination at the touch of a button; safer, less congested roads; and connected systems that will communicate traffic conditions, find a parking space and even call ahead to the garage, having already diagnosed what that weird noise was under the bonnet.

But just because something can be done, doesn't always mean that it should. Driverless technology offers the potential for a global social and transport revolution, but there are challenges to be overcome first.

The overarching goal of a team at WMG, University of Warwick, is to facilitate knowledge creation and technology transfer for industry. Not just for manufacturers, but the insurance companies, software developers, and law-makers whose business models and areas of operation will be affected. They are developing novel approaches to testing the new technology to ensure that it is not only safe and robust, but that real end users are involved throughout development.

The WMG 3xD Simulator for Intelligent Vehicles allows the team to research the new technology, while removing much of the risk associated with the testing and early adoption of autonomous cars. Able to present the complete driving environment virtually, it tricks the car into believing it is in the real world, including replicating external signal environments such as GPS, ITS and 3G/4G. The simulator comes complete with virtual traffic, cyclists, pedestrians and even dogs scampering into the road. Actuators move the vehicle as it would when accelerating, braking or cornering.

"Real-world testing is hugely valuable but limited by the risks to other road users, and the inability to control conditions," explains Professor Paul Jennings, who leads the Intelligent Vehicles and Experiential Engineering groups at WMG. "Simulation is especially useful in northern European countries, where the weather is extremely unpredictable. How do you test the reactions of autonomous sensors when driving into the sun?"

The experts are also looking at the cyber security aspect of the new technologies. By housing the simulator in a Faraday cage to block out radio signals from the outside world, WMG can control the signals and identify possible flaws. "We're going to do research that is 'attacker in the loop'," says Professor Carsten Maple, head of cyber security research. He adds: "People have gone in through DAB, through mobile networks; they may even be able to get access through malware on a phone, or an embedded SIM in the vehicle."

On the human side, engineers are working on driver in the loop and driver state monitoring (DSM) systems. How does any potential hand-over of control happen? Current research suggests a driver would need 8-10 seconds to take back control in an emergency. If the DSM system knows you are not aware, ie that you're distracted, then the car could apply the brakes without relinquishing control.

With this technology, there is also the potential to personalise warnings. Co-design with the eventual customers is vital to ensure that the technology is wanted. Full automation will be achieved in the future, but it will not be accepted if the public fails to trust it.

For more information visit: www.warwick.ac.uk/wmgautomotive

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The University of Manchester's 'Graphene City' is leading the way in micro material research. James Baker, its business director, talks to Rohan Banerjee about its ambitious plans for the future

Manufacturing a miracle in a crystal lattice

Graphene, the incredible micro material that's super flexible and 200 times stronger than steel, represents one of modern science's most intriguing developments. Discovered in 2004 at the University of Manchester by subsequent Nobel Laureates Andre Geim and Konstantin Novoselov, using a lump of bulk graphite and sticky tape no less, the world's first truly two-dimensional crystal lattice is almost completely transparent and conducts both electricity and heat very well.

Geim and Novoselov used the tape to peel flakes from the graphite and noticed that some were thinner than others and by separating the graphite fragments repeatedly they had managed to create a layer of pure carbon just one atom thick. Ultimately, the strength of a material comes down to the strength with which two neighbouring atoms are stuck together. Graphene's unprecedented thinness and its atoms' proximity to one another made for a super bond at the forefront of a range of industries today.

Manchester, still leading the way in graphene related research, is aiming to deliver hundreds of real life applications of the material through 'Graphene City' – a working body of scientists, engineers and businesses together in one campus district, committed to the exploration of 2D micro technology.

James Baker, the business director of Graphene City, cannot hide his excitement at its potential. "Graphene," he says, "was discovered more out of curiosity than for any commercial purpose, but on measuring its properties there is no denying the scope of its possible applications.

"We're looking into composites and layering, like Lego bricks, to form super materials. Graphene can serve as an additive, coating or even replacement

The Sir Henry Royce Institute for Advanced Materials represents a £235m investment into advanced materials research

for existing materials and make strides in electronics, aerospace and medicine."

Graphene City, he reveals, is built on the same principles as Silicon Valley in California, and he wants Manchester to play a leading role in fostering a knowledge-based economy. "We want to create our own innovation ecosystem, one that paves the way for a greater collaborative effort between the academic research into micro materials and the eventual industrial application of the product. We want Manchester to be not only where companies base their research but where they send their staff to be trained."

Baker points out that other advanced material research has experienced massive lulls between discovery and market presence. Silicon, for instance, was discovered in its impure form in 1811; but it wasn't isolated in its crystalline form until more than 40 years later by Henri Etienne Sainte-Claire Deville, using electrolysis. The type of furnace now used to make silicon, the electric arc, was invented in 1899 by Paul Louis-Toussaint Héroult to make steel.

By concentrating and combining collective research into a single hub in Graphene City, Baker hopes that Manchester is on to a winner for preventing any such delays; and he is encouraged by the progress so far. "What you've got to consider is that graphene is only 12 years young but we're already seeing it used in basic products." Such as? Tennis racket manufacturers Head, who supply Grand Slam champions Andy Murray and Novak Djokovic, launched their Graphene XT range last year. "The rackets are simultaneously stronger and lighter," Baker explains. "In other words, you have a faster racket but with the same weight behind the ball when you hit it.

"Graphene has been used in light bulbs – this improves heat management and retention. It stops energy from being dissipated and the LED coating helps to harness the energy and is more conductive than conventional metals.

"There is a similar potential in batteries. Batteries can be enhanced using graphene, possibly shortening charging times for phones, for example, to a matter of seconds. It could extend a battery's life-time, which is negatively linked to the amount of carbon that is coated on the material or added to electrodes to achieve better conductivity, and graphene adds that without requiring the amounts of carbon that are commonly used."

However, sporting or domestic applications, Baker stresses, are just the beginning for graphene. A father of three who was previously the vice-president of technology collaboration programmes at BAE Systems, Baker is confident that graphene can sustain and enhance Britain's reputation as a world leader in aviation.

"Graphene can help to reduce the weight of aircraft and in turn reduce emissions so there's an eco-friendly advantage to be explored. There are

Graphene factfile

STRONGER THAN STEEL
Graphene is made up of a hexagonal lattice of tightly packed carbon atoms in a honeycomb-like structure. The strength of graphene could be used in material composites and coatings in the aerospace and automotive industries.

INCREDIBLY FLEXIBLE
The strong bonds between graphene's carbon atoms are very flexible. They can be twisted, pulled and curved without breaking – making it bendable and stretchable. Its flexibility could be used in emerging technologies such as rollerball computers and flexible phones.

ULTRA LIGHTWEIGHT
Graphene is about one million times thinner than a single human hair, which means it lends itself to the development of myriad future technologies. Its high conductivity makes it perfect for aiding in central processing, unit cooling and creating more efficient technology.

EXCELLENT CONDUCTOR
Graphene's structure offers relatively little resistance to electrons which zip through quickly as a result. It is also a superb conductor for thermal energy.

NEAR TOTAL TRANSPARENCY
Its thinnness means it transmits 97-98 per cent of light (compared to 80-90 per cent for single pane window glass). TVs could be embedded in windows and satnavs built into car windscreens using graphene in the future.

Graphene can be used in composite materials as an additive or coating

many benefits and possibilities that graphene holds for planes both in the long and short term, such as improving the plastic that holds together the carbon fibre within the wings.

"Graphene could also be used to measure strain in the wings, to reveal any damage. Replacing the copper wiring and copper heating coils could reduce the weight in the wings which could overall prevent ice being built up."

Elsewhere, desalination is another process which may benefit from graphene, something which Baker describes as not only a breakthrough commercially but a "real game-changer for human welfare".

He explains that graphene-based membranes "can be modified to have a lot of tiny pores or spaces, meaning harmful molecules can be filtered out. Filtering dirty water so that it's clean and drinkable in real time is another aim which graphene can help us to achieve."

Graphene City's aspirant biomedical programmes, meanwhile, could be similarly trail-blazing if successful. While Baker concedes that the timescale on graphene's application in combatting disease is tempered by "the sheer volume of testing and evaluations still to be done", he is hopeful that it can eventually be used in the delivery of drugs. Artificial limbs may be made more durable with a coating of graphene, which also has the capacity to be used in "ultrasensitive biosensors which, if injected into the blood stream, can be trained to seek out certain enzymes and DNA which means there's a way of tracing diseases".

Baker admits that previous materials "may have suffered from hype in the past" but doesn't hesitate to hail graphene as a "miracle as long as we realise its potential" and believes Graphene City can be a spur towards that goal. "It's a complex science which means you need not only university research and involvement, but the industrial collaboration which is important for scaling up and getting the product to the market more quickly."

Earlier this year, Manchester was awarded a £5.2m government grant for its research into graphene-focused healthcare; meanwhile £61m has gone into the National Graphene Institute and £235m to the Sir Henry Royce Institute for Materials Research and Innovation. If graphene achieves even half of what its capable of, Baker feels any and all investment will be worth every penny.

For more information visit: www.graphene.manchester.ac.uk

"A real game-changer for human welfare"

Upgrading beats offshoring in the new marketplace

British manufacturing businesses can stay ahead by combining smart upgrades with skilled workers, says Forcam's **Andrew Steele**

I was speaking recently with a family-owned company that's been manufacturing since just after the war. They told me they'd been forced by their end-use customer to go offshore, to Mexico. This lasted about six months. They'd identified that rather than trying to save 20 per cent on labour costs by offshoring – which ends up as about two per cent of the total part cost, once you factor in all the shipping and waiting – that investing in technology in the UK would make them more competitive in a global marketplace. Automated equipment, supervised by a skilled person, takes away the unskilled parts of the system that people shouldn't be doing anyway. This doesn't equate to jobs being lost – in this case, they're now employing more people than they have for 15 years.

For us, this is the key to getting growth from the new wave of digital technology: making it genuinely useful by combining it with the technology you already have. We look at systems and machines that have been in place for decades, in some cases. We get inside them and share the information with other systems to make them more efficient, and to allow people to record and collate errors.

When people ask me about our work, I compare it to Nest, the smart heating controller. It's a piece of new technology that you fit it to your old boiler. You don't have to buy a new boiler, but suddenly your heating gets smarter – it comes on automatically when you get home, you can control it with your phone, and because it's better controlled and more efficient, your heating bills drop dramatically.

So, if you want a three-word answer, you could say: we digitise factories.

You could also say that we sell productivity. We look at a machine that makes 100 products per day, and we find the gap between what people think it's doing, and what it could be doing. We make the systems around it speak to each other, exchanging data, pulling maintenance information. With an older machine you might get four or six inputs; a more modern machine could have 200 sensors. It's like a modern car, in that respect. With that many inputs, you can look at the variables and collate them against the products it's making, and make finer adjustments for efficiency and quality. Soon we'll be able to do predictive maintenance – if you've got enough temperature information and vibration information, you can spot malfunctions days or even weeks before they happen, which effectively eliminates downtime.

One of our customers found a 30 per cent improvement in their productivity after we revised their systems. They effectively found 30 per cent more hours in the day, and won a significant contract, against a Chinese competitor – and this was after the Brexit vote.

For me, factories are about skilled people. It's true that the days of the 1960s, when you'd find thousands of people working in a factory, are gone, and they're not coming back. But gone too are the days of "multi-manning" – one person running around like crazy trying to run three machines. And offshoring will go the same way; it's based on greedy, short-term ideas about labour costs that don't add up.

There's still a manufacturing base in this country that has skills and potential and, if invigorated, with innovation used in the right way, could again be very strong. There are opportunities for manufacturing post-Brexit, but the UK's most fundamental assets are the skills of its people. We need to empower them, and investing in technology is the way to do that.

Engineering biology for a better world

Synthetic biology, says SynbiCITE commercial director **Dr John Collins**, is the answer to science's collective problems

Among the numerous global challenges which the 21st century presents, the creation of low-cost vaccines and drugs to combat antimicrobial resistance and meeting growing consumer demands while reducing environmental impact, identify themselves as priorities on the agenda. We will soon run out of the materials we use in manufacturing if we continue to take them for granted and we are now charged, as a matter of urgency, to explore alternatives.

Biology forms a critical part of the solution

Synthetic biology, which blends advances in engineering, biology, chemistry, computer science and design, provides technologies to enable the production of essential materials while replacing the use of finite resources.

It increases the speed and precision of transforming an idea into a product, while reducing cost and waste. This biology-based "toolkit" uses responsible innovation, computer- aided design and automated construction to change how we build biological systems and expand the range of possible products extracted from natural sources or manufactured for use in everyday goods. It can create viable equivalents of materials occurring in nature and generate entirely new materials as well, making the best possible use of bio-renewable resources and technology.

Engineering biology will facilitate global bio economic growth

BCC Research estimated in its 2015 Emerging Global Markets report that at current growth rates the market for synthetic biology-generated materials, products, tools and services will be $38bn by 2020. In Europe, the bio-economy turnover in 2013 was €2.1trn. According to the US National Academy of Science in its 2015 report "Industrialisation of Biology Roadmap", in 2012 alone the bio-based product market grew to more than 2.2 per cent of US gross domestic product, or more than $353bn in economic activity. US business-to-business revenues from industrial biotechnology reached at least $125bn.

The UK is leading the way

Synthetic biology, though still in its infancy, is at the forefront in R&D and innovation. In the UK, more than 26 universities and 100 companies are engaged in synthetic biology R&D, product development and commercialisation. The UK has a government-led roadmap and strategy with considerable funding to progress and exploit synthetic biology. This has largely been led by SynbiCITE – the UK's national centre dedicated to promoting the adoption of synthetic biology by industry.

A catalyst for a new industry

SynbiCITE is based at Imperial College London and – with its partners across UK academia and industry – is accelerating the commercialisation of emerging technologies. Its goals are to achieve significant economic impact, train skilled workers and create new jobs.

In December, SynbiCITE – associated with the Institution for Engineering and Technology (IET) – is holding a major engineering biology conference to further illustrate the reach of this science.

Find out more at http://conferences.theiet.org/synthetic-conference

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The ‘eight great’ technologies

Perhaps the most forward-looking part of the UK’s industrial strategy is a commitment to eight emerging technologies in which the UK could lead the way. Backed by £600m in investment, these are the areas in which the UK is already leading the field in research, and in which the country could be the first to commercialise the technology. They are...

SHUTTERSTOCK / ALEKSANDR BRYLIAEV

Driving online engagement with the cloud

Turning online attention into a purchasing decision is new battleground for business – and customer-centric technology is its most powerful weapon, writes **Joseph Artgole**

ZeroLight's technology allows customers to customise their dream car in virtual reality

The internet has changed the way we behave, becoming the primary reference point for almost all new information. As such its influence on attitude formation is critical, allowing us to assimilate both first- and third-party messages to formulate opinion. This directly impacts purchase behaviour, creating a need for brands to deliver highly influential propositions that engage and excite customers.

The automotive industry is no stranger to such trends, with 96 per cent of car customers researching online when considering a purchase, and at least 75 per cent of the customer journey taking place on the internet. The amount of time spent online means the relative weight and effect of online touch points is critical. During the average 14 hours spent online, 80 per cent of customers are influenced by third-party reviews.

With this in mind, brands need to drive further value on their websites to occupy more of the customer journey. Data on the growth of e-commerce suggests general growth rates between 10 and 20 per cent for Europe. As a result, 5 per cent of all new car sales are expected to be completed online by 2020, with the value of the online market predicted to reach $4.5bn by 2025.

So how do you drive engagement?

Engagement involves participation. Currently, the most popular form of visualising products online is with regular 2D images, but these do not give consumers a comprehensive level of interaction. This was the scenario experienced in automotive retail outlets when offering personalisation experiences, until ZeroLight pioneered real-time 3D visualisation, bringing the product model into an interactive scene,

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allowing the customer to freely explore and configure the product they're interested in, customising it and viewing from it from any angle.

The state of the online marketplace is therefore very similar to the retail marketplace prior to the introduction of this real-time technology. In repose to online market conditions, ZeroLight has built proprietary technology on top of existing cloud infrastructure to be the first to market in delivering disruptive real-time 3D visualisation solutions to any connected device, without the need for plugins. All rendering is carried out in the cloud and then streamed to them. The technology is highly responsive, delivering a 5-million-polygon vehicle with very low latency. This allows the delivery of a consistent, high-quality proposition online.

Discussed at SIGGRAPH 2016, Audi's deployment of ZeroLight's cloud-based technology on audi.de revealed that over the course of 100 days there were 18,500 completed configurations in 3D *v* 15,500 in 2D. This was recorded alongside a 66 per cent increase in user interaction *v* 2D online configurators. Surveyed customers rated the 3D configurator higher than the 2D configurator in every category: idea, perceptibility, enthusiasm, involvement, safety, satisfaction and – most importantly – purchase intent.

With the announcement that SEAT is selling cars on Amazon.fr marketplace and Citroën predicted to be trialling an online proposition next year, demand for technology that lets customers explore the automotive space is set to increase. The online retail landscape is changing, following the shift from bricks and mortar and a product-centric to customer-centric model.

The Customer-Centric Model

The modern trend of consumer-centric retail, empowering customers to influence the product they're buying, is driving change across a number of industries. A report by Deloitte found that more than 50 per cent of UK consumers have an interest in purchasing customised products, with 34 per cent confirming that standard products do not offer exactly what they want. Many are willing to pay more to be involved in the process, with one in five consumers expressing an interest willing to pay a 20 per cent premium. Personalisation directly contributes to purchase intent, and providing a customer with a compelling tools to visualise their preferences yields positive results to both consumers and businesses.

By empowering a consumer to tailor a purchase you remove all potential barriers relating to taste and preference, allowing them to formulate their ideal version of the product. Self-expression forms a strong affinity for the product/brand, as consumers have played a part in the creation process. This affinity leads to an emotional reaction which positively influences attitude formation around what is now their version of the product. Positive attitude formation fuels advocate behaviour, increasing conversion potential.

Increasing conversion potential for a brand can directly influence turnover, as well as drive brand value and awareness within the marketplace.

ZeroLight's cloud technology delivers the consumer-centric model outlined at every point of the customer journey. It's been recognised as a world-leading application, receiving a Gold Tier International Business Award and a Techies Award earlier this year. Critics have described the technology as the "best car configurator on the internet". Real-time visualisation's influence on how we perceive goods is disrupting every aspect of the retail landscape, completely changing the way people experience products. With the cloud, ZeroLight has delivered its benefits on a global scale.

The digital evolution of physical infrastructure

Atkins Technology director **Russell Cameron** looks at the challenges and opportunities created by the increasing digitisation of infrastructure projects

We all recognise that the physical and digital worlds are colliding, with new and disruptive business models coming to market. Companies such as Uber and Airbnb don't own the cars or properties that are their products, but instead concentrate on innovative digital service offerings. Some sectors take longer to disrupt than others, but in infrastructure we are already beginning to see global technology leaders and disruptive startups entering our markets.

It's not hard to see why – digitisation creates efficiencies, and potentially unlocks agility, responsiveness and adaptability, all of which are crucial to the delivery of infrastructure projects.

Intelligent infrastructure

The appeal to infrastructure asset owners is clear. Service providers can track and manage their assets more effectively, and they can focus more on the total lifecycle of infrastructure programmes. The performance of assets can be optimised, both for the asset owners and for end users.

Across our critical national infrastructure, we're also seeing the worlds of IT and Operational Technology (OT) coming together to drive greater efficiency. OT includes the hardware and software that controls the state of a physical system, such as a water supply. The sheer range of OT systems – and the fact that many are ageing – can be a particular challenge, especially when they are expected to be fully online and to run at 100 per cent uptime. Ensuring that they do so securely is a key challenge for many of our clients.

Big data

As the world becomes more connected, the amount of data it's possible to collect rises exponentially, especially through the emergence of the Internet of Things (IoT). Many of our clients approach us for advice on how they can

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drive value from this; there's no point collecting redundant data. There's also a real challenge about how data is managed through an asset's lifecycle, especially when those assets are not yet built or even designed.

Cyber security or resilience is a major area of concern when it comes to big data. Intellectual property must be protected against theft, but also the potential to cause disruption by influencing the algorithms that engineers use to determine outcomes. We no longer live in a single relationship world; everyone in the supply chain is now collaborating or at the least working in "co-opetition". As a result, exchanging, managing and securing data between a larger number of organisations is a growing challenge.

The skills requirement

In order to support the increasing digitisation of infrastructure assets there is a growing need for additional skills. Engineering expertise has become even more relevant, but we also need technology, systems engineering skills and data science skills.

Given the technical skills deficit we face in the UK, we need to harness innovation and talent from more disparate skill groups – whether that's geographically or demographically. Businesses will benefit from a more diverse and cross-sectional view from across their organisation, and moving to a fully networked organisation is key.

There is, of course, a challenge to keep the best we've got while also building flexibility, agility and diversity. We need to strive to create more hybrid rounded professionals who can meet this digital demand.

Procurement barriers

The infrastructure world has been traditionally conservative, relying on proven and trusted methods in order to deliver safe and robust outcomes. As a result, a lot of big infrastructure organisations have invested significantly in assets and systems that are already potentially obsolete. Procurement methodologies need to adapt to meet these changing needs. Organisations are used to procuring solutions using a price-competitive approach, rather than looking to deliver innovative outcomes and pricing for value rather than cost. New approaches can often have a higher upfront cost, despite offering considerable whole life savings, and this can prove a real barrier to adoption. Furthermore, the risk of investing in an ultimately unproven solution, however technically sound, often stymies the adoption of innovative new approaches.

Digital by design

You'll be unsurprised to learn that, as an engineer, I believe that fully embracing the opportunities, and mitigating the risks, of making our infrastructure more digital requires greater planning.

More emphasis needs to be applied to upfront visualisation to allow infrastructure asset owners to make better choices about how they invest in and manage those assets, what data they need and how they might improve the performance of those assets.

This can be achieved through the introduction of tools and techniques in the design process, such as Building Information Modelling (BIM), Digital (enterprise) Asset Management (DAM or DEAM) and digital engineering. We're also exploring how virtual reality can be employed to this end to help model different potential outcomes or build data on to things. By displaying this raw data in an interactive way, people can see the impact of their choices and make better decisions.

By focusing on design, we also have the opportunity to build intelligent infrastructure that is more resilient. We can achieve this by employing a holistic view of interdependencies between various elements of the end-to-end customer journey rather than just looking at providing individual elements of the infrastructure.

Finally, we have an opportunity to invest with organisational and asset resilience in mind. I've had many conversations with our clients about how their investment in new assets and processes can actually drive resilience in their business at the same time as achieving the KPIs they are working towards. It's not only practical and possible to achieve this but, in doing so, you almost get the security and resilience for free.

The leadership challenge

The adoption of a more holistic industry or sector view, taking risks with innovative procurement opportunities and handling infrastructure assets strategically ultimately requires a board-level leadership approach.

As the designers, builders and operators of infrastructure that millions of people rely upon every day, we are not only taking steps to address these considerable challenges, but are helping our clients to seize the opportunities and thrive in this new and exciting digital age.

Technology policy should not put progress before human concerns, writes Shadow Minister for Industry and Chair of the Business, Innovation and Skills Select Committee Iain Wright MP

We must innovate with one on the risk of human obsol

It's often easy to forget that we are living in a revolution. Our lives pass by at a glacial pace, without much obvious change. Big, specific events happen – getting a job, losing a job, getting married, losing a loved one, a birth in the family – but human experience tends to see one day like another, with today looking very much like yesterday.

Yet we are living through a period of profound change for business, the economy and, by implication, the way society and government are organised. We are in the early stages of the fourth Industrial Revolution (4IR): the first such revolution, which began in the 18th century, used water and steam power to mechanise production; the second, in the early 20th century, used electric power to create mass production; and the third, in the late 20th century, used electronics and information technology to automate further and revolutionise the means of communication.

Everybody is shaped by previous generations and how they adapted to earlier industrial revolutions. In my own family, my great, great, great grandfather moved in the 1860s from North Yorkshire, where the Wrights had worked as farm labourers for generations, to the new industrial town of West Hartlepool, where he got a job working in the shipyards. Each wave of economic change and industrial revolution unleashes disruption which significantly affects the lives – and the life chances – of millions, if not billions, of people for good or ill.

The fourth Industrial Revolution will be no different. If anything, it seems likely that, given globalisation and the scale of connectivity, the disruption will be more widespread than anything the modern world will have seen before.

Artificial intelligence, smart robotics and metadata are the building blocks of 4IR. Increasing the scale of automation has been one of the key hallmarks of every industrial revolution since the 18th century: repetitive, boring and unsafe labour-intensive tasks have been gradually replaced by automated processes. The combination of AI and smart use of data, in which machines will not only produce output, but increasingly analyse performance and customer feedback to improve the means of design, production and distribution, will have huge implications for the economy.

What impact might it have? On one positive level, the fourth Industrial Revolution might herald the mass revival of manufacturing in Britain. Throughout my lifetime, manufacturing has moved away from these shores. De-industrialisation has been a painful process for communities such as mine. There are many reasons for the decline, but a key one was the move from high labour cost areas to low wage economies. If labour costs as a proportion of total product cost are falling in such a marked way, there could be a real opportunity to see a major reshoring of manufacturing in this country. Emphasising our country's traditional strengths in design as well as new strengths in data analytics and targeting improvements in co-ordination with the supply chain could lead to more and more modern manufacturing based in Britain.

However, there will be undoubtedly be more negative repercussions. The

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We should not simply say "this is progress"

process of automation has removed many no and low skill jobs from the economy; 4IR presents the dilemma of seeing more and more jobs becoming obsolete through technology. Previous professions in the services industry, such as law and accountancy, face the same risks in employment obsolescence that manufacturing has faced for the past few decades.

Take driverless vehicles as an example of a technological advance that will alter employment in its sector in the future. If AI means safe and reliable and increasingly efficient vehicles that will remove the need for drivers, what impact does that for employment prospects for taxi, lorry and delivery drivers? London's black cab drivers have waged a high-profile campaign against Uber and the impact that this disruptive business model has on their prospects. What sort of protests will we see when drivers are taken out of the equation altogether? What impact will this technology have on existing and new, emerging and innovative business models?

The changing structure of the employment market is also making things difficult for many workers. We have seen the rise of zero hours contracts and a squeezing of terms and conditions for people working on low pay. We have seen over the past 30 or 40 years a move away from security in retirement, as firms seek to push the risk of paying for such retirement, in the form of final salary payments, on to workers, in the form of defined benefits. A similar pattern is emerging in the job market, as firms sometimes seek to move away from full-time, permanent employment towards more contract-based work.
The "gig economy", where a person is self-employed and is commissioned on an often sporadic basis, is spreading. While it originated in high-value sectors such as the media, the gig economy is spreading to other areas.
The construction sector has much bogus self-employment; it is sectors such as this, as well as traditional staple areas of the economy such as retail that will see profound change and systematic job loss as a result of the coming advances in technology.

It is spreading obsolescence throughout the employment market. We are seeing – and will see much more, as the costs of AI and smart machines come down – growing inequality. Low skilled jobs continue to be automated, and this process is moving to middle skilled and middle-class jobs. Growing insecurity is making matters worse. The "squeezed middle", articulated by Ed Miliband, is going to be squeezed, if not choked, even more.

It is useless to protest at technological change and resulting disruption. To do so would be akin to King Canute on the beach. That is not to say, however, that policy makers should wash their hands and say this is all progress. With accelerating disruption and spreading job obsolescence, it is clear that people will have to be flexible and adapt to rapidly changing economic fortunes. Workers will need to train, upskill and retrain, as part of a career which will have several distinct elements.

These trends will also place a strain on the traditional welfare state. If National Insurance contributions are sporadic, how can people in the gig economy build up sufficient credit in the welfare state to ensure help when they fall on hard times? If more and more economic activity will be automated, and wealth will accrue to those who own the machines, how will people be able to secure the income in order to actually make a living? Does this mean that the time is now to actively consider a Citizen's Income?

Michael Heseltine, when he came before the BIS Select Committee recently, said that "industrial strategy starts in primary school". He is absolutely right. It is a modern education system which will help us to combat the human problems associated with the fourth Industrial Revolution. A flexible and adaptable curriculum is necessary to help people move up the skills ladder, to stay clear of technological obsolescence. We are some way from that, but it is vital to being a success in the 21st century.

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