

THE FUTURE OF WORK: TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

Part IV: The Fourth Industrial Evolution

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The Future of Work: Technology and Artificial Intelligence
Part IV: The Fourth Industrial Evolution
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About the Centre for Social Justice

Established in 2004, the Centre for Social Justice (CSJ) is an independent think tank that studies the root causes of Britain's social problems and addresses them by recommending practical, workable policy interventions. The CSJ's vision is to give people in the UK who are experiencing the worst disadvantage and injustice every possible opportunity to reach their full potential.

Since its inception, the CSJ has changed the landscape of our political discourse by putting social justice at the heart of British politics. This has led to a transformation in Government thinking and policy. The majority of the CSJ's work is organised around five 'pathways to poverty', first identified in our ground-breaking 2007 report, *Breakthrough Britain*. These are: family breakdown; educational failure; economic dependency and worklessness; addiction to drugs and alcohol; and severe personal debt.

In March 2013, the CSJ report *It Happens Here* shone a light on the horrific reality of human trafficking and modern slavery in the UK. As a direct result of this report, the Government passed the Modern Slavery Act 2015, one of the first pieces of legislation in the world to address slavery and trafficking in the 21st century.

The CSJ delivers empirical, practical, fully funded policy solutions to address the scale of the social justice problems facing the UK. Our research is informed by expert working groups comprising prominent academics, practitioners and policy-makers. Furthermore, the CSJ Alliance is a unique group of charities, social enterprises and other grass-roots organisations that have a proven track record of reversing social breakdown across the UK.

The 13 years since the CSJ was founded has brought with it much success. But the social justice challenges facing Britain remain serious. Our response, therefore, must be equally serious. In 2018 and beyond, we will continue to advance the cause of social justice in this nation.

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The Future of Work programme: overview

The Future of Work research programme was conceived in response to the 2017 report by the Centre for Social Justice (CSJ), *The Great British Breakthrough: Driving productivity growth in the UK*. That report concluded that there were several significant barriers to productivity growth in the UK and proposed a whole series of policy initiatives to address this. The barriers included: low investment, including low capital investment across the UK economy that had resulted in a slow take-up of new technologies and a low rate of investment in training of staff; a regional growth imbalance, explained by many factors including the deindustrialisation of large parts of the Midlands and North of England and by the competitive strength of London; and a lack of occupational mobility in the labour market, alongside low wage growth, that led a large number of people to just manage in low-paid and low-skilled work for the majority of their working lives. Where *The Great British Breakthrough* was retrospective, this report aims to look to the future. Work is changing, both here and across the globe, and Britain needs to be prepared for this. This has implications for people, for businesses, and for policy makers in Westminster, who need to be aware of the drivers of change, prepared for them and positioned for the future. If not, then Britain will not succeed in tackling the drivers of low productivity, issues connected with low pay and low skills, or in maintaining high levels of employment. This research programme seeks to better understand the future of work, and in particular its impact on those at the bottom of the ladder. In order for the UK to have informed policy decisions and look after its most vulnerable, there is a need to understand fully the changes that are occurring, and could take place, in the world of work. These include socio-economic change, demographic trends, technology advancements, greater levels of globalisation, evolving skill demands and a cultural shift among younger workers. Informed policy decisions should help ensure employment rates remain high and that no one is left behind, allowing the market mechanism to work properly and intervening where needed. Work is a vital route out of poverty and central to future prosperity.

Structure

This paper is the fourth in a series of five separate reports, as part of The Future of Work Programme:

1. Working in Britain today: State of the nation
2. Regional revolution: Rebalancing growth and opportunity in post-industrial Britain
3. A vision for the National Retraining Scheme: Building a workforce for the future
4. Technology, AI and the future of work: Understanding how technology can be a job creator, not a job killer
5. The supply of labour: Population growth, immigration and an ageing workforce

Working Group

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- Dr Adam Marshall, Director General, British Chamber of Commerce
- John Mills, CEO, JML Ltd
- Dame Helena Morrissey, Head of Personal Investing, L&G
- Chris Oglesby, CEO, Bruntwood
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Executive summary

Each industrial revolution has involved a significant degree of disruption. However, the seeds of economic growth and social progression have been sown within each period of industrial change. Without embracing this upcoming 4th Revolution, Britain runs the risk of missing out on the chance to stimulate economic growth, alleviate poverty and enrich society.

The risks that are posed are real. Artificial Intelligence technology will streamline and automate the production processes for goods and services across our economy. People will find themselves out of a job. Technologies such as the spinning jenny, steam engine, mass production line and word processor had this effect in the past. The infiltration of technology into our daily lives will mean less privacy and a greater risk of fraud, theft and data misuse. The problems related to third party use of social network data to influence election results in America is a good example of this.

However, these risks should not serve to dissuade or disincentivise Britain from being bold. Technology offers many more positive opportunities for the most disadvantaged in society. Wearable technology could help social care workers and patients to monitor health indicators and reduce fatalities. Big Data and software programming will create new industries with millions of new jobs available across the income spectrum. Algorithms could help HR recruiters to reach potential employees far quicker, reducing the risk of long-term unemployment. Technology could be used to reduce crime with better tools to reduce response times and increase detection.

Our recommendations are rooted first and foremost in our optimistic attitude towards technology. We also believe that provisions must start being made now to reduce the risk of unemployment for the most vulnerable in society. The displacement of workers linked to deindustrialisation across the second half of the 20th century meant many communities experienced significant spikes in unemployment.

The lack of preparation for this has meant many of these communities have not emerged from the economic depression that developed as a result. Towns that once thrived due to local jobs linked to coal, steel and shipbuilding have not been able to attract new industries and jobs, meaning poverty is rife.

Among other policies, introducing Automation Taskforces and the National retraining Scheme will significantly reduce the risks of this happening again. However, there is also a risk of trying to do too much when history shows us that technology has been evolutionary and largely beneficial, so this paper only considers four policy areas:

1. Accelerate technology take-up

While risks from technology, in terms of job losses and keeping the efficacy of regulation, are real, there is no good reason in the long term to adopt the Luddite approach, underinvest in technology and ban the uptake of new technologies across our economy. The best option for the Government, the economy and wider society is to be ahead of the curve in terms of take-up. This argument is no truer than for the most disadvantaged in society. For example, Jobcentres could be linked to a national labour market exchange that uses an algorithm to match individuals to job opportunities. Distance learning has already been made more possible as a result of the internet. However, algorithms and machine learning could help to analyse test scores and exam performance to predict which adult learners are struggling in their course. An AI bot could then target that student with extra tailored support, produced by a machine rather than a teacher.

2. A Royal Commission

Technology, AI, and Big Data will radically change our relationships with the state, business, each other and our employer. These socio-economic trends are significant enough for the Government to set up a bipartisan Royal Commission that will be used to inform Government policy over the next generation. A Royal Commission is reserved for multigenerational issues. Previous Royal Commissions in Britain have looked at environmental pollution, long term care for the elderly, the press and the constitution.

Specific areas of focus should include use of Big Data, autonomous vehicles, autonomous machines, public provisions for those who are at risk of unemployment, and digital education and inclusion for the most disadvantaged in society, including high speed broadband coverage across the UK.

3. Set up local Automation Taskforces

The threat of technology-related unemployment is significant. Jobs in Britain's most important employers are most at risk; retail, manufacturing, transport and logistics. However, there are huge opportunities for helping employers to transition workers within their business.

The CSJ has previously advocated for the creation of Automation Taskforces to be established by each LEP. Each taskforce would be tasked with preparing for the problem of technological unemployment. They would be tasked with liaising between employers, employees, education providers and the public sector, aiming to minimise disruption, maximise transition opportunities for staff within their current employer and smooth the transition in to employment for staff that find themselves out of work. Co-operation and planning at a local level will be key to prevent mass unemployment. It would be negligent for the Government to allow such a major socio-economic disruption to occur without planning for those most affected.

4. Implement the National Retraining Scheme

There is no doubt that improving the quality of human capital will help workers to weather the negative effects of technology and leverage the positive opportunities that technology presents. The negative effects will include unemployment linked to businesses increasing the role of technology in the production process.

For today's workers to mitigate against the negative and leverage the positive, we need to think radically about training and up-skilling the current British workforce. The Government have already announced the creation of a National Retraining Scheme and we believe that it should focus on the creation of a Personal Learner Account (PLA) for every worker in the country. The PLA would prompt workers to save a small portion of their income each month; this portion would then be ring-fenced for training and up-skilling opportunities. The PLA invites employers and employees to contribute small sums over time. These sums could then be used for a college course, a professional license or a qualification from level 2 upwards.

For this to work, we will also need an overhaul of funding for Further Education (FE) Colleges in the UK. FE has experienced a real-terms cut in funding of almost 10 per cent since 2010. We believe the spending review would offer the Government a good opportunity to make the distribution of funding over post-18 education more equitable for FE.

Introduction

We are entering a new industrial revolution – commonly referred to as the fourth industrial revolution (4IR). This will have a profound impact on the future of work in the UK and across the globe. 4IR will be defined by technological change, specifically Artificial Intelligence (AI). AI is expected to not only impact work but also the approach that firms take to capital investment, means of production, supply chain, interaction with consumers and ultimately their recruitment and training policy.

This is the fourth report in our Future of Work Series. The first was a state of the nation, summarising Britain's strong labour market to date. The second report, Regional Revolution, spoke to the imbalanced demand for labour across different regions in the UK. It argued for a radical reboot to the devolution agenda, greater powers for local policy-makers and support for localities to develop their own competitive advantage. The most recent paper examined the supply of labour and discussed how the Government can leverage the National Retraining Scheme to retrain millions of low skilled and low paid workers who face a more precarious labour market in the future. This report considers how technology will impact both the demand and supply of labour.

The relentless advances of 4IR technology generate two conflicting visions of the future. In the dystopian view of the world to come, workers at every level, from the CEO's office to the shop floor are surplus to requirements, to be replaced by cheaper, more efficient machines. In an alternative world, we will enjoy the next phase of the 4IR, with monotonous, routine jobs being replaced by more creative, productive and better paid forms of employment. Published forecasts struggle, however, to take account of many unknown variables and impacts on the labour market vary from positive to negative, insignificant to very significant.

While 4IR technology is likely to impact both skilled and unskilled workers, the reality is that those at the bottom of the income spectrum will be the least resilient to change. The Centre for Social Justice (CSJ) was founded on the principle that work is the best route out of poverty. Jobs must continue to be the same mechanism for opportunity and economic progress that they have always been. It is for that reason, therefore, that this report analyses the evidence around the impact 4IR technology will have on jobs and discusses how we can best prepare our economy and labour market for these developments.

chapter one

Industrial revolutions across history

There is widespread agreement that the world is entering its fourth industrial revolution. This is despite this term being first used in the US in 1940. The first industrial revolution was in the UK from around 1760 to the middle of the following century. The second was across a range of countries, the US, Germany and Russia, as well as the UK, from 1870–1914. The third industrial revolution has been global, associated with the latter part of the 20th century, driven by electronics, the computer age and information technology. There were many different facets to each of these revolutions, but increased efficiency in the production process and improved communication were key.

Despite disruption caused to working practices, the net effect of every previous industrial revolution has been to see more jobs created, with three effects on jobs:

a substitution (or destruction) effect. As firms invest in new machines and develop the latest technology, routine and repetitive jobs are the first to go, with new technology helping to substitute for some roles previously undertaken by humans. All too often, it is this substitution effect that is the focus of attention, and it feeds resistance to change.

an income (or productivity) effect. There has been a productivity effect in all previous industrial revolutions. There are a number of avenues through which this works. New technology can lower prices and thus help boost demand, output and income. Lower prices leads to increased competition across a swathe of goods and services. Increased spending power and demand sees people buy more of new, as well as of existing goods and services that were already available but previously out of their income reach. Over time, such goods and services will become more widely affordable, as their relative prices fall, or as spending power increases. Thus, many existing jobs will be boosted as some products become mass market.

a creation effect. There are new jobs created as technology leads to the advent of products and services that did not previously exist. For instance, this would have been the personal computer and the Ipad during the third industrial revolution. However, these jobs are, by their very nature, hard to predict.

Although empirical evidence that breaks down each of these effects is lacking, it is generally accepted that they occur sequentially. That is, technology and automation will first have a substitution effect, then an income effect and lastly a creation effect. Jobs are lost in the short term, they are recreated along the supply chain in the medium term, and in the long term entire industries create the need for new occupations and workers.

Additionally, as Bhaskar Chakravorti,¹ a commentator in India, alludes to, while we keep anticipating rapid future change, the situation globally hitherto has been more one of a slow pace than of fast change, with the first three industrial revolutions yet to filter down completely to economies such as India.

Elizabeth Garbee said said in 2016:²

The phrase the fourth Industrial Revolution has been around for more than 75 years. It first came into popular use in 1940, in a document titled "America's Last Chance" by Albert Carr, to usher in "modern communications, merely as an additional manifestation of the industrial revolution—as the beginnings of a new phase, a 'fourth industrial revolution.' He delivers a hauntingly familiar warning to the American people that their democratic way of life is at risk and suggests a technological revolution as the way forward. Since then, historians and scientists have proclaimed this "new" revolution's commencement with the arrival of atomic energy in 1948.

1 www.huffingtonpost.com/bhaskar-chakravorti/the-next-big-thing-a-fift_b_9185692.html?guccounter=1

2 Garbee, "This is not the Fourth Industrial Revolution", 29/01/2016 Slate, Future Tense www.slate.com/articles/technology/future_tense/2016/01/the_world_economic_forum_is_wrong_this_isn_t_the_fourth_industrial_revolution.html

chapter two

What is 4IR?

The new aspects of 4IR are the scale and complexity of what is now confronting us. There are numerous different elements to the 4IR, including stem cell research, green technology, blockchain, financial technology, quantum computers, biotechnology, new generational robots, 3D printing that revolutionises manufacturing and AI.

According to the World Economic Forum (WEF),³ the 4IR is

characterised by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres... Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance.

And,

On the supply side, many industries are seeing the introduction of new technologies that create entirely new ways of serving existing needs and significantly disrupt existing industry value chains.

This is a point that needs to be emphasised; it is not just about existing business models, it is that business models could change. Indeed, the combination of an acceleration of innovation and velocity of disruption point to ongoing surprises or shocks. Disruption is evident from agile, innovative competitors who,

Thanks to access to global digital platforms for research, development, marketing, sales, and distribution, can oust well-established incumbents faster than ever by improving the quality, speed, or price at which value is delivered.

These new entrants also avoid cumbersome legacy systems impacting incumbents.

What is AI?

AI is a vast domain spanning software, its input into hardware and methodologies for handling and processing data. As it is so vast, there can be competing visions of what is meant by AI. PwC,⁴ for instance, consider four elements of artificial intelligence. This would appear to mirror much of the debate. However, it would seem that the important point is to differentiate between Autonomous Intelligence and the other three components of AI:

³ World Economic Forum, WEF, www.weforum.org/agenda/2018/08/economic-policy-for-artificial-intelligence

⁴ www.pwc.co.uk/economic-services/assets/ai-uk-report-v2.pdf

- Automated intelligence: Automation of manual, routine tasks. *"Automation of manual and cognitive tasks that are routine. This does not involve new ways of doing things – automates existing tasks."*
- Assisted intelligence: Helping to perform tasks faster and better. These, PWC describe as, *"AI systems that assist humans in making decisions or taking actions. Hard-wired systems that do not learn from their interactions."*
- Augmented intelligence: Helping people to make better decisions. These are, *"AI systems that augment human decision making continuously learn from their interactions with humans and the environment."*
- Autonomous intelligence: Automating decision-making processes without human intervention. *"AI systems that can adapt to different situations and can act autonomously without human assistance."*

One definition of AI, according to research summarised by the House of Commons Library,⁵ is that it is:

Considered as an evolving set of technologies that enable computers to simulate elements of human behaviour such as learning, reasoning and classification by analysing data to model some aspect of the world and predict and anticipate possible future events.

Reinforcing the importance of the need to differentiate, a House of Lords Select Committee⁶ report earlier this year distinguished between 'artificial general intelligence' and 'narrow AI'. That is, AI was either 'general' or 'narrow' in scope.

Artificial general intelligence refers to a machine with broad cognitive abilities, which is able to think, or at least simulate convincingly, all of the intellectual capacities of a human being, and potentially surpass them – it would essentially be intellectually indistinguishable from a human. In their analysis, the House of Lords found that there has been, "Little to no progress in the development of artificial general intelligence." Hence their report focused on narrow AI:

Narrow AI systems perform specific tasks which would require intelligence in a human being, and may even surpass human abilities in these areas. However, such systems are limited in the range of tasks they can perform.

Additionally, "It is these systems which have seen so much progress in recent years." This analysis would seem to be borne out by the facts. It also reinforces the need to differentiate between the short and longer-term.

There are some well-known, widely cited examples of AI that would fit within this umbrella of narrow AI. Much of what looks like intelligent operation – with machines now thinking as humans – may in fact be applicable in narrow applications only.

For instance, IBM's Deep Blue supercomputer beat Chess World Champion Garry Kasparov in 1997. This was not an example of advanced AI and more a reflection of an aspect that computers are good at: processing information quickly within a clearly defined set of rules and being able to conduct multiple more calculations than a human.

⁵ House of Commons Library, "Artificial Intelligence and Automation in the UK" By Laurie Points and Ed Putton, Briefing Paper, 8152, 21/12/2017

⁶ Select Committee on Artificial Intelligence, Report of Session 2017–19, March–April 2018 "AI in the UK: ready, willing and able?"

Another interesting media focus was in 2016 when DeepMind's AlphaGo beat Lee Sedol, who was then the best human Go player. This was a step on from Deep Blue because although the game rules and data were programmed, the underlying software and algorithms were more general-purpose and capable of learning from the experience of playing many games during its creation.

Furthermore, as James Crabtree notes from the recent world chess championships in London,⁷ where:

much talk was of AI when I visited the start of the championships, mostly because chess has recently become a crucial testing ground for new machine learning technologies. Google's DeepMind division pulled off a coup last year when its AlphaZero program learned the rules in a few hours, and then triumphed against Stockfish, until then the world's best chess computer.

A learning system is quite an advance and may be seen as an early example of 'black box' AI, referred to below.

More recently, in early November 2018, at the World Internet Conference in Zhejiang, China, the news agency Xinhua, along with the search engine sogou.com, unveiled an AI news anchor that looked like a human, with voice and facial expressions.⁸ Given the need for a new anchor to interpret news in a neutral, unbiased and sensitive way, occasionally with humour, it could raise questions about the news coverage that citizens may receive, but again it highlights the way AI can make advances in specific tasks.

The lesson from these examples is that these were different capabilities and thus they should be considered as different technologies. It highlights that in certain tasks, machines can perform well.

How do we expect AI to develop?

The big issue is whether it is economically feasible to implement. Investment in 4IR technology must be financially rational before we can expect it to be fully implemented.

Our experience with computing and communication technology proves that over time technology becomes both more powerful and cheaper to build. As a result, computing applications have grown exponentially, from the desktop to our mobiles, from basic games to virtual reality, and from electronic messaging to internet calling. Presumably, mobile technology in the future will be supplemented by a digital and data revolution that provides consumers with access to vast stores of information. The reality is that these forms of technology will become economically feasible in time.

Some excellent new work has been produced for this paper by Jonathan Steel⁹ that puts the timeline and development of AI in perspective. For outsiders, it is difficult to get a context around the timing of the AI revolution and the different facets contributing to

⁷ <https://asia.nikkei.com/Opinion/Chess-AI-and-Asia-s-future> James Crabtree on CapX, via the Nikkel Asian Review, "Chess, AI and Asia's future", November 21, 2018

⁸ Via sogou.com

⁹ As mentioned at the beginning, these original charts and descriptions of AI in terms of four waves have been provided directly for this Report by Jonathan Steel, an AI expert.

it. He has produced charts 3 and 4 that help outline the evolution – and the revolution – associated with AI. It can be thought of in four waves, and we are probably at the end of the second and start of the third:

- the first wave was process execution and took place after the Second World War. This was characterised by the automation of the existing tasks and involved the ability to write software to undertake routine tasks more efficiently than people. This period saw the availability of ever-more powerful computers and culminated in the advent of desktop PCs, spreading computing capability to individuals in offices and at home.
- the second wave started around the beginning of the 21st century and we are probably at its end now. It has been characterised by communication, reflected in the World Wide Web and rapidly increased availability of bandwidth. A new wave of companies has risen to prominence during this time; evolving from those supplying the networking infrastructure (for instance, Cisco Systems or Oracle) to those providing the platforms providing web-based services (Google, Amazon, Facebook), and followed by the mobile technology enabling us all to have powerful computers in our pockets (Apple, Samsung et al.). The consumer market dominated this development of technology and hence the focus has moved from computing and networking infrastructure to the delivery of services made possible across both fixed and mobile hardware. Over the last decade or so, the focus has shifted towards platforms that have become dominant in providing consumer services, and most importantly, collecting and exploiting the resulting data.

The data and digital revolution we are currently going through, has implications, naturally, for business and the world of work. The advent of cloud computing has moved much of the work traditionally done by servers and even data centres onto the cloud leaving, in theory, only what is required in the end-user device to happen locally. This has occurred alongside the exponential growth of data from consumer products and services and increasing digitisation of B2B activities. Big Data is the profound outcome from this wave of digitisation. For learning systems, the more data available the more refined the algorithms that have been around for ages can become. The algorithms are a vital part of the software, determining future uses that technology can be applied to.

In the future, the progress of AI is likely to fall into the path outlined in waves three and four. These waves fall into the overall field of AI in which computers start to adopt some human characteristics:

- we are in the early stages of the third wave, which is about learning systems. Here, machines can acquire data from multiple sources and learn from this without being programmed to do so.
- the fourth wave is expected to be evolution to cognitive and self-awareness, whereby machines improve themselves through re-design without human intervention. This is often where the Sci-fi debate about AI is. However, it is a long way from where we are now. This describes technologies that can not only learn new ways of doing things, based on self-modifying data, rules and algorithms using new inputs and experiences. Also in this phase it is expected that AI will be able to modify its underlying software, memory structures, physical operation and even hardware (such as designing new hardware which is more effective or efficient than that from which it is currently constructed).

chapter three

How will we use 4IR and AI?

The capacity for 4IR and AI to be disruptive comes when it is combined with other rapidly developing technologies. Forbes magazine,¹⁰ for instance, recently, talked of, “The trifecta: Big Data, AI, Blockchain.” It stated that,

While blockchain and AI have been forging their paths with little overlap in their own past 10 years of existence, there is a clear link between the technologies in the form of data. Big Data’s emergence and importance recently have catalysed the relationship between blockchain and AI.

For instance, data has:

fuelled blockchain’s advancement as its distributed ledger is a new and novel way for data to be stored in an alternative and effective manner. To this end, the need for data analytics with AI is growing.

Blockchain is an enabling technology. In a similar vein, Keith Bedell-Pearce¹¹ writes:

The next 10 years will see technological innovation dominated by three new additions to the line-up of defining digital technologies. They are Blockchain, Artificial Intelligence and the Internet of Things.¹²

The issue is that each can deliver standalone functionality, but the final impact could be considerable through interacting with other technologies. One example he cites is,

Microsoft’s use of AI in providing its ScanDiags service that automates MRI interpretation and documentation. Diagnostic outcomes now are said to be far more accurate than those produced by specialist MRI radiologists.

10 Darren Pollock, “The Fourth Industrial Revolution Built on Blockchain And Advanced with AI”, 30/11/2018, Forbes, www.forbes.com/sites/darrynpollock/2018/11/30/the-fourth-industrial-revolution-built-on-blockchain-and-advanced-with-ai/amp/

11 ‘Bringing together Blockchain, Internet of Things and Artificial Intelligence Turning Skynet into reality’, Keith Bedell-Pearce 1/11/2018 forthcoming publication in Forbes. He also cites Matt Turck, a US venture capitalist, describing how AI and Blockchain can combine into: Decentralised AI marketplaces – where Blockchain platform can manage AI services – and AI networks and decentralised autonomous organisations – a decentralised organisation entirely run by machines with no or limited human input.

12 The Internet of Things is a network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. For instance, AI and IoT allowed Rolls-Royce to launch in February 2018 its IntelligentEngine vision with an aircraft engine. According to Matt Turck, <http://mattturck.com/iot2018/> “2017 was most likely the year when the total number of IoT devices (wearables, connected cars, machines, etc.) surpassed mobile phones.”

In this case, one could view this as capacity enhancing, as opposed to job threatening. This highlights the potential inroads into higher skilled roles such as in medicine, allowing scope for specialists to focus on new aspects of their discipline. As mentioned earlier, the data and digital revolution underpins the changing landscape, resulting in major changes in working processes.

Complementarity and how 4IR could improve our working lives

Just as the focus here is on the complementarity between the different technologies, so one of the future challenges – perhaps for policy makers – is for complementarity between workers and the various forms of technology. Indeed, the distinctive features of the various forms could mean their combined impact has a wider impact across the world of work.

An important part of the outlook will be the ability for machines and humans to work alongside one another, much as people have embraced and used technology up to now. Used in the right way, this should improve productivity.

It is important to retain an open-mind about future possibilities. Just as the roles that people work in may change, with machines undertaking routine roles, so too might the relationship between machines and workers. There is the marriage of people with computers. It may involve HR departments using algorithms to select candidates or allowing doctors to see more patients in a surgery, or help salespeople reach more segmented markets.

Again, this will have to be driven heavily by the economic justification, but it may include co-bots, where machines or computers provide support to humans in different outlets, even across the retail sector, in which there are many low-paid workers, as well as across warehouses and storage centres.

The opportunity for a mutually supportive relationship between technology and humans in the workplace is significant however. Technology is not limited to replacing an individual within a specific production function but complementing them by taking over some tasks. We refer to this at length later in the report.

Digitisation and retail

Today, digitisation has already had a profound impact on the way we buy things in the UK and thus, also on jobs across low paid sectors, such as retail. The high street is shrinking, while growth areas include warehousing and delivery.

Along with the exponential growth of data from consumer products and services, there is also increasing digitisation of B2B business and processes. To give a flavour of what some expect, at the WTO Public Forum in October 2018, Jack Ma, executive Chairman of Alibaba Group, forecast that,¹³

In the next 30 years, 80 percent of small business will benefit from globalization. In 2030 more than 85 percent of business will be e-commerce. Ninety-nine percent of trade will be online and less than one percent of trade will be offline.

Much of current world trade is seen in containers, while in 2020 most of it will be in packages.

Today, we see made in China, made in the U.S., made in Switzerland. In 2030 we will see made in the Internet.

Ma also stated, “We cannot stop technology. The only thing you can do is to embrace it.” Many would agree.

At the same event, according to the Director General of the WTO, Roberto Azevedo,¹⁴ “More and more trade will be happening through digital platforms. New ways of delivering products will come on stream. New kinds of services will be created.”

Digitisation is therefore another technological source of major change and opportunity. Azevedo also stated,

If the proper synergies are in place, particularly regarding public policies, by 2030 the technological revolution could help fuel additional trade growth of around 30 percentage points.

Big Data is the profound outcome from this wave of digitisation. When we shop offline, for example, most retailers know only what we bought; larger chains may well offer loyalty cards so they can keep track of what we buy. A few have systems that can track what people do around their stores (with advanced computer vision systems). Online, however, an e-tailer will know where we came from, what else we have been browsing, what we looked at before buying and for how long, and what we bought. They will also probably have awareness of who our friends are, what they have been doing, who we can influence, and so on, with boundless possibilities.

¹³ <http://en.people.cn/n3/2018/1003/c90000-9505664.html> Xinhua, 3 October, 2018

¹⁴ See reference above

chapter four

The story on jobs so far

In terms of jobs, it is widely accepted across the literature that technological change and automation has already contributed to:

- ‘routine-biased technological change’ where demand for routine jobs and tasks has fallen considerably, regardless of whether such jobs or tasks had a cognitive or manual character. In contrast, non-routine tasks, which is everything requiring face-to-face communication, are needed.
- job polarisation, where demand for people with middle skill levels has decreased relative to a rise in demand for both high-skilled (and high paid) and low-skilled (and low paid) occupations. Writing in 2007, economists Goos and Manning¹⁵ highlighted that the UK had exhibited this since 1975. Globalisation, as well as technology, may have played a role here, as routine jobs are more likely to be off-shored than non-routine jobs.

This is not entirely consistent with the idea of skill-biased technical change as a hypothesis about the impact of technology on the labour market. Acemoglu and Autor argue that the “routinisation” hypothesis proposed by Autor, Levy, and Murnane (2003) is a better explanation of job polarisation, though other factors may also be important. However, if this is the case, then these very routine jobs would look more vulnerable to automation.

Research by Acemoglu and Autor (2011)¹⁶ felt it necessary to move on from what they described as the “canonical model” that saw labour as two distinct skill groups, skilled versus unskilled, performing different and imperfectly substitutable tasks. Thus, technology is assumed to take what has been called a “factor-augmenting form”, complementing either high or low skill workers.

Their answer suggested that a distinction of manual versus cognitive and routine versus non-routine jobs may be better suited than skilled versus unskilled. Going from a two to four-dimensional assessment of jobs makes more sense and, in their words,

Is valuable to consider a richer framework for analysing how recent changes in the earnings and employment distribution in the United States and other advanced economies are shaped by the interactions among worker skills, job tasks, evolving technologies, and shifting trading opportunities.

15 Alan Manning, Centre for Economic Performance, London School of Economics. *The Review of Economics and Statistics* Vol. 89: Issue. 1, Pages. 118–133. (Issue publication date: February 2007) “Lousy and Lovely Jobs: The Rising Polarization of Work in Britain” Maarten Goos Department of Economics, Catholic University Leuven and Erasmus University

16 <https://economics.mit.edu/files/5571> Daron Acemoglu and David Autor, Chapter 12, “Skills, Tasks and Technologies: Implications for employment and earnings”

The bottom line, though, is the substitution of machines for certain tasks previously performed by humans.

In previous industrial revolutions, it was the manual jobs of the time that disappeared. Now, the perception is that many routine tasks are the ones disappearing, whether manual or cognitive. Routine manual work will likely become the domain of technology and robots. When one thinks of the numbers that would flock out of factories as recently as the 1970s, this already represents a significant change.

While this distinction works for this debate, it is not the answer to all the challenges in the labour market. Indeed, the analysis of Acemoglu and Autor suggested this failed to account for a number of key labour market developments such as:

- significant declines in real wages of low skilled workers, particularly low skill males;
- non-monotone changes in wages at different parts of the earnings distribution during different decades;
- job polarisation of broad-based increases in employment in high skill and low skill occupations relative to middle skilled occupations;
- rapid diffusion of new technologies that directly substitute capital for labour in tasks previously performed by moderately skilled workers;
- expanding off-shoring in opportunities, enabled by technology, which allow foreign labour to substitute for the specific tasks of domestic workers.

Routine cognitive work is already changing and will continue to do so. It is this impact of technology and AI that often attracts attention, as roles or parts of roles previously undertaken by skilled or well-qualified people can now be performed by computers and machines. This can include economic forecasting, accounting and much legal work. However, it is in the non-repetitive or non-routine areas that humans will still be at a premium. The areas that involve emotional intelligence, or people skills, in particular, will be impossible to displace. This could include non-routine manual tasks such as public relations, cooking, hair dressing or personal training. It also includes non-routine cognitive tasks that can characterise many jobs. There have already been vast inroads of technology into most aspects of our lives, which in turn will have already had an impact on how jobs are done and work undertaken. Roles continue to change, even if jobs sometimes do not. This creeping and constant evolution will continue.

chapter five

Manufacturing matters

The UK is a service sector economy. However, it is often overlooked how important it still is as a manufacturing nation.

Manufacturing contributes £6.7 trillion to the global economy. Contrary to widespread perceptions, UK manufacturing is thriving, with the UK currently the world's eighth largest industrial nation. If current growth trends continue, the UK will break into the top five by 2021. In the UK, manufacturing makes up 11% of GVA, 44% of total UK exports, 70% of business R&D, and directly employs 2.6 million people.¹⁷

The importance of manufacturing has long been a debate in this area, but it also merits attention in its importance in the technology debate and its impact on employment. Much low-cost manufacturing, like food processing, occurs in the home market. Technology, too, may allow some production to be re-sourced, as the cost advantages of out-sourcing may change, although this is linked to the importance of supply chains and end markets. It is, likely many other aspects of this debate, complex and nuanced.

Talk of the 4IR owes much to the January 2016 annual meeting of the WEF in Davos that appears to have been influenced heavily by events in Germany,¹⁸ where in April 2011 Industry 4.0 was launched at the Hannover Mess, one of the world's largest trade fairs. First, a working group, and then the German Government itself, focused on Industry 4.0 and the automation and digitisation impacting manufacturing. It led to a focus on the smart factory and highlighted the importance of the use of data and of computers in manufacturing. As noted, it became the trigger for the focus on the 4IR.

For a factory or manufacturing system to be considered Industry 4.0 it needed, according to the analysis conducted as part of Industry 4.0, to fulfil four criteria: interoperability; information transparency; technical assistance; and decentralised decision making. Interoperability is about machines, devices, sensors and people that connect and communicate with one another. Information transparency is where a system creates a virtual copy of the physical world through sensor data in order to contextualise information. Technical assistance is both the ability of the systems to support humans in making decisions and solving problems and also the ability to assist humans with tasks that are too difficult or unsafe. Decentralised decision-making is the ability of cyber-physical

¹⁷ www.themanufacturer.com/uk-manufacturing-statistics/

¹⁸ www.vdi-nachrichten.com/Technik-Gesellschaft/Industrie-40-Mit-Internet-Dinge-Weg-4-industriellen-Revolution See also eef: the manufacturers' organisation, "UK manufacturing and the Fourth Industrial Revolution" www.eef.org.uk/~media/9e140eedffe44a6b8cf205c078393434.pdf?la=en

systems to make simple decisions on their own and become as autonomous as possible. The implication of this is that manufacturing employment changes, as roles evolve, perhaps becoming more computer sophisticated.

This description by Pradeep Amladi¹⁹ is insightful.

Industry 4.0 is the next phase in manufacturing. It represents a shift in manufacturing from stand-alone, isolated business processes and systems to fully integrated data and product flows that move beyond a company's manufacturing plant. Industry 4.0 involves applying new technology innovations to shorten cycle times, improve product quality and implement efficiencies across operations. As a result, manufacturers can be more responsive to customer needs with highly customised products and services on a global scale.

Amladi goes on to state that it is the combination of, "intelligent products, emerging technologies and shifts in customer attitudes." This suggests a shift in labour focus from production, to innovation of production and also to customisation and selling of the product. It requires a different skill set, reinforcing a central theme about the 4IR, namely even when jobs remain, roles may need to change.

The focus on automation in the general policy debate appears to have very much been on manufacturing. For example, a briefing by the European Parliament²⁰ in September 2015 stated,

The nature of manufacturing work has been shifting from largely manual labour to programming and control of high performance machines. Employees with low skill levels risk becoming replaceable unless they are retrained. On the other hand, workers able to make the transition to Industry 4.0 may find greater autonomy and more interesting or less arduous work. Employers need personnel with creativity and decision-making skills as well as technical and ICT expertise. By 2020, labour markets in the EU could be short of as much as 825,000 ICT professionals; this shortage may be even more pronounced in advanced manufacturing settings where Big Data analysts and cybersecurity experts are required.

The need to acquire 'eSkills' was part of the message. This up-skilling of staff and preparation of students and others is hard to disagree with. It is about being prepared for the future. However, the future that was triggered by this debate would evidently not just impact Germany or manufacturing. Data and digitisation have the potential to transform services and the provision of public goods too, globally.

19 <https://moneyinc.com/industry-4-0-really-mean-manufacturing/>

20 European Parliament, [www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI\(2015\)568337_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf)

chapter six

The future impact on jobs?

There is little straight consensus on the gross or net impact of technology; the estimated number of UK jobs at risk ranges from 10 million to 15 million. Globally estimates range from 400 million to 2 billion (by 2030).

Table 1

When	Where	Jobs lost	Jobs added	Predictor
2016	Worldwide	900,000–1,500,000		Metra Martech
2018	US Jobs	13,852,530	3,078,340	Forrester
2018	Worldwide	1m–2m		Metra Martech
2020	Worldwide	1.8m	2.3m	Gartner
2020	15 countries	7.1m	2.0m	WEF
2021	Worldwide	1.9m–3.5m		Int Fed of Robots
2021	US Jobs	9.1m		Forrester
2022	Worldwide	1 B		Thomas Frey
2025	US Jobs	24,186,240	13,604,760	Forrester
2025	US Jobs	3,400,000		ScienceAlert
2027	US Jobs	24.7m	14.9m	Forrester
2030	Worldwide	2 B		Thomas Frey
2030	Worldwide	400m–800m	555m–890m	McKinsey
2030	US Jobs	58.164m		PwC
2030	UK Jobs	10.4m		PwC
2035	US Jobs	80m		Bank of England
2035	UK Jobs	15m		Bank of England
Unset	US Jobs	13,594,320		OECD
Unset	UK Jobs	13,700,000		IPPR

This debate is vast; suffice to say, the key paper to be aware of is a seminal piece of academic work by Oxford economists, Frey and Osborne,²¹ whose analysis examined the different tasks within various jobs, determining which may be liable to be automated. Their analysis has been the bedrock of many of the forecasts of widespread job losses.

21 Carl Benedikt Frey and Michael A. Osborne, 17/09/2013. "The Future of Employment: How susceptible are jobs to computerisation?" www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Frey and Osborne assume that beyond three bottlenecks of: creative intelligence tasks; social intelligence tasks; and perception and manipulation, “that it is largely already technologically possible to automate almost any task, provided that sufficient amounts of data are gathered for pattern recognition.” Nine variables describing these three bottlenecks were then used for 70 occupations and the model was applied to 702 occupations from the US Bureau of Labour Statistics data set to provide an ex ante probability of computerisation. They suggested 47 per cent of US jobs could be impacted, although not all would disappear. Furthermore, they found a strong negative relationship between wages and educational attainment and an occupation’s probability of computerisation. Not all academics agreed with their approach; “The paper is a set of guesses with lots of padding to increase the appearance of ‘scientific precision’”.²²

Notably, the key differentiating factor is education. For those with only GCSE-level education or lower, the estimated potential risk of automation is as high as 46 per cent in the UK, but this falls to only around 12 per cent for those with undergraduate degrees or higher levels of education. However, in practice, not all of these jobs may in fact be automated for a variety of economic, legal and regulatory reasons.

The Bank of England²³ applied the occupational definitions of Frey and Osborne to the UK to conclude that half of our jobs may be at risk. Like much of the projections in this area, it seemed largely speculative, and was not a deep dive but a rather speculative approach. The Bank concluded the proportion of employment that was at risk from automation in the UK: 37 per cent was low risk (less than one-third probability of being automated), 28 per cent medium risk (between one-third to two-thirds) and 35 per cent high risk (more than two-thirds probability).

The debate has moved on to examining how roles will change, as opposed to whether jobs will disappear. Moreover, there is a need to be aware that the research is evolving, exploring the rate of technical change on business models.

Expectation management is likely necessary, with a basic rule needed to not over-estimate what can be achieved in the near-term and not to under-estimate what might be possible in the future.

The discussion about technological unemployment is just one aspect of the debate impacting the labour market. Over time, other trends have been very evident and the issue is whether these are secondary effects of technology. For instance, hours worked, across economies, have trended down since the middle of the 19th century.

22 <http://curriculumredesign.org/wp-content/uploads/Comments-on-Oxford-and-Martin-Study.pdf>

23 See Andy Haldane, 12/11/2015, ‘Labour’s Share’, www.bankofengland.co.uk/-/media/boe/files/speech/2015/labours-share.pdf?la=en&hash=D6F1A4C489DA855C8512FC41C02E014F8D683953

According to Maddison,²⁴ annual hours worked per person employed fell from 2,984 in 1870 to 1,688 in 1973 to 1,489 in 1998. In Germany, the corresponding figures were 2,841 to 1,804 to 1,523. They have continued to decline. Interestingly, the total number of hours worked has continued to vary across countries, rising from 39,260 million in 1870 to 40,383 million in 1998 in the UK, and by far more, from 45,979 million to 54,971 million in Germany.

As described by the Bank of England's Chief Economist Andy Haldane,²⁵

Viewed over the sweep of history, then, there is essentially no evidence to suggest technology has damaged jobs and plenty to suggest it has boosted wages. Technology has enriched labour, not immiserated it.

24 Angus Maddison, *The World Economy*, OECD, Table E-3, p347

25 "Labour's Share", Speech given by Andrew G Haldane, Chief Economist, Bank of England, Trades Union Congress, London 12 November 2015

chapter seven

Robots, jobs and how technology accelerates take-up

In terms of discussion about AI, the term is often used interchangeably with robotics – but they are different things. AI is about software and data such as programming, rules and algorithms. Robots are the hardware. Most of the capabilities of robots are therefore dictated by the limits of the software controlling them. To date, the field of robotics has largely been involved in automating very routine tasks across the manufacturing sector or in places like warehouses or production lines. The UK is 22nd in terms of the number of robots in relation to workers in manufacturing, just below the global average.

Table 2: Installed instrumental robots per 100,000 workers in manufacturing, 2016

Country	Installed robots per 100,000 workers	Country	Installed robots per 100,000 workers
1 South Korea	631	13 Canada	145
2 Singapore	488	14 Australia	144
3 Germany	309	15 Finland	138
4 Japan	303	16 Slovenia	137
5 Sweden	233	17 Slovakia	135
6 Denmark	211	18 France	132
7 USA	189	19 Switzerland	128
8 Italy	185	20 Czechoslovakia	101
9 Belgium	184	21 Austria	83
10 Taiwan	177	World Average	74
11 Spain	160	UK	71
12 Netherlands	153	China	68

Source: International Federation of Robots

The message from this table is that the bulk of robots are concentrated in capital intensive, manufacturing focused economies and that the UK is below the world average. However, China is the exception and although it is only 23rd in the list, given the scale of its population, it is expected to have 40% of all robots by 2019. From global value chains, the relationship between technology and employment means rising demand, spurred by improved efficiency or labour productivity, more than compensates for technology induced displacement of jobs. Evidently, one underlying aspect for the UK is the extent to which the low cost of labour and an open approach to migration has deterred the need to automate aggressively.

In considering the impact on business and employment, the development of AI connected to robotics will drive the adoption of robotics into many more traditionally human fields of activity. Given this, the two areas of technology that could most rapidly drive the capabilities of AI, and thus impact employment, are machine learning and sensory technologies.

Consider a February 2013 International Federation of Robotics²⁶ report about the positive impact of robotics on employment. This interesting analysis examined six countries, and although the UK was not one of them, the research is relevant for our discussion. The six were Brazil, Japan, China, South Korea, Germany and the USA. Over the period 2000–2011, there were employment gains.

This is driven by increasing participation of women, and increases in population, including immigration in some cases. It is also caused by the increasing demand for services, and the creation of completely new products and markets, often related to the application of electronics to communication. The statistics mainly show reduction in employment in manufacturing in the developed countries, often a small reduction. It coincides with an increase in output and an increase in robotics use, except in the case of Japan.

In particular, the small job losses in manufacturing were offset by job gains elsewhere, such as in distribution and services and “also in new manufacturing applications, particularly using technology advances to create new consumer products [phones, computers, games etc].” Say’s Law in economics – that “supply creates its own demand” comes to mind.

As the report notes, the concept of “Jobless recovery”, where an industry comes out of a recession leaner, needing fewer employees, is only short-term. It may be relevant for future thinking. It is likely to lead to more job creation by the leaner, more competitive companies. Concurrently, the service sector continues to absorb most of the displaced people. Some of these new service people owe their jobs to new robot driven industry.

The authors of the study envisage robots creating jobs primarily due to the use of robots in new product development, current industry expansion, and downstream job development. “A much larger source of employment, at least partly due to robotics, is the newly created downstream activity necessary to support manufacturing which can only be done by robots.”

26 https://robohub.org/wp-content/uploads/2013/04/Metra_Martech_Study_on_robots_2013.pdf
International Federation of Robotics, “Positive Impact of Industrial Robots on Employment” February 2013

Occupations to tasks

Within the focus of Frey and Osborne's research on at-risk job computerisation was a recognition of what computers are doing and how their scope is expanding. Within the service sector economy in the UK, particularly in low paid work, Frey and Osborne found that the

substantial share of employment in services, sales and construction occupations exhibit high probabilities of computerisation. Yet these findings are largely in line with recent documented technological developments.

The market for personal and household service robots is already growing rapidly. They state,

As the comparative advantage of human labour in tasks involving mobility and dexterity will diminish over time, the pace of labour substitution in service occupations is likely to increase even further.

Second, while it seems counterintuitive that sales occupations, which are likely to require a high degree of social intelligence, will be subject to a wave of computerisation in the near future, high risk sales occupations include, for example, cashiers, counter and rental clerks, and telemarketers. Although these occupations involve interactive tasks, they do not necessarily require a high degree of social intelligence. Our model thus seems to do well in distinguishing between individual occupations within occupational categories.

They also expected more computerisation in construction work. The overall effect was the view that machine learning would point to a substantial share of employment, across a wide range of occupations, being at risk in the near future.

For PwC,²⁷ potential job losses are driven by the proportion of jobs in that sector that are seen as high risk and the employment share in the sector. Thus, transportation and storage in the sector is seen as most at risk, with around 56% of jobs at potential high risk of automation, but the sector seen as losing the most number of jobs is wholesale and retail trade, with 2.3 million (44%) of its jobs at risk. The other big job losses are in manufacturing at 1.22 million, administrative and support services at 1.09 million, and professional, scientific and technical at 0.78 million. While the risk was lower in sectors like health and social work (17%), because of its size that still equates to 0.73 million.

The general tendency, for instance, is to examine an occupation and to cite the likely degree of automation. In a January 2017 report on automation, for instance, McKinsey,²⁸ tried to identify the degree of automation within jobs, across a range of economies. They found 8% of jobs being more than 90% automatable, 42% more than 50% automatable, and around 62% of occupations had at least 30% of their activities that were automatable.

This would reinforce a key message that it is roles that need to change and jobs do not always need to disappear. This may, however, require detailed and longer-term planning about how to incorporate this within firms, as well as up-skilling existing staff as roles change.

27 www.pwc.co.uk/economic-services/ukeyo/pwcukeyo-section-4-automation-march-2017-v2.pdf "Will robots steal our jobs? The potential impact of automation on the UK and other major economies", PwC, UK Economic Outlook, March 2017

28 McKinsey Global Institute, January 2017, "A Future that Works: Automation, employment and productivity"

However, the analysis of scrutinising occupations has been taken one step further. Drawing on earlier research, such as by Autor, OECD analysis by Arntz, Gregory and Zierahn (OECD, 2016),²⁹ evidence suggests that it is not whole occupations that will be replaced by computers and algorithms, but only particular tasks that are conducted as part of that occupation.

Tasks, not jobs, will change. Thus, using a new OECD database to analyse the work of Frey and Osborne and Arntz, Gregory and Zierahn produced a far lower estimate that around 10% of jobs in the US were under a “high risk of computerisation”. Likewise, the figure for the UK would thus be far lower.

By adopting what they called a “task-based approach”, reflecting the heterogeneity of workers’ tasks within occupations, the OECD found that on average, across 21 countries, only 9% of jobs are automatable.

Differences between countries may reflect general differences in workplace organisation, differences in previous investments into automation technologies as well as differences in the education of workers across countries.

This welcome OECD approach took an extra step compared with most other analysis.

Gownder,³⁰ while reiterating the oft-made point that automation will spur the growth of many new jobs and industries, stressed the point that the largest effect will be job transformation. The point is that humans will find themselves working side by side with robots. It is this aspect that has largely been seen in parts of manufacturing, where robots dominate some assembly lines that will likely have economy wide implications.

Many significant innovations in the past have been associated with a transition period of temporary job loss, followed by recovery, then business transformation and AI will likely follow this route.

This research echoed that elsewhere AI will improve the productivity of many jobs.

Where can we accelerate technology take-up?

The need to focus on tasks was referenced in this year’s annual economic outlook from the Asian Development Bank³¹ with a special report into how technology would affect Asia. Their conclusion was a positive one. It is relevant for the UK not only because the same generic issues may apply but also because of the intense global competition now being seen and which has largely impacted those at the bottom of the income distribution.

The report concluded that policy-makers will have to be proactive if the benefits of new technologies are to be shared widely across workers and society. This will require coordinated action on skills development, labour regulation, social protection, and income redistribution. Significantly, new technologies can help to deliver solutions in many of these

29 OECD, 14/5/2016, Melanie Arntz et al, “The risk of automation for jobs in the OECD”, www.oecd-ilibrary.org/social-issues-migration-health/the-risk-of-automation-for-jobs-in-oecd-countries_5j1z9h56dvq7-en

30 www.forrester.com/report/The+Future+Of+Jobs+2027+Working+Side+By+Side+With+Robots/-/E-RES119861. J.P.Gownder “The Future Of Jobs, 2027: Working side by side with robots” 3/04/2017

31 Asian Development Bank (ADB): *Asian Development Outlook 2018: How Technology Affects Jobs* (April 2018)

areas. Adaptive learning technology, an educational method that uses computer algorithms designed to adjust to individual students, has enhanced learning outcomes in schools; the ADB believe that governments across Asia should use and promote their adoption. These recommendations could be equally relevant to the UK. Similarly, technological advances in biometric identification can improve how social protection programmes function by reducing costs, overcoming implementation challenges in sophisticated unemployment benefit systems, and enabling the tracking of job-placement services.

There are first adopter advantages and disadvantages at every level. Britain has benefited hugely from being the first industrial nation, but peers quickly caught up, helped by supportive governments and policies that were enacted, because not only were the mistakes that Britain made avoided but also redundant capital was sidestepped. For instance, Germany had a far greater focus on distributed energy supply to electrically powered industrial machinery compared to the UK's focus on local steam and coal powered machinery.

chapter eight

Policy

Earlier this year, the WEF³² identified what they felt were the three key variables, and how by changing the speed at which each of these three changes, there would be eight possible scenarios, with very different implications for work.³³

- *Rate of technical change on business models.* How quickly and broadly recent technical developments are adopted and how quickly and broadly further developments impact business models, will determine the relative stability or volatility of future labour markets. They consider what happens if the current slow pace of technical change and diffusion continues, and what happens if change and diffusion accelerate.
- *Learning evolution.* The key here is the extent to which workers acquire the right skills needed to undertake the tasks required of them in the workplace. Two outcomes are considered: learning outcomes remain in line with the status quo ('slow'), and another in which there is a rapid learning evolution in the current workforce as well as among the students who will form the workforce of the future ('fast').
- *Talent mobility.* They consider two outcomes: one in which labour concentrations largely continue where they currently are ('low'), and another in which labour is highly mobile within and between national borders ('high').

Previous research by the WEF³⁴ included a survey covering firms across nine sectors, in 15 countries, employing over thirteen million workers. 44 per cent believed that the changing work environment and flexible working arrangements were the biggest socio-economic change currently impacting business while mobile and cloud internet technology was the most significant technological trends. The WEF called for business collaboration within industries to create larger pools of skilled talent, as will multi-sector skilling partnerships that leverage the very same collaborative models that underpin many of the technology-driven business changes underway today.

McKinsey³⁵ offer a global outlook on the labour market and the perceived effect of technology. One of the first anomalies they identify is the decline in income paid to workers over capital; the decline is due in part to the growth of corporate profits as a share of national income, rising capital returns to technology investments, lower returns

32 World Economic Forum, January 2018, "Eight Futures of Work", www3.weforum.org/docs/WEF_FOW_Eight_Futures.pdf

33 World Economic Forum in association with The Boston Consulting Group, "Eight Futures of Work: Scenarios and their Implications", January 2018. www3.weforum.org/docs/WEF_FOW_Eight_Futures.pdf

34 www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf World Economic Forum, January 2016, "The Future of Jobs"

35 McKinsey Global Institute: *Technology, Jobs and the Future of Work* (2016).

to labour from increased trade, rising rent incomes from home ownership, and increased depreciation on capital. They also point to the problem of low skill attainment amongst young people. McKinsey found 40 per cent of employers said a lack of skills was the main reason for entry-level job vacancies and sixty per cent said that new graduates were not adequately prepared for the world of work. They go on to forecast 49 per cent of the world economy or 1.1 billion employees (and \$12.7 trillion in wages) were at risk of being affected by automation technologies. Concurrently, 20–30 per cent of workers in the UK and US are engaged in ‘independent’ (gig) work.

This idea of the lower paid being most vulnerable is supported by research from Deloitte³⁶ of the net effect of technology on the UK labour market between 2000 and 2015. The conclusion was that technology led to the loss of over 800,000 lower-skilled jobs. However, on the plus side, it helped create 3.5 million new jobs. Each of these jobs paid on average £10,000 more than the low skilled job lost, adding £140 billion to the UK’s economy.

There are many steps, therefore, that need to be taken. However, the CSJ has outlined three important steps that will ensure Britain both leverages technology to benefit from its many opportunities but also protects against the potential downside.

Policy recommendation 1: Accelerate technology take-up further

While risks from technology, in terms of job losses and keeping the efficacy of regulation, are real, there is no long term good reason to adopt the Luddite approach, fail to invest sufficiently in technology and ban the uptake of new technologies across our economy. The best option for the Government, the economy and wider society is to be ahead of the curve in terms of take-up. This argument is no truer than for the most disadvantaged in society.

As we refer to later, new technologies and industries will create millions of jobs, wages and tax revenue for the Exchequer. However, technology in the future could play a bigger role in helping people access the labour market. Better information of where jobs exist and what those jobs require in terms of skills will help labour markets become more efficient. Jobcentres could be linked to a national labour market exchange that uses an algorithm to match individuals to job opportunities.

Technology is ripe to disrupt the education and skills market. Distance learning has already been made more possible as a result of the internet. However, algorithms and machine learning could help analyse test scores and exam performance to predict which adult learners are struggling in their course. An AI bot could then target that student with extra tailored support, produced by a machine rather than a teacher.

Technology could help support older workers with physical and mental health problems. New monitoring technology could help identify health problems far in advance, reduce the cost of making reasonable adjustments and increase the power of medical staff to react to medical emergencies before they get serious. One of the potential costs to this would be the virtual surrendering of a huge amount of private information.

36 Deloitte: *From Brawn to Brains – The impact of technology on jobs in the UK* (2015)

Policy recommendation 2: Announce a Royal Commission

Technology, AI, and Big Data will radically change our relationships with the state, business, each other and our employer. These socio-economic trends are significant enough for the Government to establish a bipartisan Royal Commission that will be used to inform Government policy over the next generation. A Royal Commission is reserved for multigenerational issues. Previous Royal Commission's in Britain have looked at environmental pollution, long term care for the elderly, the press and the constitution.

Specific areas of focus should include:

- Regulation of companies that use Big Data, personal information and who risk undermining privacy.
- Regulation of autonomous vehicles, including self-driving cars, drones and haulage carriers.
- Regulation of autonomous machines, bots, and AI service providers.
- Public provisions for those who are at risk of unemployment due to technology.
- Digital education and inclusion for the most disadvantaged in society, including high speed broadband coverage across the UK.

With Britain leaving the European Union, there is a big opportunity to redefine regulatory parameters and build a new legal framework for the regulation of 4IR technology.

Policy recommendation 3: Set up local Automation Taskforces

The threat of technology-related unemployment is significant. Jobs in Britain's most important employers are most at risk; retail, manufacturing, transport and logistics. However, there are huge opportunities for helping employers to transition workers within their business. As we pointed out previously,

Transitions can be based on similarities in job competencies – for instance someone working in the mineral production industry can be transitioned in to the construction industry. Equally transitions can be forged between similar industries; the offshore oil and gas industry with the renewable off-shore wind energy sector. Lastly, transferable skills are an easy means of helping an individual transition – the skills of someone in a sales role can be valued in the food and hospitality industry.³⁷

In the CSJ's previous report *Regional Revolution*, we advocated for the creation of Automation Taskforces to be established by each LEP. Each taskforce would be tasked with preparing for the problem of technological unemployment. They would be tasked with liaising between employers, employees, education providers and the public sector, aiming to minimise disruption, maximise transition opportunities for staff within their current employer and smooth the transition to employment for staff that find themselves out of work.

³⁷ Centre for Social Justice, *Regional Revolution* (September 2018)

Co-operation and planning at a local level will be key to prevent mass unemployment, like that experienced across industrial communities in the North, Midlands and Wales during the 1970s and 1980s. It would be negligent for the Government to allow such a major socio-economic disruption to occur without making a plan for those most affected.

Policy recommendation 4: Implement the National Retraining Scheme

There is no doubt that improving the quality of human capital will help workers to weather the negative effects of technology and leverage the positive opportunities that technology presents. The negative effects will include unemployment linked to businesses increasing the role of technology in the production process. As Frey and Osborne found, these aren't solely low skilled jobs. Insurance underwriters, paralegals and traders are at as much risk as machine operators, administrative assistants and telemarketers. Employers, local government, and unions should all work together (though a local Automation Taskforce) to minimise the impact of technological unemployment; as we noted earlier, employers can divert their human capital to other parts of the business where it is more efficient and productive.

The positive opportunities that technology presents for workers include more job opportunities and higher wages. In the last 50 years, the proliferation of PCs and their connection to a global internet has allowed for the incredible growth of online advertising, e-commerce and social networking (to name a few). Alphabet (Google), Amazon and Facebook have between them a revenue of USD327 billion and 742,346 employees. The oldest is Amazon, having been founded in 1994. The next disrupters may come in the form of biotechnology companies, smart home providers, self-driving vehicles and AI assistants. You can envisage a time that wearable technology monitors your health more precisely, interacts with a Smart Home and AI assistant to prepare food and drink autonomously according to what your preferences are and before you get hungry. In the emergence of these new industries, we can expect with a large degree of certainty that millions of jobs will be created and hundreds of billions (if not trillions) of dollars' worth of sales, revenue and wages will be generated. The beneficiaries will be those ready to take-up those opportunities and have the skills that employers in new industries are looking for.

For today's workers to mitigate against the negative and leverage the positive, we need to think radically about training and up-skilling the current British workforce. As we noted in the previous paper, *A Vision for the National Retraining Scheme*,³⁸ the Government have already announced the creation of a National Retraining Scheme and we believe it should focus on the creation of a Personal Learner Account (PLA) for every worker in the country. The PLA would prompt workers to save a small portion of their income each month that would then be ring-fenced for training and up-skilling opportunities. British employers fail to sufficiently invest in skills and training of their workforce. As we found earlier:

McKinsey found 40 per cent of employers said lack of skills was the main reason for entry-level job vacancies and sixty per cent said that new graduates were not adequately prepared for the world of work.

38 Centre for Social Justice, *A Vision for the National Retraining Scheme* (February 2019)

While taxing employers is one possibility, the apprenticeship levy already does this. The PLA encourages employers and employees to contribute small sums over time, sums that could then be used for a college course, a professional license or a qualification from level 2 upwards.

Our report also recommended an overhaul of funding for FE Colleges in the UK. FE has experienced a real-terms cut in funding of almost 10 per cent since 2010. We believe the spending review would offer the Government a good opportunity to make the distribution of funding over post-18 education more equitable for FE.



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