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Automation and the future of work

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Business, Energy and Industrial Strategy Committee

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Summary

The problem for the UK labour market and our economy is not that we have too many robots in the workplace, but that we have too few. In 2015 the UK had just 10 robots for every million hours worked, compared with 167 in Japan. By 2017, we represented just 0.6 per cent of industrial robotics shipments. The UK led the First Industrial Revolution because we embraced new technologies and the opportunities that they create. The risk we face is not a robot takeover of our workplaces, but that our lack of adoption and the reluctance of businesses and the Government to lead the way in the Fourth Industrial Revolution means other countries will seize the initiative and take the advantage of new technologies, not least the growth and jobs they bring, while we are left behind.

While we do not want to dismiss fears about technology replacing workers, we also urge policy makers, businesses and the public to think about the alternatives. If we fall further behind in productivity and the adoption of new technologies, then future investment decisions will not follow. Businesses, investment and jobs will move overseas. The UK's low automation adoption is part of our lagging productivity, especially for SMEs, which is preventing a much-needed rise in economic growth, wages and living standards. Efforts to remedy this has been slow. The abolition of the Manufacturing Advisory Service has left businesses unsure where to look for support, while the Made Smarter Review has shown potential but has so-far been restricted to a single regional pilot.

The UK missed its chance to lead on developing industrial automation, but it should be adopting it. Where we have a new chance to lead and succeed is with service robotics and in AI, but only if we are supporting British businesses and researchers to innovate. The Government needs to provide support for businesses, through research funding and incentives for investment, and for academia, by ensuring our universities have access to researchers, investment and projects from around the world.

The school curriculum has become increasingly narrow in recent years. Yet, the areas in which people have a competitive and absolute advantage over robots is in the in creative industries, design and areas where human interaction is essential. Education and lifelong learning will be crucial to allow workers to retrain in areas where jobs will likely be creates in the years to come, and where tasks are at low risk of automation. We know already that there will be demand for STEM subjects, enabling people to design, build and programme the robotics, automation and data technologies required for the Fourth Industrial Revolution. But we also know that many of the technologies and jobs that people in education now will now have the chance to access in the future are yet to exist. A flexible and relevant school and university curriculum, as well as a large-scale expansion of lifelong learning and reskilling are essential and ensure opportunities don't just fall to those with the 'right' degrees and skillsets, and enables the UK to improve on the only 17 per cent female workforce in the technology sector.

The ownership and use of new technologies, processes and robots is likely to make businesses richer and more powerful. For a fairer society it is important that we consider ownership models of technologies whilst being cautious not to stifle innovation. We have seen from previous inquiries that the practices of businesses such as Amazon and Uber can lead to workers being exploited by increasingly monopolistic firms who earn huge returns that do not flow back to the workers who help create that wealth.

More co-operative ownership models, as well as greater employee engagement, stronger employment legislation and a fairer corporate tax regime are key to ensure public support for the benefits of a growth in automation, a rise in living standards and a fair economy and society.

1 Introduction

Automating Work

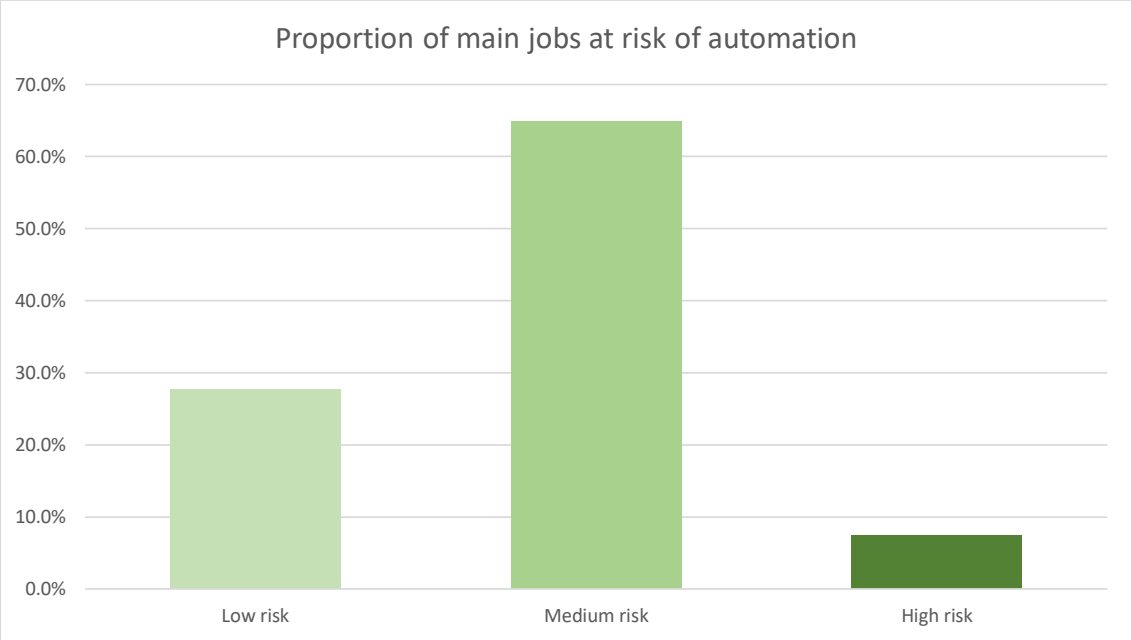
1. The automation of tasks otherwise carried out by people has been a focus for civilisation for more than 2000 years. Waterwheels for processing grain and stone were recorded from 350 BCE in Syria and Egypt.[1] The Industrial Revolution in the nineteenth century saw the wider adoption of automated technology, such as punch-card controlled looms, that would simplify tasks previously done by hand.[2] Such changes were the subject of protest and sabotage as skilled craftsmen sought to prevent the diminishing of their trades.[3] The modern rise of industrial automation and the use of robots in the workplace has trigged similar concerns on the potential impact it could have on the quality and availability of work, albeit so far without the destructiveness of the Luddite movement in the early 1800s.

The Impact of Automation

2. Rapid technological development since the first modern industrial robots in the 1960s combined with the lowering of product costs has triggered an array of studies and statistics, all of which warn of a significant proportion of jobs being at risk from an increase in automation. A 2013 study by Carl Frey and Michael Osborne of the Oxford Martin School, widely cited in the oral and written evidence received by the Committee,[4] predicted that 47 per cent of jobs in the United States were at high risk of automation.[5] In 2018 a more optimistic report from the OECD predicted that while only 14 per cent of jobs in member states were highly automatable, half would be changed by automation.[6] During our inquiry, the Office for National Statistics published its findings on the impact of automation, which put the proportion of UK workers at high risk of automation at 7.4 per cent, but with 64.9 per cent of workers at medium risk.[7]

1 Adriana de Miranda (2007),Water architecture in the lands of Syria: the water-wheels, L'Erma di Bretschneider, pp 37–8
2 PWC, UK Economic Outlook: March 2007, p30
3 As above.
4 See, for example, Department for Business, Energy and Industrial Strategy (AFW0008); Work and Equalities Institute, University of Manchester (AFW0015); Unite the Union (AFW0010)
5 Carl Benedikt Frey and Michael A. Osborne, The Future of Employment, (Oxford, 2013), p 38
6 OECD, Automation, skills use and training (Paris, 2018)
7 Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019

Figure 1: Proportion of jobs at risk of automation



Source: Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019

Alongside each of these high-profile studies comes a wave of reporting that warns people will be losing their job as a result of automation, with no suggestion of when this will happen or what can be done. In 2015, the BBC News website translated Frey and Osborne's study and work from Deloitte into an accessible tool that enabled the public to search for their job and ask whether it will be taken by a robot.[8] Telephone salesmen, typists and legal secretaries using the site would find themselves at most risk, while schools inspectors, hoteliers and publicans could discover they faced the least chance of replacement.[9]

3. In contrast to the negative outlook that a worried worker might get from Frey and Osborne, ONS and the BBC, other commentators have been more positive about the potential impact that automation can have on the future of work. The Trades Union Congress have argued that an increase in technology in the workplace, including automation, could reduce the people needed to work and eventually lead to a four-day working week.[10] Andy Haldane, Chief Economist at the Bank of England, who has previously warned of 15 million people affected and the hollowing-out of mid-skilled tasks[11] argues that automation could bring about a new focus on better, more creative jobs and shorter working hours.[12] While acknowledging the challenges raised in existing studies, the previous Government was "optimistic" about the impact of automation on the future of work on jobs and productivity, despite basing its predictions on the same studies negative studies we have cited.[13]

8 Will a robot take your job? BBC News, 11 September 2015
9 As above.
10 The fourth industrial revolution can benefit everyone, but only if unions are involved, TUC Blog, 7 September 2017; and, TUC calls for new tech to pave way to shorter working week and higher pay, TUC Press Release, 10 September 2018.
11 Speech by Andrew G Haldane, Chief Economist, Bank of England, Ideas and Institutions: A Growth Story, 23 May 2018; and Speech by Andrew G Haldane, Chief Economist, Bank of England, Labour's Share, 12 November 2015.
12 Speech by Andrew G Haldane, Chief Economist, Bank of England, The Creative Economy, 22 November 2018; and Bank of England Close to Endorsing the Four-Day Week, Gizmodo, 11 June 2019.
13 Q275 [Stephenson]; and, Department for Business, Energy and Industrial Strategy (AFW0008)

Our Inquiry

4. While there is little consensus about the full impact that the growth of automation will have on the workplace, there is no suggestion that it can or should be prevented from happening. Rather than producing a further study that warns of the effects that automation could have and adds to concerns, we have undertaken this inquiry to examine how businesses, workers and the Government should prepare for and manage this transition, and to consider the UK's current and potential strengths in the automation sector. Our focus has been on physical automation—robotics and autonomous systems—rather than the wider role of Artificial Intelligence (AI), which has been considered in detail by an ad hoc House of Lords Select Committee that reported in 2018.[14] Our inquiry includes consideration of the skills and retraining that will be required to deal with a more automated workplace, but we heard throughout the inquiry that there needs to be more action to improve the pipeline of people interested and able to work with automation. We welcome the work of the Education Select Committee who have examined this challenge in their recent inquiry into the Fourth Industrial Revolution.[15]

5. We invited evidence from businesses, trades unions, universities and other interested parties on the impact of automation on the quality and availability of work, the role of Government in reskilling, the effect it is having on businesses and the potential it has for productivity, growth and reindustrialisation. We also sought evidence on the opportunities for the UK's tech sector and academia to become a world leader in automation technologies. We received 39 pieces of written evidence and held four oral evidence sessions, hearing from robotics developers and manufacturers, businesses who have been at the forefront of automation, trades unions, leading robotics academics and experts on the world of work, including from the newly formed Institute for the Future of Work.

6. At the start of our inquiry, the Committee visited Tokyo and Kitakyushu in Japan to examine the country's role as the world leader in industrial robotics and a nation that has embraced automation as both necessary and desirable to meet the challenges faced for the future of work.[16] The Committee also held a private briefing with Professor Mark Kennedy of Imperial College London and visited Bristol Robotics Laboratory, a collaboration between the University of the West of England and the University of Bristol. Our work has also been informed by earlier visits to the Manufacturing Technology Centre in Ansty and the Advanced Manufacturing Research Centre in Sheffield, both part of the High Value Manufacturing Catapult. We are grateful to all those who contributed to our inquiry.

14 House of Lords, Select Committee on Artificial Intelligence, Session 2017–19, HL Paper 100

15 Education Committee, Inquiry into the Fourth Industrial Revolution, Session 2017–19

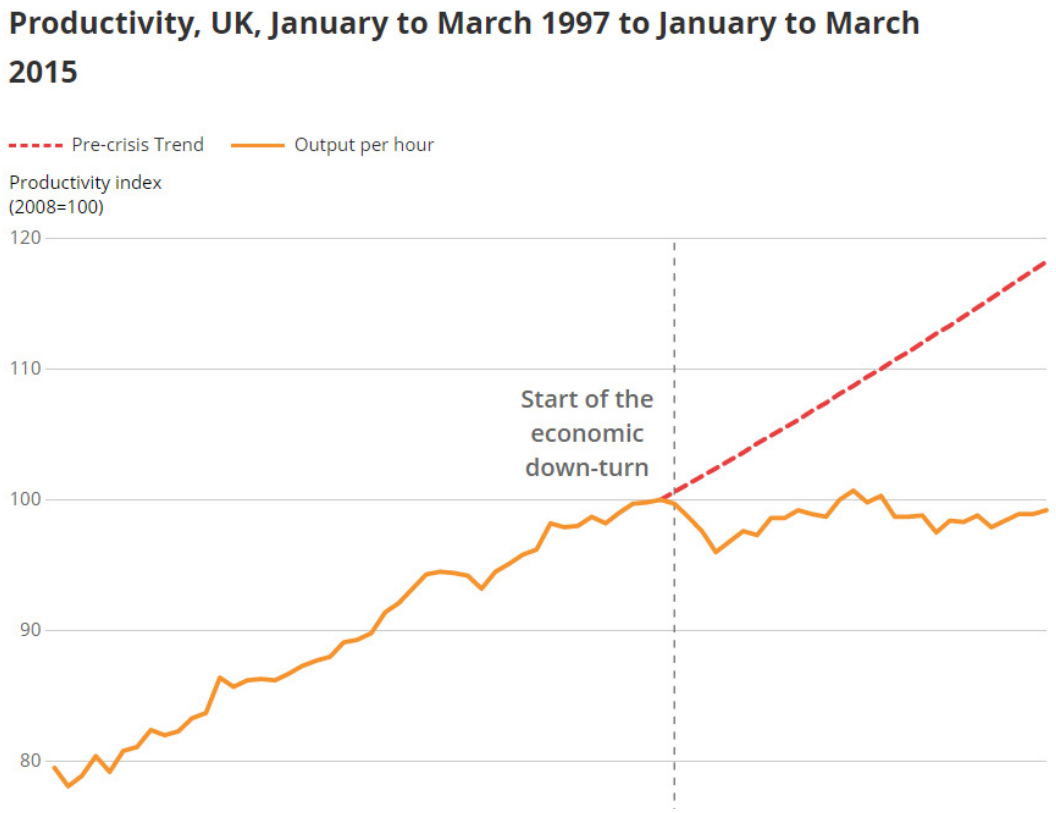
16 See Annex for details of the visit programme.

2 Automation Adoption

Productivity

7. Productivity in the UK—the measure of the country's efficiency in the production of goods and services—has grown much more slowly since the 2008 economic downturn than it had previously, despite other economic measures improving at their previous rate.[17] The reasons for the country's slow productivity growth, described as 'the Productivity Puzzle', are difficult to identify due to the large number of variable inputs for productivity and the means by which they can be affected.[18] The previous Government made boosting productivity the focus of their Industrial Strategy, promising to do so with investment in skills, industries and infrastructure.[19] We have examined the puzzle and the Government's attempt to solve it during our inquiries into Small Businesses and Productivity and into the Industrial Strategy's Sector Deals,[20] and are considering regional productivity disparities as part of our current inquiry into regional investment and growth.[21]

Figure 2: The Productivity Puzzle (ONS)



Source: Office for National Statistics, What is the Productivity Puzzle?, July 2015 (accessed 5 July 2019)

17 Office for National Statistics, Labour Productivity Statistics: January to March 2019, 5 July 2019 (accessed 6 July 2019)

18 Office for National Statistics, What is the Productivity Puzzle?, July 2015 (accessed 5 July 2019)

19 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017, p 11

20 Business, Energy and Industrial Strategy Committee, Fifteenth Report of Session 2017–19, Small Businesses and Productivity, HC 807; and, Business, Energy and Industrial Strategy Committee, Seventeenth Report of Session 2017–19, Industrial Strategy: Sector Deals, HC 663

21 Business, Energy and Industrial Strategy Committee, Inquiry into Regional Investment and Growth, Session 2017–19

8. Automation in the form of industrial robotics encompasses a wide range of sectors, from the high-profile and long-standing role they have building and finishing products in the automotive industry, to growth sectors like the pharmaceutical, cosmetics, food and beverages industries.[22] The automated solutions employed range from complex industrial systems provided by multinational automation businesses such as Mitsubishi, Fanuc, KUKA, Siemens and ABB to simple programmable robotics arms that can be bought and used by businesses with minimal set-up and intervention.[23] Research covering the years 1993 to 2007 identified industrial robotics as a contributor to the growth of labour productivity and value-added productivity across industrialised nations, accounting for as much as a tenth of aggregated growth.[24]

9. Ocado, a British company at the global forefront of retail automation and bespoke industrial robotics, told us that automation had doubled the productivity of their warehouse operations.[25] However, the potential productivity boost of robots that could benefit the wider UK economy has not yet been seen across the wider economy.[26] No one who contributed to our inquiry disputed that increased automation could improve productivity, but a range of factors, in common with some of the causes of the productivity puzzle, are holding UK businesses back.[27] These include:

- management who don't understand or recognise the potential of automation;
- a lack of digital skills among parts of the workforce; and,
- business environments where new technology does not coalesce with existing practices.[28]

As, Kate Bell, Head of Policy at the Trades Union Congress (TUC) explained to us: "we do not invest enough in technology or get the most out of it."[29] We agree.

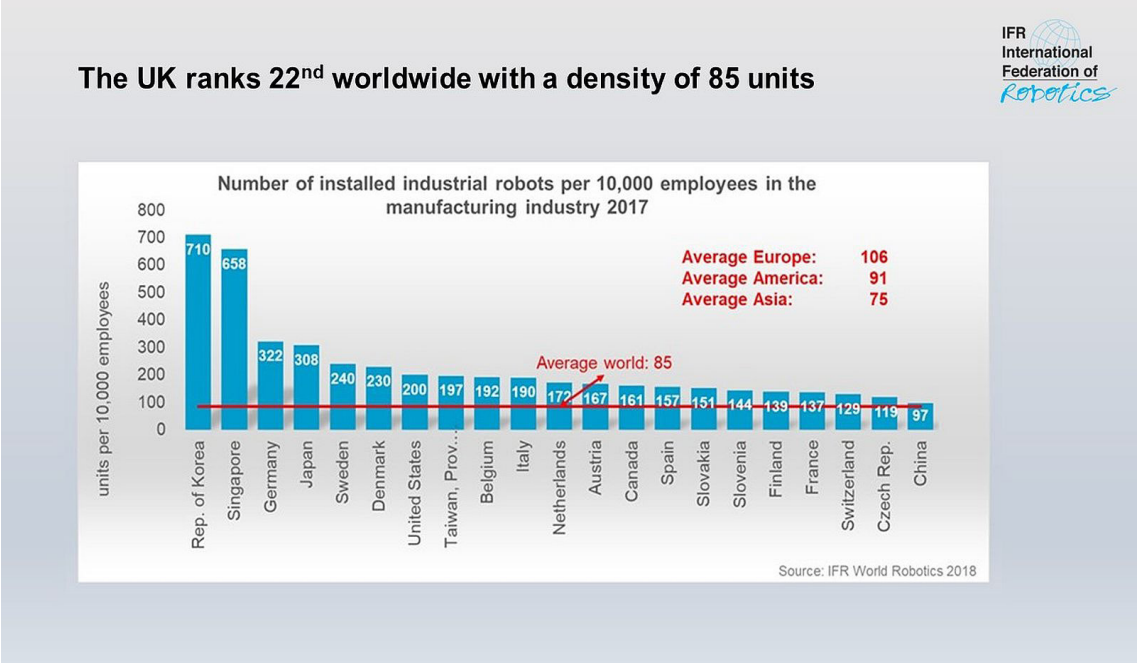
Global Comparators

10. The UK is lagging far behind its international competitors on the adoption of automation. Five major industrial robotics markets represent 73 per cent of the total global sales volume in 2017: China, Japan, the Republic of Korea, the United States and Germany.[30] In 2017 the UK accounted for only 0.6 per cent of annual global shipments of industrial robots and 3.5 per cent of European shipments.[31] The UK's adoption rate lags behind any of our G7 competitors and only by 2017 had the UK managed to reach the worldwide average of 85 robots per 10,000 workers, having previously been the only G7

22 International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018, p 16
23 Q125 [Palmer]
24 Centre for Economic Performance, CEP Discussion Paper No 1335: Robots at Work, March 2015, p 21
25 Q104 [Richardson]
26 Qq204–205 [Brinkley]
27 ABB (AFW0014); Manufacturing Technology Centre (AFW0006); Department for Business, Energy and Industrial Strategy (AFW0008); Unite the Union (AFW0010)
28 Q116 [Ali]
29 Q217 [Bell]
30 International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018, p 16
31 International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018, p 21

nation to have fewer robots than the global average.[32] Sales of industrial robots to the UK actually decreased in the period between 2014 and 2015, at a time when the UK had just 10 robots for every million hours worked, compared with 131 in the US, 133 in Germany and 167 in Japan.[33]

Figure 3: Worldwide Robot Density 2017



Source: Brexit: UK falling back in global automation race–robot sales down 3%, International Federation of Robotics Press Release, May 2019

11. Japan has more than 297,000 industrial robots in use and a 23 per cent share of all robots in the world.[34] On our visit, Ministry for Health, Labour and Welfare officials were clear that the demographic change facing Japan was the major driver for an increase reliance on automation. Necessity is the mother of invention. The size of the Japanese population peaked in 2008, meaning a declining population combined with an increasing proportion of citizens beyond retirement age. With a reluctance to increase immigration beyond a limited number of temporary visa schemes, and slow growth of the proportion of women remaining in work, the Japanese Government has turned to focus on automation to ensure that a worker shortage across all employment status and job type could be managed.[35]

Robot Strategy

12. Yet, the Japanese focus on automation is not solely a response to its demographic challenges. The Government has identified and welcomed the potential impact it could have on productivity and has long supported the automation industry, identified by the

32 Q5 [Bouchier]; and, Brexit: UK falling back in global automation race – robot sales down 3%, International Federation of Robotics Press Release, May 2019

33 Trades Union Congress, A Future that Works for Working People, September 2018, p 11

34 University of Tokyo, Japan: The Land of Rising Robotics (accessed 8 July 2018) and Why Japan leads Industrial Robot Production, International Federation of Robotics Blog, December 2018 (accessed 8 July 2019)

35 Private discussion with Japanese Ministry for Health, Labour and Welfare, see Annex.

Ministry for Economics, Trade and Industry (METI) as a "robotics superpower".[36] It has a long history of automation and is home to major robotics manufacturers such as Fanuc, Denso and the Yaskawa Electric Corporation. As a manufacturer, Japan is the origin for half of robots sold globally.[37] The Japanese Government has made a conscious choice to support automation as part of its 'Abenomics' reforms, recognising the need for continued growth and development of automation to enable the country to "drastically improve productivity,"[38] having faced a similar lack of productivity growth as the UK.[39] Actions to date include the creation of a Robot Revolution Realisation Council in 2014 and the New Robot Strategy in 2015., which promises to create a "new Industrial Revolution" in Japan through the use of robots.[40]

Box 1: Japan's New Robot Strategy

The New Robot Strategy includes plans for Japan to further itself as the robot innovation hub of the world, the world's leading robot utilisation society, and the world leader on robotics in the Internet of Things, which is focused on the use of big data, networking and artificial intelligence.[41]

For industrial robotics this means a target by 2020 of a 25 per cent rate of robot automation for large-scale companies and a 10 per cent increase for small and medium-sized enterprises (SMEs), focusing on areas and industries where automation has previously been difficult.[42] The strategy also aims for significant growth in sectors beyond established industrial robotics, seeking to be world-leading in the utilisation of nursing and medical automation, infrastructure, disaster and construction robotics and automated agriculture and food production.[43]

During our visit, METI officials were optimistic about delivering the goals of the first five years of the New Robot Strategy, and were preparing for the World Robot Challenge that will coincide with Tokyo's hosting of the 2020 Olympics.[44] NTT Data, who presented us with an overview of their work in collaboration with Daiwa Taxi and Gunma University, are developing technology to enable visitors to the Olympics to be transported around the city using a new network of autonomous vehicles.[45]

13. While other nations make significant investment in technology a failure to automate risks our global competitiveness. As Tom Bouchier, Managing Director of Fanuc UK told us: "we cannot put this automation genie back in the bottle somehow".[46] **The UK's progress on automation, to ensure its industries are globally competitive, has not**

36 The Headquarters for Japan's Economic Revitalization, Japan's Robot Strategy, February 2015, p 3
37 University of Tokyo, Japan: The Land of Rising Robotics (accessed 8 July 2018)
38 The Headquarters for Japan's Economic Revitalization, Japan's Robot Strategy, February 2015, p 14
39 Office for National Statistics, International comparisons of UK productivity (ICP), final estimates: 2016
40 Robot Revolution Realization Council, Office of the Prime Minister of Japan Press Release, 23 January 2015; and, Ministry for Economy Trade and Industry, Government of Japan, Japan's New Robot Strategy Presentation, April 2018
41 Ministry for Economy Trade and Industry, Government of Japan, Summary of Japan's Robot Strategy - Its vision, strategy and action plan, January 2015, p 2
42 Ministry for Economy Trade and Industry, Government of Japan, Summary of Japan's Robot Strategy - Its vision, strategy and action plan, January 2015, p 7
43 Ministry for Economy Trade and Industry, Government of Japan, Summary of Japan's Robot Strategy - Its vision, strategy and action plan, January 2015, pp 7–9
44 World Robot Summit, Challenge Guidelines, accessed 11 July 2019
45 Private discussion with NTT Data, see Annex; and, NTT Data, Gunma University to test self-driving ride services on public roads near Toyosu, Japan Times, 13 September 2018
46 Q14 [Bouchier]

been fast enough. The UK's problem is too few, not too many, robots. The potential for an increase in automation to help tackle the Productivity Puzzle and improve living standards has not yet been effectively addressed by the Government. ***We recommend that the Government should develop a UK Robot and AI Strategy by the end of 2020 to improve automation adoption and support British industries. The remainder of this report includes some of the key measures we expect to see in the Government's new strategy.***

3 Automating UK Businesses

Reindustrialisation

14. During visits to the Advanced Manufacturing Research Centre in Sheffield, and the Manufacturing Technology Centre (MTC) in Ansty, we saw examples of new technologies, including automation, that would improve the efficiency and quality of UK manufacturing, if adopted.[47] Businesses, trades bodies and organisations including the MTC were optimistic with us about the potential that automation has to lead to reindustrialisation in existing UK industries, a view shared by the Government.[48] The Institute of Mechanical Engineers were optimistic that if intelligent automation was adopted more widely in the UK, it would provide an opportunity for us to leapfrog other nations who are currently more automated and more productive.[49] Other membership bodies such as techUK and the Royal Academy of Engineers were positive about the potential for reindustrialisation, but suggested that it would be unlikely to trigger a revival of declining industries, instead leading to a growth in new sectors.[50] A small proportion of those who submitted evidence to us were sceptical about the opportunities for reindustrialisation. The Association of Accounting Technicians did not believe it to be a likely outcome, citing economist Jean-Luc Biacabe who suggests that a natural trend towards more services could not be overcome by industrial automation,[51] while the trade union USDAW told us that reindustrialisation was unlikely without significant policy changes and long-term investment from Government.[52]

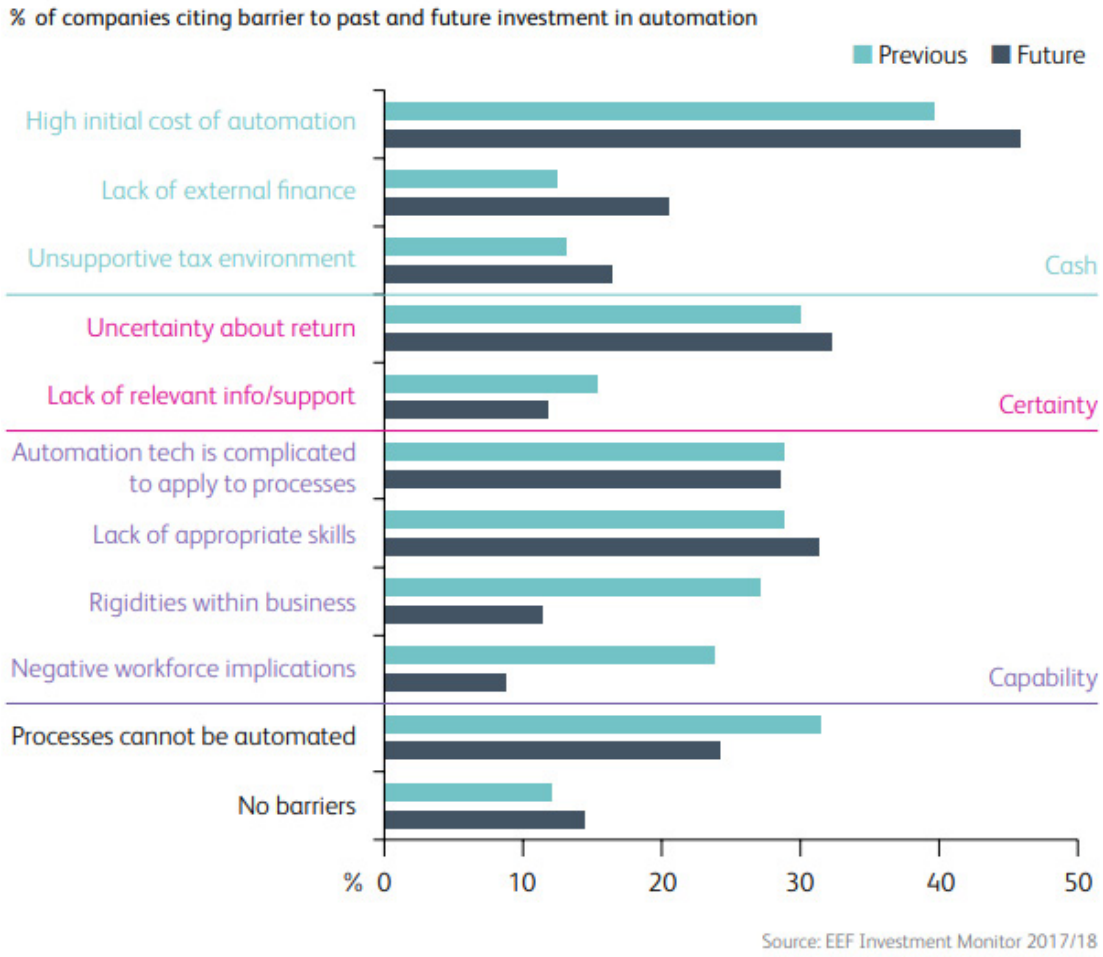
15. A 2016 study from the Oxford Martin School, commissioned by Citigroup, found that the reshoring of some industries, where they form part of a supply chain and can be located in a geographically critical hub, was likely.[53] 70 per cent of businesses surveyed agreed with this view, although the majority of those who responded believed that this would be only to a minor degree.[54] The MTC, who are working with manufacturing businesses and other technology developers, identified automation as a driver for several companies reshoring manufacturing back to the UK, and as a preventative measure for avoid companies deciding to relocate or offshore in the first place.[55] In evidence to us Make UK—the manufacturers' organisation—did not see automation as a "silver bullet" that would guarantee reindustrialisation, but would make the UK more competitive as a manufacturing nation.[56] **It is clear to us that the future of manufacturing in the UK depends on higher levels of productivity. Robotics and automation provide possibilities to enhance productivity and therefore support higher production and more jobs in the UK.**

47 Q70 [Hadall]
48 ABB (AFW0014); Siemens plc (AFW0012); Ditto AI Limited (AFW0020); British Automation and Robot Association (AFW0037); British Institute of Facilities Management (AFW0041); Manufacturing Technology Centre (AFW0006); Department for Business, Energy and Industrial Strategy (AFW0008)
49 Institution of Mechanical Engineers (AFW0032)
50 techUK (AFW0042); Royal Academy of Engineering - Engineering the Future (AFW0040)
51 Association of Accounting Technicians (AAT) (AFW0005)
52 Usdaw (AFW0017)
53 Oxford Martin School, Technology at Work v2.0, January 2016, p 27
54 As above.
55 Manufacturing Technology Centre (AFW0006)
56 EEF, the manufacturers' organisation (AFW0038) (note: since submitting evidence EEF has been renamed as Make UK)

Barriers to Automating

16. For Make UK, the UK's low automation adoption rate can be blamed on three Cs: cost, certainty and capability.[57] These are the same challenges that face the adoption of all new technologies by businesses. Make UK's 2017/18 business investment report breaks down these issues in more detail (see Figure 4) with the high initial cost of automation and an uncertainty on the time taken to recoup the value of investment being the most significant barriers.

Figure 4: Barriers to Automation Investment



Source: EEF and Santander, EEF Investment Monitor 2017/18, 2018, p 16

The complex nature of automation and the lack of availability of skills required to deal with it are also among the greatest perceived barriers. We have considered the lack of digital skills and awareness as part of our previous inquiry into Small Businesses and Productivity,[58] While there has been some progress, it remains a challenge for businesses, especially SMEs, to develop themselves and their employees on even simple technologies.[59] It is therefore of little surprise that automation is perceived as difficult and potentially incompatible with current ways of working for many businesses.

57 EEF, the manufacturers' organisation (AFW0038)

58 Business, Energy and Industrial Strategy Committee, Fifteenth Report of Session 2017–19, Small Businesses and Productivity, HC 807, para 53

59 Q122 [Ali]

17. Fewer than 15 per cent of businesses surveyed by Make UK cited a lack of relevant information and support as a barrier to automating.[60] However, from the evidence we received, it seems likely that misconceptions or a lack of awareness are partly to blame for the other perceived barriers. Witnesses with experience in the automation sector, and the Minister, told us that costs of automation were falling but that businesses were unaware of the lower costs and the increased rates of return, often recouped within just one to two years of adoption.[61] Businesses working in the automation sector admitted to us that they have been slow to counter these misconceptions.[62]

18. 98 per cent of manufacturing businesses were unable to identify potential benefits that automation could have for their work, such as increases in productivity and quality and a reduction in production errors.[63] **Some of the barriers to automation identified by UK businesses are real, and we make recommendations throughout this report on how they can be overcome. However, some of the barriers to automation are issues of perception.** ***We recommend that the Government works with the automation industry and businesses who have introduced automation to make information and case studies on the costs and benefits of automation easily available to businesses.***

Made Smarter

19. In 2017, industries and Government supported Siemens UK's Chief Executive, Professor Juergen Maier, to deliver an independent review into industrial digitalisation, including robotics, artificial intelligence, the Internet of Things and data analytics. Initially intended as leading to a Sector Deal in line with the Industrial Strategy Green Paper,[64] the resultant Made Smarter Review published in October 2017 intended to "drive UK manufacturing growth, productivity and transformation".[65] The review found that the positive impact of faster innovation and adoption of industrial digitalisation technology could be as much as £455 billion for UK manufacturing over the next decade, increasing manufacturing sector growth by up to three per cent per annum, creating an estimated net gain of 175,000 jobs throughout the economy and reducing CO_2 emissions by 4.5 per cent.[66]

60 EEF and Santander, EEF Investment Monitor 2017/18, 2018, p 21
61 Q18 [Bouchier]; Q115 [Ali]; Q267 [Lane, Prescott, Jennings]; Q296 [Stephenson]
62 Q18 [Bouchier]
63 EEF and Santander, EEF Investment Monitor 2017/18, 2018, p 19
64 Department for Business, Energy and Industrial Strategy, Building Our Industrial Strategy: Green Paper, January 2017, p 105
65 Business leaders and academics join forces with government to make manufacturing 'smarter', Department for Business, Energy and Industrial Strategy Press Release, 27 September 2018
66 Department for Business, Energy and Industrial Strategy, Made Smarter Review, October 2017, p 8; and, Q12 [Holliday]

Box 2: Recommendations of the Made Smarter Review

Adoption. Build a national digital ecosystem that will be significantly more visible and effective and that will accelerate the innovation and diffusion of industrial digital technologies. This includes a National Adoption Programme to be piloted in the North West, focused on increasing the capacity of existing growth hubs and providing more targeted support. Critical to the success of our recommendations will be the upskilling of a million industrial workers to enable digital technologies to be adopted and exploited through a single Industrial Digitalisation Skills Strategy.

Innovation. Refocus the existing innovation landscape by increasing capacity and capability through 12 Digital Innovation Hubs, 8 large-scale demonstrators, and 5 digital research centres focused on developing new technologies as part of a new National Innovation Programme.

Leadership. Establish a national body, the Made Smarter UK (MSUK) Commission, comprising industry, government, academia, further education, and leading research and innovation organisations, which would be responsible for developing the UK as a leader in industrial digitalisation technologies and skills, with a mandate to develop the UK's own Industry 4.0 domestic and global brand.[67]

20. The Made Smarter Review has identified some of the causes of low adoption of industrial digitalisation technologies, including automation, and seeks to:

> see more widespread and rapid adoption of new technologies by manufacturers (especially SMEs), and across their supply chains, through the creation of a significantly more visible and effective ecosystem that will accelerate the innovation and diffusion of the technologies.[68]

The first step in achieving this is the Made Smarter North West pilot, a programme intended to boost UK manufacturing productivity and growth across the North West, delivered in partnership with the Greater Manchester Combined Authority, North West Local Enterprise Partnerships and North West Business Growth Hubs.[69] Since its launch in November 2018, SMEs in the pilot region are offered fully-funded specialist advice to assess operations and develop a digitalisation strategy, 50 per cent grant funding for technology investments and access to information and placements to support the programme.[70]

21. The Made Smarter Review and the North West pilot have been welcomed by automation businesses and manufacturers.[71] There has been significant interest in the pilot, which signed up more than 140 businesses in the first two months.[72] Before the pilot was launched in January 2019, we were told that progress on implementing the recommendations of the Made Smarter Review had been slow, with the focus being on a Sector Deal that has not materialised.[73] Manufacturers were supportive of the Made Smarter approach, but called for additional measures such as sector specific support,

67 Department for Business, Energy and Industrial Strategy, Made Smarter Review, October 2017, p 4
68 Made Smarter UK, The National Landscape (accessed 10 July 2019)
69 Made Smarter UK, North West Pilot (accessed 10 July 2019)
70 As above
71 Q12 [Funnell, Holliday]; Q290 [Stephenson]; Q306 [Stephenson]; EEF, the manufacturers' organisation (AFW0038)
72 Q140 [Funnell]
73 ABB (AFW0014); British Automation and Robot Association (AFW0037)

including narrower Sector Deals, to increase automation.[74] Following the pilot launch, witnesses from the automation and engineering sectors encouraged the Committee to support the work of Made Smarter to help progress it beyond this stage and expand the its reach to other SMEs to learn about automation.[75] We are happy to do so, but we are also concerned that it represents almost the entire extent of the Government's attempt to increase automation in UK businesses, and despite BEIS being enthusiastic to wide its coverage, signs of progress remain slow.[76]

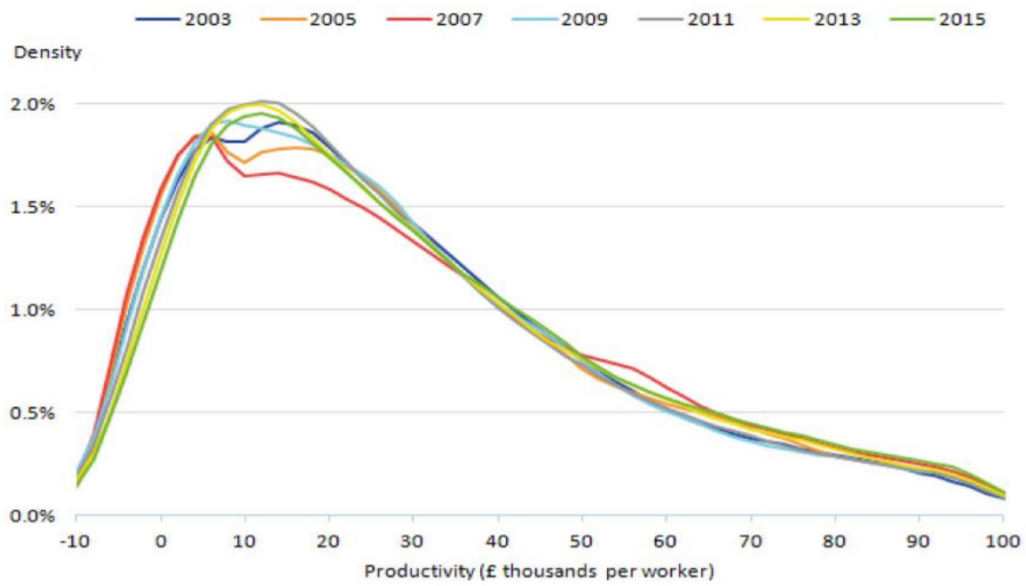
22. **Made Smarter has the potential to boost UK productivity in SMEs through the adoption of new technology, and while take-up of the North West pilot has been impressive, overall progress has been slow.** ***We recommend that in responding to this report, the Government provides a timeline for the evaluation of the North West pilot and commit to a fully-funded roll-out of the scheme across the UK based on the results of that work.***

SMEs

23. The UK suffers from a 'long tail' of low-productivity businesses that are contributing to the UK's overall productivity gap (see Figure 5).[77] Many of these are SMEs who, as the Minister told us, "lack access to finance, knowledge, or managerial and leadership skills."[78] SMEs are also the businesses most likely to lack digital skills and most unlikely to adopt technology, with an automation adoption rate of only four per cent, compared to 28 per cent of large businesses.[79] In his evidence to us, the Minister raised the high proportion of SMEs in the UK economy as one of major reasons for which overall automation adoption is low.[80]

74 EEF, the manufacturers' organisation (AFW0038)
75 Q49 [Holliday]; Q68 [Sillem]; Q265 [Lane]
76 Q290 [Stephenson]; Q305 [Stephenson]
77 See for example: Inside the project to fix Britain's low-performing businesses, Financial Times, August 31 2017; and, Speech given by Andrew G Haldane, Chief Economist, Bank of England, Productivity Puzzles, 20 March 2017
78 Q297 [Stephenson]
79 RSA, Automation on Our Own Terms, (accessed 6 July 2019)
80 Q299 [Stephenson]

Figure 5: Long Tail of Low-Productivity Businesses (Distribution of real firm-level productivity, Great Britain, 2003–2015 (ONS))

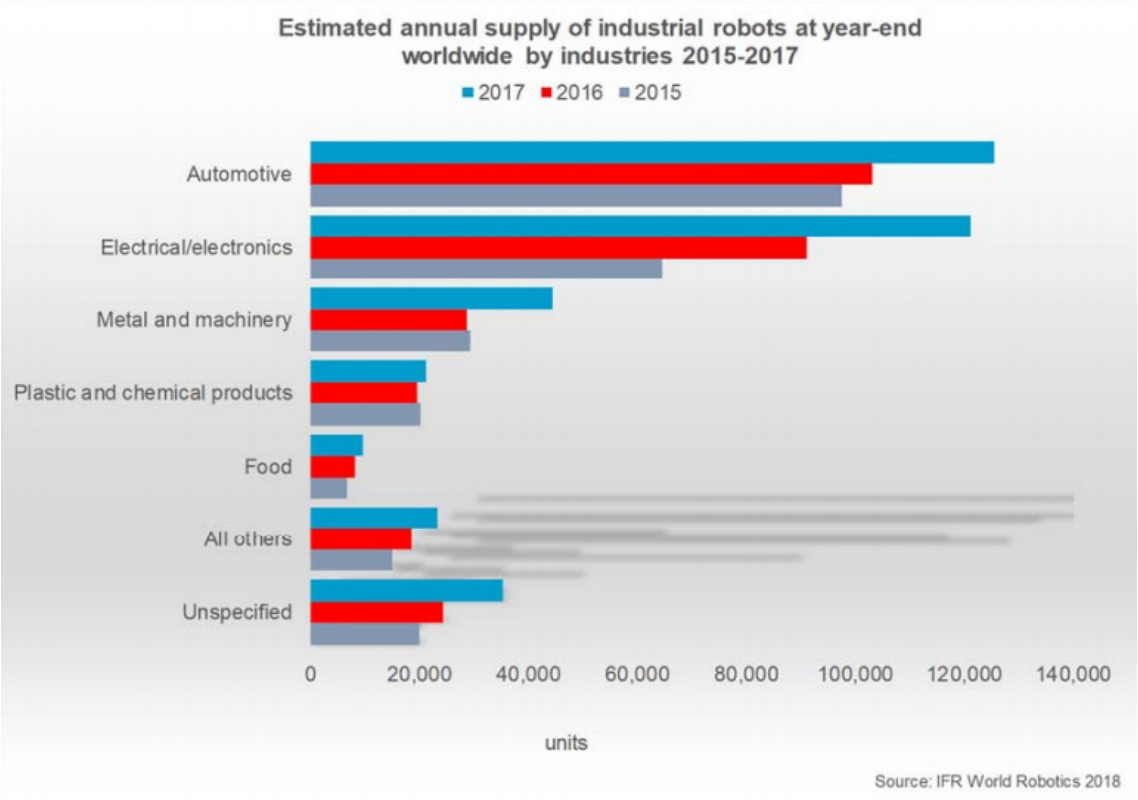


Source: Department for Business, Energy and Industrial Strategy, Business Productivity Review: Call for Evidence, May 2018, p 13

24. While it is not the case that all SMEs should be looking to automate, there are many businesses who are missing out on the benefits of automation adoption only because they are small businesses.[81] Globally, the most automated businesses are those in the automotive and electrical and electronics sectors (see Figure 6 below). However, automation is increasingly being adopted across other industries, and more widely through the supply chains for the existing highly-automated industries. As Make UK set out in their evidence to us, the Government's current approach to business support, such as the Industrial Challenge Fund, favours new, innovative or highly productive industries.[82] There is a potential for significant cost advantages for SMEs automating, according to the Institute for Mechanical Engineers, but up-front capital costs have been a barrier to investment.[83] However, focused support on SMEs with the potential to automate could enable a productivity boost at the firm level, and a diffusion of technology and expertise that could benefit supply chains, regions or ultimately UK productivity.[84]

81 Q67 [Sillem]
82 EEF, the manufacturers' organisation (AFW0038)
83 Institution of Mechanical Engineers (AFW0032)
84 Manufacturing Technology Centre (AFW0006)

Figure 6: Automation Adoption by Industry



Source: International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018

25. Businesses which have the potential to automate, including SMEs, could seek bespoke automation solutions, but many of those who can automate do not need or want complicated customised technology and could automate using simple 'off-the-shelf' solutions.[85] The challenge is to communicate this to SMEs. Jeremy Hadell, Chief Engineering at the MTC, told us that SMEs are keen to talk to bodies who know about automation, but do not have the time to engage with methods more intended for larger business.[86] The then Minister, experienced in running a small business himself, shared this frustration.[87] While the High Value Manufacturing Catapult, of which the MTC is a part, has a fund to reach out to SMEs who want to automate, the £14 million available per annum is seen by some, such as the Institute for Mechanical Engineering, as inadequate to cover the variety of sectors who are or could benefit from automation.[88]

26. Just as automation businesses struggle to communicate with SMEs, so SMES struggle to find a way to engage with automation businesses. Manufacturers have found that the current array of local and national Government institutions can be difficult to navigate for small businesses who are seeking independent and authoritative advice.[89] The British Automation and Robot Association (BARA), a trade body for the automation industry, has called for a simple and coordinated means of communication to raise awareness of

85 Q115 [Ali]
86 Q72 [Hadall]
87 Q297 [Stephenson]
88 Institution of Mechanical Engineers (AFW0032)
89 ABB (AFW0014); British Automation and Robot Association (AFW0037)

automation and improve access to it.[90] While BARA do not prescribe a specific solution, Brian Holliday, Managing Director of Siemens Digital Factory highlighted the closure of the Manufacturing Advisory Service in 2015, an impartial agency funded by the Government to offer technical and strategic advice and signpost further resources, including funding, as a big loss[91] Those who used the service welcomed the stability of support, local availability of advisors and their manufacturing knowledge and the project approach to delivery.[92] An industry-led version of the Manufacturing Advisory Service was launched in 2017, however unlike its predecessor, it is now only a portal for articles about manufacturing and cautions visitors to its website that it is unable to provide official or up-to-date information.[93]

27. **A lack of awareness and understanding of automation is harming business productivity, especially for SMEs. The Government's decision to close the Manufacturing Advice Service in 2015 was a mistake and has contributed to making it more difficult for businesses to find help and advice.** ***We recommend that the Government funds an impartial source of advice for businesses that want to invest in automation. This new service should be commissioned with a focus on ensuring it is fully accessible to SMEs, building on the experience of successful examples like Be the Business.***

90 British Automation and Robot Association (AFW0037)
91 Q46 [Holliday]
92 EEF, the manufacturers' organisation (AFW0038)
93 Manufacturing Advice Service, About Us (accessed 9 July 2019)

4 Automation and the Industrial Strategy

UK as a World Leader

28. There are a range of technologies where automation can improve productivity, work and life, and where the UK has the potential to excel. The Government has chosen in its Industrial Strategy to embrace AI and data as one of its four Grand Challenges, a move that witnesses from whom we heard supported.[94] However, many of those who mentioned our AI prospects also highlighted our potential to lead in healthcare robotics and other parts of the service robotics sector.[95] Although UK businesses are already delivering some world leading products, such as bionic arms from Bristol-based Open Bionics, for us to fully deliver on this potential, there will need to be a shift in how businesses and researchers are supported.[96]

29. Parliamentarians in the Japanese Diet singled out the UK's university research base as a major strength and an area from which Japan can learn.[97] The UK already has a range of centres of academic research and collaboration on automation, including Bristol Robotics Laboratory, the Edinburgh Centre for Robotics, Sheffield Robotics and Imperial College London. We examine the potential for UK research and innovation, including these institutions further in Chapter 5. The Committee visited Bristol Robotics Laboratory (BRL) in October 2018, where we met with academics and students, alongside the Mayor of the West of England, Tim Bowles, and saw first-hand their work on emerging technology. Rather than the established forms of automation seen on factory floors, BRL demonstrated work on wearable robotics, health and social care support solutions, connected and autonomous vehicles and swarm robotics.[98] While a fleet of connected and autonomous vehicles could ultimately see the replacement of drivers, the majority of technologies we saw in development were collaborative and would support workers rather than replace them. By comparison, at the University of Tokyo's Department of Mechano-Informatics in September 2018, we saw students and researchers focused on developing humanoid-style robots to undertake existing, currently difficult to replicate, repetitive tasks usually done by workers, such as picking and moving products or sorting items. This was part of a three-pronged approach to developing automation, focusing on labour support for workers, lifestyle support for older people, and household and care support for families.[99]

30. Comparing the fields of work undertaken by BRL, and the work by the other UK robotics centres from which we heard, there is a clear overlap with the Grand Challenges set out by the previous Government in its Industrial Strategy White Paper.[100] Beyond AI and data, which underpin many new forms of automation, the grand challenge on the ageing society will benefit from new forms of medical, health and social care robotics, the grand challenge on the future of mobility requires connected and autonomous vehicles, while the grand challenge on clean growth will need to be supported by new technologies

94 IS;Q123 [Ali]; Q236 [Jennings, Prescott]; Q309 [Stephenson]
95 Q63 [Sillem]; Q236 [Lane, Prescott]; Q309 [Stephenson]
96 Open Bionics, About (accessed 7 July 2019)
97 Private discussion with Japanese Diet Parliamentary Group on the Promotion of Robot Policy, see Annex
98 Bristol Robotics Laboratory hosts Commons select committee, University of the West of England Press Release, 26 October 2018
99 Private discussion with academics and students at University of Tokyo Graduate School of Information Science and Technology, Department of Mechano-Informatics, see Annex
100 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017 p 10

to support the delivery of low-carbon energy. However, the Industrial Strategy, as published in 2017, makes almost no reference to the potential for robotics. **Developing the UK as a leader in service robotics has the potential to make a significant contribution to the delivery of the Government's Grand Challenges.** ***The Government should ensure that a UK Robot Strategy forms part of the Government's Industrial Strategy, and that robotics is considered an integral part of all of the Grand Challenges it is pursuing.***

Government Action

31. The UK's potential as a world leader in automation depends on businesses being able to both develop new technologies and to commercialise these successes. Success stories of UK tech businesses, such as Cambridge-based semiconductor firm Arm Holdings, are often bought out by large multinationals, in Arm's case the Japanese conglomerate SoftBank Group.[101] Although the acquisition of successful UK companies is a welcome sign of business strength in the technology sector, the lack of large, successful British-owned success stories should be of concern to the Government.

32. The Government's Industrial Strategy does include measures to support the UK's technology sector as a whole, including the AI and data Grand Challenge, AI Sector Deal, and the creation of a Future Sectors team intended to consider how best to support emerging industries.[102] While this approach has been seen as "moving in the right direction."[103] robotics and automation have only a handful of mentions in the Industrial Strategy White Paper, mostly about the need to prepare workers for an increase in these disruptive technologies,[104] or the potential that these technologies have. The strategy lacks any actions or strategies on how risks can be managed or how automation can be exploited to benefit the UK.[105] The lack of clear Government action to support robotics in the UK, despite the Industrial Strategy acknowledging that "UK innovators push boundaries" and the showcasing of an Ocado research project, suggests that the Government is not yet taking seriously the opportunities can offer.[106] **The lack of focus on automation, beyond AI, in the Government's Industrial Strategy is a missed opportunity. Its absence strengths the case for a UK Robot Strategy, which supports British innovation as well as encouraging automation adoption**. ***We recommend that a UK Robot Strategy includes actions that support UK automation businesses to grow and remain in the UK.***

Industrial Strategy Challenge Fund

33. The only Industrial Strategy-linked commitment to support British automation businesses to date has been the announcement of a £93 million investment from the Industrial Strategy Challenge Fund (ISCF) into the "robots for a safer world challenge".[107] The ISCF is part of the Government's attempt to increase research and development

101 Q243 [Prescott]
102 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017, p 212
103 Q122 [Ali]
104 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017, p 41 and pp 115–7
105 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017 pp 212–13,
106 Department for Business, Energy and Industrial Strategy, Industrial Strategy: building a Britain fit for the future, 27 November 2017, pp 36–37
107 GOV.UK, Robots for a safer world: Industrial Strategy Challenge Fund (accessed 9 July 2019)

in spending to the 2015 OECD average of 2.4 per cent of GDP, albeit only by 2027, by supporting existing businesses in large or fast-growing markets.[108] The challenge is intended to support British businesses working on automation to replace dangerous and difficult jobs[109] in extreme environments, such as nuclear energy, offshore energy, deep mining and space.[110]

34. Robotics being developed with support from the ISCF include solutions that can entirely change how tasks are undertaken. Robots capable of inspecting and repairing underground pipes have the potential to reduce not only the number of gas or water leaks, but also the need for roadworks and disruption as part of repairs.[111] During our inquiry we heard from Innovative Technology and Science Ltd (InnoTecUK), which has secured ICSF funding for their work on automated inspections of off-shore wind turbines.[112] If successful, the RobFMS project funded by the ISCF could reduce the overall cost of offshore wind by £7/MWh.[113] InnoTecUK is part of a trend of businesses working in this environment, where human inspection is either dangerous or impossible, and where the Government has chosen to support the sector with the use of the ISCF.[114] Parliamentarians from the Japanese Diet highlighted to us their work on replacing difficult, dangerous and demanding work with automation, as a means to improve the quality of jobs available to Japanese workers, and to deal with the lack of workers willing to undertake the jobs. While the UK's dominance in this field if far from guaranteed, Diet Members identified the UK's successes, via the ISCF, in supporting research and innovation in this area and were considering how the Japanese Government can replicate this.[115]

35. From a proposed £2.4 billion investment into research and development over 5 years, the ISCF's £93 million contribution to robotics is positive but small. It is a welcome first step that many of the projects invested in as part of the robots for a safer world challenge have been funded as part of the UK's increasing support for low-carbon energy. By supporting these projects, the Government has been able to shape the R&D undertaken by British research institutions and businesses and develop our potential as a world leader in one area of robotics. **We welcome the Government's support, via the Industrial Strategy Challenge Fund, for reducing the number of dirty, dangerous and demanding jobs which workers may be required face while supporting clean growth.** ***We recommend the Government should identify new areas of automation for further waves of Industrial Strategy Challenge funding and support British automation businesses to deliver the Grand Challenges.***

Commercialising Innovation

36. The UK does have successful examples of automation businesses. Open Bionics, spun-out from Bristol Robotics Laboratory, is a world leader for bionic arms for human

108 HM Treasury, Autumn Budget 2017 Red Book, November 2017, p 44; and, Meeting the 2.4% target, Russell Group press release, 27 November 2018 (accessed 9 July 2019)

109 A translation of the Japanese concept of the 3Ks—kitani (汚い), kiken (危険), kitsui (きつい).

110 GOV.UK, Robots for a safer world: Industrial Strategy Challenge Fund (accessed 9 July 2019)

111 Robots to fix underground pipes and help cut roadworks, Department for Business, Energy and Industrial Strategy Press Release, 31 December 2018

112 Q61 [Avdelidis] and Robots to fix underground pipes and help cut roadworks, Department for Business, Energy and Industrial Strategy Press Release, 31 December 2018

113 Project Kick-off: RobFMS – The project's consortium meet in Cambridge to kick-start this innovative project, InnoTecUK Press Release, 18 June 2018

114 Q62 [Avdelidis]

115 Private discussion with Japanese Diet Parliamentary Group on the Promotion of Robot Policy, see Annex

use.[116] The Small Robot Company is developing agricultural robots is innovating to make farming more productive.[117] Online retailer Ocado has partnered with robot designer and manufacturer Tharsus to automate its warehouses and sell its technology to retailers around the world.[118] However, while businesses and universities and getting more adept at commercialisation, we heard from businesses and researchers at Bristol Robotics Laboratory that there remains a significant challenge in commercialising new technologies to bring them to market.[119]

Box 3: Ocado and Tharsus

Ocado was founded in 2000 as an online grocery delivery business, initially in partnership with Waitrose.[120] Identifying as both a retail company and a technology company, it initially bought in machinery from other firms, but increasingly uses almost entirely in-house developed technology for its automated warehouses to pick and pack groceries., and for an increased use of AI in its processes.[121]

Mark Richardson, Ocado's Chief Operating Officer, told us that in recent years the balance between retail and technology has shifted towards the latter. Working together with smart machine and robot designer and manufacturer **Tharsus,** the business has been able to retain the intellectual property for its bespoke products and design them with a wider market in mind.[122] This has allowed the company to negotiate exclusive deals to provide robotics solutions for retailers in France, Canada and the United States.[123]

As both a retailer and a technology company, Ocado has also begun collaborating with other businesses. In June this year it announced new partnerships and acquisitions in vertical farming—indoor farming undertaken across multiple layers—to utilise Ocado technology and provide products for retail customers.[124]

37. The challenge for British innovators to commercialise new technologies is not a new one. The House of Commons Science and Technology Committee examined this issue in 2013 and called for the Government to do more to support innovation.[125] The transformation of the Technology Strategy Board into innovate UK, and the establishment of the UK Research and Innovation umbrella body has gone some way to meeting their recommendations for a more joined-up approach to supporting commercialisation. Similarly, Government support for the Catapult Network has remained and is welcome, although there has been little Government attention to the Catapults since a 2017 review identified both strengths and weaknesses of the network.[126]

116 Open Bionics, About (accessed 7 July 2019)
117 Small Robot Company, Who Are We? (accessed 7 July 2019)
118 Ocado (AFW0034)
119 Private discussion at Bristol Robotics Lab, 25 October 2018
120 Ocado Group, Our Story So Far (accessed 7 July 2019)
121 Qq119–120 [Richardson]; Ocado (AFW0034)
122 Q118 [Richardson]
123 Ocado shares rise 44% on news of Kroger tech deal, BBC News, 17 May 2018
124 Ocado Brings its Innovation and Automation Expertise to Sustainable Vertical Farming, Ocado Group Press Release, 10 June 2019
125 Science and Technology Committee, Bridging the valley of death: improving the commercialisation of research, Eighth Report of Session 2012–13, HC 348
126 EY, Catapult Network Review, 17 November 2017, pp 12–13

38. For new areas of automation where the UK is or can be leading the world, we should be attracting funding to ensure commercial success. However, in the past two years the UK has managed to secure only around £250 million of venture capital (VC) funding for automation despite a total global investment of around £10 billion per year.[127] While researchers are encouraged about the UK's gradual growth in this area, we are not reaping the full potential of the 10-times increase in VC funding that global automation has attracted in the past two to three years.[128] The work of incubators, accelerators and catapults, covered in Chamber 5, are going some way to rectify this and can do more, but there is more that the Government can do to support the industry to ensure we do not fall further behind in this key growth area.

39. There have been signs of action from Government before now. In 2014, RAS 2020, a Robotics and Automated Systems Strategy focused on stimulating growth in the sector, was launched.[129] The following year the Government responded but with few firm commitments to act,[130] and with agreed recommendations, such as the creation of a RAS Leadership Group eventually dropped entirely.[131] In the last Parliament the Science and Technology Committee considered this issue and recommended the Government revive proposals for the Leadership Group and provide more support the industry.[132] The Government agreed to consider support for the industry, including the best model of leadership, as part of the then forthcoming Industrial Strategy.[133] Two and a half years on from this response and more than 18 months on from the publication of the Industrial Strategy, the Government has yet to show any sign of reconsidering industry engagement and leadership.

40. UK automation businesses and researchers are innovating but many are failing to attract large scale investment and successfully commercialise their work. The Government has repeatedly promised to do more to help, indeed the Minister for Business and Industry told us that the Government is keen to support the automation "in every way we can."[134] Researchers and businesses have been working together to examine support for the sector, but what is needed now is the promised Government support.[135] **Having ignored calls to build and support leadership for the automation sector, the Government now has a chance to rethink its attitude. Using the Sector Deals approach, on which it has focused the Industrial Strategy, the Government has a chance to bring together the industry, drive investment in the sector and demonstrate actual support for a sector in which we can be world leading. *We recommend that the Government establish a robotics leadership group, co-chaired by a Minister and an industry leader, to bring together Government, business and academia in support of a Robotics Sector Deal.***

127 Qq246–248 [Lane]
128 Q246 [Lane]
129 Q265 [Lane]; and, UK Sitting on a Robot Goldmine, Herriot-Watt University Press Release, 2 July 2014
130 Department for Business, Innovation and Skills, Letter from Greg Clark to Professor David Lane and Professor Rob Buckingham in response to the Robotics and Autonomous Systems Strategy, March 2015
131 Science and Technology Committee, Robotics and Artificial Intelligence, Fifth Report of Session 2016–17, HC 145, para 93
132 Science and Technology Committee, Robotics and Artificial Intelligence, Fifth Report of Session 2016–17, HC 145, para 99
133 Science and Technology Committee, Robotics and artificial intelligence: Government Response to the Committee's Fifth Report of Session 2016–17, Fifth Special Report of Session 2016–17, HC 896, p 2
134 Q275 [Stephenson]
135 Q267 [Lane]

Robot Taxes and Incentives

41. At the start of this inquiry, we sought evidence on proposals put forward by Bill Gates and others on the imposition of a robot tax to mitigate the impact of automation on workers.[136] In both the written and oral evidence we received, there was no support for the idea, with opposition to the UK adopting a tax unliterally given our low rate of adoption ("A robot tax is only useful if there are robots to tax in the first place."[137]) alongside a wider rejection of the negative impact that a robot tax anywhere would have on driving up productivity and therefore increasing living standards and traditional tax income.[138] In his evidence to us, the Minister indicated that the Government too found the idea of a robot tax in current automation environment as "perverse".[139] **We need more robots and not fewer. A tax on them would further discourage take up. We do not believe that a tax on robots is in the interest of businesses or workers in the UK.**

42. Although the cost of automation has decreased, and the availability of more usable and affordable products has made it easier for businesses to adopt the technology, it remains the case that cost can still be prohibitive to many businesses. Companies who are reluctant to automate on cost grounds are not, in the most part, objecting to the principle of making such an investment, but instead are dealing with a finite ability to invest, either from retained earnings or external finance sources.[140] Many of those who opposed a robot tax, including the Minister, promoted the need instead for incentives for automation that would tackle this problem.[141] The Government has promoted its popular R&D tax credits and capital allowances for business investment as the means by which automation can be incentivised.[142] However, we heard criticism from manufacturers such as Siemens and ABB that the current incentives are not specifically designed to encourage automation or innovation.[143]

43. During the Committee's visit to Japan, we visited the Yaskawa Electric Corporation on Kyūshū. As a manufacturer of components for automation and of industrial robots themselves, the company told us that it received no direct Government support, but that the Japanese Government has created an environment that encourages and incentivises automation that ultimately benefits their business while also supporting national goals, such as the New Robot Strategy.[144] Key to this incentivisation was a tax credit system that directly rewarded investment in robotics, stimulating demand for products. In support of this cross-party Members of the Diet and Government officials highlighted a shift towards support for SMEs and a new tax system that incentivised innovation and investment.[145]

44. The decision of the Japanese Government to incentivise robot adoption in a nation already far advanced, compared to the UK, should be a warning sign to the UK Government that more needs to be done here. While existing tax credits and allowances highlighted

136 Bill Gates calls for income tax on robots, Financial Times, 19 February 2017
137 Siemens plc (AFW0012)
138 See, for example, GAMBICA (AFW0022); Institution of Mechanical Engineers (AFW0032); British Safety Council (AFW0035); Q21 [Holliday] Q261 [Prescott, Jennings, Lane]
139 Q303 [Stephenson]
140 EEF and Santander, EEF Investment Monitor 2017/18, 2018, p 17
141 Q303 [Stephenson]
142 Q303 [Stephenson]
143 Q21 [Holliday]; Q22 [Funnell]; Q40 [Holliday]
144 The Headquarters for Japan's Economic Revitalization, Japan's Robot Strategy, February 2015
145 Private discussions with Japanese Government Departments and Japanese Diet Parliamentary Group on the Promotion of Robot Policy, see Annex

by the Minister are welcome, there was concern that they were "blunt instrument[s]" that do not encourage specific types of investment that would directly affect business productivity.[146] This compares poorly to international examples such as the Industrie du Futur in France that targets support.[147] As Vinous Ali of techUK explained in evidence to us, these forms of targeted incentives, which go beyond rewarding any capital expenditure, help to signpost technological solutions to businesses and boards who are less "tech-savvy".[148] The Minister indicated to us that the Government was considering incentives and going beyond just support for investing in machinery and towards a focus on future technologies.[149] **Incentivising business investment in productivity-boosting technologies such as automation should benefit both individual businesses and the economy as a whole. The UK's lagging rate of automation adoption is undermining efforts to boost productivity and risks leaving Britain behind in the automation revolution. The Government should adopt measures which include prioritising SME adoption of automation.** ***We recommend that the Government brings forward proposals in the next budget for a new tax incentive designed to encourage investment in new technology, such as automation and robotics.***

Regulation

45. In Japan, we heard how the Government had created a regulatory sandbox system to ensure that new automated technology could be tested and rolled out with limited intervention from the state.[150] NTT Data, working on self-driving cars to be trialled next year, highlighted to us the willingness of the Government to address regulation by supporting limited trials for its work. In the UK, there have been signs that the Government and regulators are willing to work with the automation industry to ensure that laws are fit for purpose, for example for legislating on the insurance of autonomous vehicles as part of the Autonomous and Electric Vehicle Act 2018 and dialogue between robotics businesses and nuclear and offshore energy regulators on licencing robots intended to work in difficult environments.[151] The challenge of balancing innovation with public safety is one that the Government seems to be managing well to date.[152]

46. Those who gave evidence to us were satisfied that at present there were no significant regulatory barriers to the effective development and deployment of automation.[153] The UK can be an attractive market for businesses wanting to test new technologies. Business leaders at Keizai Doyukai highlighted the enormous potential of the National Health Service as a testbed for medical and social care robotics if managed correctly.[154]

47. **The regulatory environment for automation is currently working well in the interests of both businesses and the public. There is likely to be significant pressure on regulators and other public bodies to reconsider how automation is managed in light of rapid technological developments**. ***We recommend that the Government ensures that***

146 Q40 [Holliday]
147 Qq39–40 [Holliday]; and, European Commission, Digital Transformation Monitor - France: Industrie du Futur, January 2017
148 Q157 [Ali]
149 Qq303–304 [Stephenson]
150 Private discussion with Japanese Ministry for Economy, Trade and Industry, see Annex
151 Automated and Electric Vehicle Act 2018, Part 1; and, Q263 [Lane]
152 Qq86–88 [Sillem]
153 Qq262–263 [Jennings, Lane, Prescott]
154 Private discussion with Keizai Doyukai, Japanese Institute of Directors, see Annex

regulators in industries likely to be impacted by automation have the necessary expertise to ensure that innovation is fostered among automation businesses, while maintaining public safety.

5 Research and Innovation

48. The focus on industrial automation in Government policy, mostly in manufacturing, reflects the highest proportion of robots being in the automation sector. In 2017, industrial robots accounted for 381,335 robotics unit sales globally.[155] By comparison service robotics, which are more assistive and collaborative with existing workers, accounted for 109,543 global units in 2017.[156] However, while the increase in industrial robotics reflected a 30 per cent year on year growth, the increase for service robotics in 2017 was more than 80 per cent.[157]

Table 1: Types of Robots

Industrial	Service
- Polar coordinate (rotating arm)	- Logistic systems
- Cylindrical coordinate (sliding arm)	- Defense applications
- Cartesian coordinate robot (3D grid)	- Public relation robots
- Articulated robot (highly flexible arm)	- Field robots
- Selective compliance assembly (assembly)	- Powered human exoskeletons
- Parallel link (positioning, sorting, selecting)	- Medical robots

Source: Kawasaki, Industrial Robots: Features of the Major 6 Types (accessed 11 July 2019) and International Federation of Robotics, World Robotics 2018 - Service Robots: Executive Summary, September 2018

The largest exporters of industrial robotics are well established. Beyond Japan's dominance of the sector, Germany, Italy, France and China are all leading in their development and sale.[158] As Professor David Lane of the Edinburgh Centre for Robotics told us, the chance for the UK to become a world leader in industrial automation has largely passed.[159]

Incubators and Catapults

49. For the development of new technologies, including service robotics (see Table 1 above), there is an obvious benefit in collaboration and knowledge transfer. In Japan, officials from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) stressed its importance for developing and retaining Japan's place as a robotics superpower.[160] With the exception of Imperial College London, which has an extensive network of robotics labs,[161] the robotics centres in Bristol, Edinburgh and Sheffield are joint endeavours between pairs of universities.[162] This approach has enabled these centres

155 International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018
156 International Federation of Robotics, World Robotics 2018 - Service Robots: Executive Summary, September 2018
157 International Federation of Robotics, World Robotics 2018 - Industrial Robotics: Executive Summary, September 2018, and International Federation of Robotics, World Robotics 2018 - Service Robots: Executive Summary, September 2018
158 Plant Automation Technology, Top Industrial Robotics Companies in the World (accessed 11 July 2019)
159 Q236 [Lane]
160 Private discussion with Japanese Ministry of Education, Culture, Sports, Science and Technology, see Annex
161 Imperial College London, Robotics Research Labs (accessed 11 July 2019)
162 The University of Bristol and the University of the West of England, the University of Sheffield and Sheffield Hallam University, Heriot-Watt University and the University of Edinburgh.

to better reflect the multidisciplinary nature of robotics.[163] At Bristol Robotics Laboratory, the Committee saw their incubator programme for businesses who were collaborating with the BRL to develop and commercialise their business ideas. [164] By providing support such as a rent-free period at the beginning of their time with the incubator and longer-term subsidies, the Lab is able to recruit and retain the skills close to the organisation, and potentially develop the local area and region as a cluster for automation.[165]

50. During the Committee's visit to the University of Tokyo, Prof Masayuki Inaba expressed concerns about the risk to universities of making significant investment in researchers and projects, only for spin-off businesses to be bought out by large companies, such as Google or Softbank, removing knowledge and expertise, as well as intellectual property, from the universities. Prof Inaba identified this as primarily an American issue, for institutions such as the Massachusetts Institute of Technology, but was concerned that it could become the norm across innovative nations. Incubators are designed to help businesses establish, with accelerators able to support more established businesses to secure long-term funding, so it is an inevitable part of the business cycle that acquisitions occur. As Professor Nick Jennings, Vice Provost of Imperial College, and Professor Tony Prescott of Sheffield Robotics told us, successful businesses are not unhappy to have been bought out.[166] **The sale of successful technology businesses to overseas investors is an issue for countries or regions trying to develop their own expertise or competitive advantage in robotics and automation.** ***We recommend that the Government and Universities should work with spinout businesses to offer an alternative to selling-off, including helping with access to finance, networking and business advice.***

51. In our inquiry into Industrial Strategy and Sector Deals, we praised the work of the Catapult Centre network, established by Government to drive innovation and economic growth by collocating businesses, scientists and engineers.[167] These centres have been supported by Government through Innovate UK and are expected to operate on a 'thirds' funding model, with a third each expected to come from public funding, private funding and mixed investment.[168] The High Value Manufacturing Catapult (HMVC) was identified to us as a success story for encouraging innovation in industrial automation and providing a visible example to businesses interested in automation.[169]

52. The collaborative examples of universities and businesses working together that we saw at Bristol and heard about from Edinburgh and Sheffield have much in common with the basis of a Catapult Centre. They are establishing centres of automation excellence outside London and the South East, where Imperial College has taken a leading role. However, unlike the existing Catapult system, these centres are not working on the same model that guarantees funding from Government that can support them and drive other public and private funding. As we heard from Prof Inaba at the University of Tokyo, their success comes from the ongoing mix of Government and private support for their work.[170] **Given the success of an industrial automation and robotics focused Catapult in the High**

163 Q265 [Lane]
164 As above.
165 Private discussion with Tim Bowles, Mayor the West of England at Bristol Robotics Laboratory, 25 October 2018
166 Qq242–243 [Jennings, Prescott]
167 Catapult UK, About Catapults (accessed 27 February 2019)
168 EY, Catapult Network Review, 17 November 2017, p 18
169 Qq75–77 [Avdelidis, Sillem]
170 Private discussion, University of Tokyo Graduate School of Information Science and Technology, Department of Mechano-Informatics, see Annex

Value Manufacturing Catapult, there is an untapped potential for a similar model for service robotics, where the UK has a chance to lead globally by building on academic excellence. ***We recommend that the Government works with research institutions to consider establishing a service robotics catapult within the Catapult Network. Based outside of London and the South East, a Catapult would help grow a robotics cluster, ideally near a university or technical hub, to encourage public and private funding and support British robotics businesses and other businesses who would benefits from the diffusion of new technologies.***

Recruiting Researchers

53. For UK research institutions, including our automation success stories, to continue to succeed and grow, they need to be able to attract the right skills and the right people. This includes ensuring that education pipeline promotes science, technology, engineering and maths (STEM) skills and specifically the engineering and programming skills required for automation.[171] The Education Select Committee is considering this issue in detail as part of its inquiry into the Fourth Industrial Revolution.[172] During the course of our inquiry we have seen and heard the failures to bring more women into the automation sector.[173] During our visit to the Advanced Manufacturing Research Centre in March 2018 we found that fewer than 10 per cent of their apprentices were women, and while we heard examples of businesses and institutions trying to improve this, there are few positive results that could be highlighted to the Committee. This is not a UK-only problem. We heard in Japan that women were structurally excluded from the workplace, with efforts to change this only recently taking the number of women working to above 50 per cent.[174] Although at an industry level, Japanese women occupying 10.2 per cent in engineering is similar to the UK's performance,[175] and as Dr Anne-Marie Imafidon of Stemettes told us, UK women face structural and cultural barriers to entering the tech sector.[176] Women make up only 17 per cent of those working in the technology sector, and are only 10 per cent of those taking computer science, highlighting an ongoing challenge that has yet to be solved.[177]

54. **Businesses and research institutions are not doing enough to ensure women are entering the automation field. Failing to actively work to ensure opportunities for half of the available UK workforce, in a sector where the UK has potential to lead globally, is a major barrier to success.** ***We recommend that the Government works with business and academia to ensure automation is an attractive career with a diverse pipeline of applications to higher education, research and the wider world of work.***

55. Recruiting automation researchers at all is difficult. Professor David Lane told us that as well as a lack of UK talent, some of those we do foster end up themselves going overseas.[178] As the UK does not currently produce enough automation researchers, we

171 Q95 [Sillem]
172 Education Committee, Inquiry into the Fourth Industrial Revolution, Session 2017–19
173 See, for example, Q156 [Ali]
174 Japan's female employment tops 50% for 1st time in half-century, Nikkei Asian Review, 2 February 2019
175 Katsuhiko Yoshikawa et al., A Cultural Perspective on Gender Inequity in STEM: The Japanese Context, Industrial and Organizational Psychology, Volume 11, Issue 2, pp 301–9; and, Women Engineering Society, Useful Statistics (accessed 11 July 2019)
176 Q156 [Imafidon]
177 Association of Accounting Technicians (AAT) (AFW0005)
178 Q254 [Lane]

heard that academic institutions have welcomed students from overseas, but since the UK voted to leave the EU have found there is a reluctance for applications from EU nationals for research positions, as well as for positions in start-up businesses.[179] Businesses and engineering organisations also told us of the concerns about recruitment that have come from uncertainty around Brexit, with the UK needing to fill an annual engineering shortfall of at an estimated 59,000 people per year.[180]

56. **Unless and until Government and business act to create a pipeline of UK researchers and workers who can support the domestic automation industry, we will need to recruit from overseas.** ***The Government's immigration policy should provide certainty and ensure that as we leave the EU, we can recruit and retain researchers from around the world to support the sector, including where they earn below the £30,000 threshold recommended by the Migration Advisory Committee.***

Collaboration

57. Institutions such as Sheffield Robotics and Imperial College London are both in competition and working together, competing for grant funding but also collaborating nationally on large or diverse challenges.[181] Leaving the EU also provides academic institutions with risks to academic collaboration with institutions from Europe, harming both the UK and EU in areas where investment in research is lagging behind competitors.[182] Before the UK voted to leave the European Union, 80 per cent of EU/UK collaborative funding came from the EU. This has now reversed, with the UK having to fund 80 per cent of projects.[183] While the Government has committed to replacing the funding that could be lost as a result of leaving the EU, academics are concerned about the loss of access to expertise and collaboration if the UK is no longer able to participate in EU research projects and programmes, or have easy access to institutions and businesses.[184]

58. **Automation research institutions benefit from international collaboration, and while we welcome commitments to maintain and replicate EU funding when the UK leaves the EU, this is no substitute for the collaboration that comes from joint projects.** ***We recommend that the Government seeks to ensure that the UK has at least associate membership of EU research projects and can effectively collaborate with neighbouring states.***

59. There are also opportunities beyond the EU. Meeting with business leaders at the British Embassy in Tokyo, we heard a clear enthusiasm for a closer relationship with Britain on research as well as trade.[185] At present there are limited opportunities by which UK institutions outside the EU framework where the UK can establish partnerships with universities in the USA, Canada and Japan which are also leading on automation.[186] As the UK looks to establish new trading relationships outside of the EU, there is a potential to build new relationships with funding arrangements that support global collaboration. **For the UK to be a world leader in service robotics and automation, it will need to work**

179 Q225 [Lane]; Siemens plc (AFW0012);
180 Q84 [Avdelidis, Hadall, Sillem]
181 Qq251–252 [Prescott, Jennings]
182 Liverpool John Moores University (AFW0027)
183 Q256 [Lane]
184 Q255 [Lane]; Q259 [Jennings]
185 Private dinner discussion, see Annex.
186 Q258 [Prescott]

globally to succeed. ***The Government should seek to ensure that our future relationship with the EU and future deals with the rest of the world support new collaboration between institutions, including the free flow of researchers and academics.***

6 Workers

Automating Jobs

60. Throughout our inquiry we have asked all those who gave evidence, and those we visited in Japan and Bristol, whether working people should be optimistic or concerned about the rise of automation in the workplace. From research such as Frey and Osborne's 2013 study or the latest National Statistics, we would have predicted some pessimism about the threat of an automated workplace.[187] While the positivity from robotics manufacturers and developers was to be expected, the shared optimism of all our witnesses, ranging from the Trades Union Congress and Chartered Institute of Personnel and Development to Nobel laureate Sir Christopher Pissarides and Stemettes founder Anne-Marie Imafidon, has shaped the Committee's view that the potential of automation is one that should be welcomed.[188] The public have a similar view. While 23 per cent of workers are concerned that their current job may be automated, more than half are optimistic about their working life and almost three quarters of workers are confident they personally can navigate any change.[189] One potential reason for this optimism is that while some reports suggest that robots will be taking people's jobs, the evidence is that we were told that the reality is that where automation is adopted it will largely be replacing specific tasks, rather than whole jobs.[190] During the Committee's visit to the Yaskawa Electric Corporation, we saw robots building robots on the factory floor, suggesting an obsolescence of workers and a potentially exponential growth of robotics.[191] The reality is more prosaic, as workers are likely to find themselves faced with cobots—collaborative robots—that will make jobs different, rather than take them over entirely.[192] Robotics is also creating new jobs and opportunities, including many highly skilled roles.

61. The types of task most associated with a risk of automation include those that are focused on operating machinery, while tasks that require creativity, human contact or planning are those least associated with automated replacement.[193] Ian Funnell of industrial automation manufacturer ABB told us that their projects are intended to take tasks that are "repetitive, boring for people to do, perhaps dangerous", while Brian Holliday of Siemens highlighted automation allows workers to undertake value-adding tasks instead of routine ones.[194] Daniel Susskind, co-author of The Future of the Professions, which examines how technology will affect expertise and careers, encouraged a focus on interpersonal tasks, social skills, the ability to act creatively or the ability to solve problems as skills that machines cannot currently do.[195] Some sectors of the economy have already faced a dramatic shift due to automation. Production lines—a type of automation themselves—for the automotive industry saw robots arrive and workers decrease over the 1970s and 1980s.[196] In the retail sector, a rise in self-checkouts and automated warehouses has seen fewer jobs in retail, a trend that the industry expects to continue with up to 60 per cent

187 Carl Benedikt Frey and Michael A. Osborne, The Future of Employment, (Oxford, 2013); and, Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019
188 Qq163–164 [Pissarides], Q166 [Imafidon, Susskind]; Q196 [Bell]; Q200 [Brinkley]
189 Workers fear automation will worsen their role, Personnel Today, 6 August 2018
190 Q136 [Ali]
191 Private meeting with Yaskawa Electric Corporation, Kitakyushu, see Annex
192 Q42 [Bouchier]; Q267 [Prescott]; Private roundtable discussion including Nomura Research Institute, see Annex.
193 Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019
194 Q11 [Funnell, Holliday]
195 Q170 [Susskind]
196 Rise of the robots: The evolution of Ford's assembly line, CNN Business, 29 April 2015

of jobs identified as at high risk of automation.[197] In banking, there are fewer jobs for cashiers as people move to online banking and rely on ATMs or without physically cash at all.[198]

62. When considering which tasks will be replaced, and therefore which jobs may be most impacted, the threat is not restricted only to low-skilled or low-paid tasks. Andy Haldane of the Bank of England has highlighted the experiences of previous industrial revolutions in which workers affected by the rise of technology and automation were those undertaking mid-skilled tasks.[199] This hollowing-out of skilled 'blue collar' workers has led to an increase in both 'white collar' work and also unskilled jobs in the economy.[200] Many of the dirty, dangerous and demanding jobs, which we consider in Chapter 4, are also highly specialised and can be highly paid, with their replacement by automation potentially harming the employability of workers who have developed the skills necessary to undertake the roles.[201] As automation technology develops, the types of jobs at risk will also change. An increase in the use AI, big data and machine learning could reduce the value of traditional professions that rely on judgement such as lawyers, accountants and clinicians.[202] Dr Daniel Susskind told us:

> the question we should be asking is whether a machine can deal with uncertainty better than a human being can, and the answer is that in many cases, thanks to advances in processing power, data storage capability and algorithm design, they can.[203]

In practice, this includes examples such as a system developed at Stanford University that identifies cancerous freckles as effectively as a dermatologist through the use of pattern recognition from previous cases.[204]

63. The then Minister for Business and Industry shared the view of the majority of witnesses that it makes more sense to think of tasks rather than jobs that are at risk from automation.[205] For individuals who do jobs that are wholly or mainly tasks that are highly automatable there might be little comfort from these assertions or our inquiry. It is these roles and these industries that the Government should prioritise reskilling, training and bringing in investment. **The Government's optimism on the impact of automation on UK jobs is justified only if it is working with industry to ensure that the most at risk sectors and professions have the support they need to manage this transition. The lack of any proactive research or strategy to deal with this change to how we work suggests an complacency or a faith in the market, which is at odds with the approach**

197 British Retail Consortium, Retail 2020, February 2016; and, Susan Hedley (AFW0007)
198 Self-checkouts and ATMs are not true forms of automation, as the task has simply been transferred from an employee to a consumer. New technologies, such as Amazon Go supermarkets that entirely remove the need for checkout are more closely linked to automation. (Amazon.com, Amazon GO (accessed 28 August 2019)
199 Speech by Andrew G Haldane, Chief Economist, Bank of England, Ideas and Institutions: A Growth Story, 23 May 2018
200 National Bureau of Labour Research, Technical Change and the Relative Demand for Skilled Labour: The United States in Historical Perspective, February 2013
201 See paragraphs 34 to 36
202 Daniel Susskind and Richard Susskind, The Future of the Professions: How Technology Will Transform the Work of Human Experts (Oxford, 2015)
203 Q176 [Susskind]
204 As above
205 Q275 [Stephenson]

in the Industrial Strategy. ***We recommend that the Government works with industry to identify the sectors and skills most at risk from automation and develops an action plan for how this transition will be managed.***

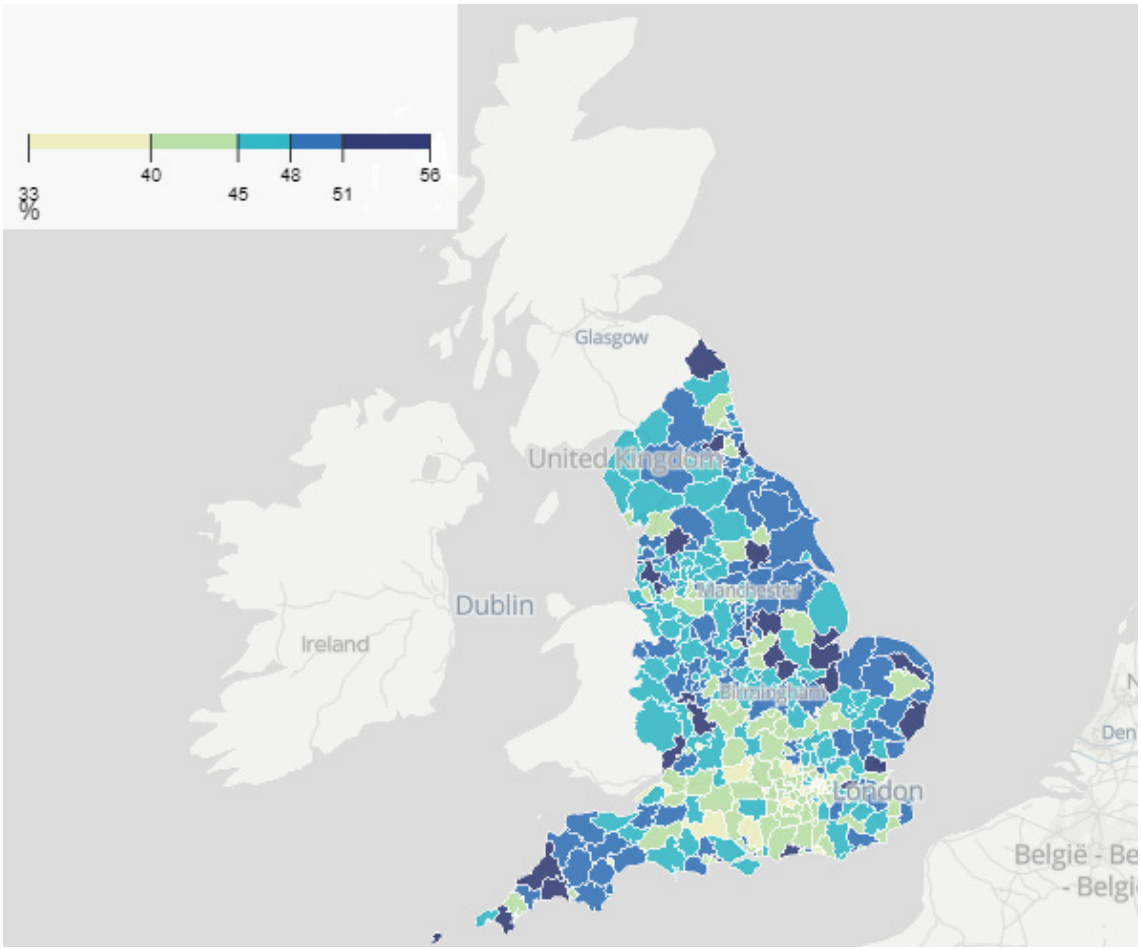
Who is at risk?

64. The uneven spread of automation risk across different industries and occupations means that the impact will be felt differently across a range of demographics beyond just in what role a person works.[206] The Office for National Statistics research into who is most at risk of automation found that women account for 70.2 per cent of employees in jobs undertaking the most at risk tasks, but only 42.6 per cent of employees in jobs at low risk of automation.[207] ONS also found that jobs that have a low risk of automation are mostly held by employees with a degree (87 per cent) while almost 60 per cent of high risk jobs were held by those with A-Level and below qualifications.[208]

65. Mapping the risk of automation to different parts of England, as undertaken by the ONS (see Figure 7), shows a wide disparity between how areas will be affected, with London and the South East mostly at low risk, but concentrations in other regions, especially poor, former industrial areas.[209] As a Committee we have pressed the Government to ensure that its Industrial Strategy delivers for all parts of the UK and the Government monitors the impact of its Industrial Strategy.[210] During our visit to the Japanese Diet, Parliamentarians there expressed similar concerns on how their Government could ensure that technological benefits could be shared across the country, especially in declining towns and villages that are suffering from a loss of jobs, a workforce migrating to cities and an aging remaining population.[211]

206 Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019
207 As above.
208 As above.
209 As above; and, Q235 [Bell]
210 Business, Energy and Industrial Strategy Committee, Seventeenth Report of Session 2017–19, Industrial Strategy: Sector Deals, HC 663, para 59
211 Private discussion with Japanese Diet Parliamentary Group on the Promotion of Robot Policy, see Annex; and Can Anything Stop Rural Decline? , The Atlantic, 23 August 2017

Figure 7: Probability of Automation in England (2017)

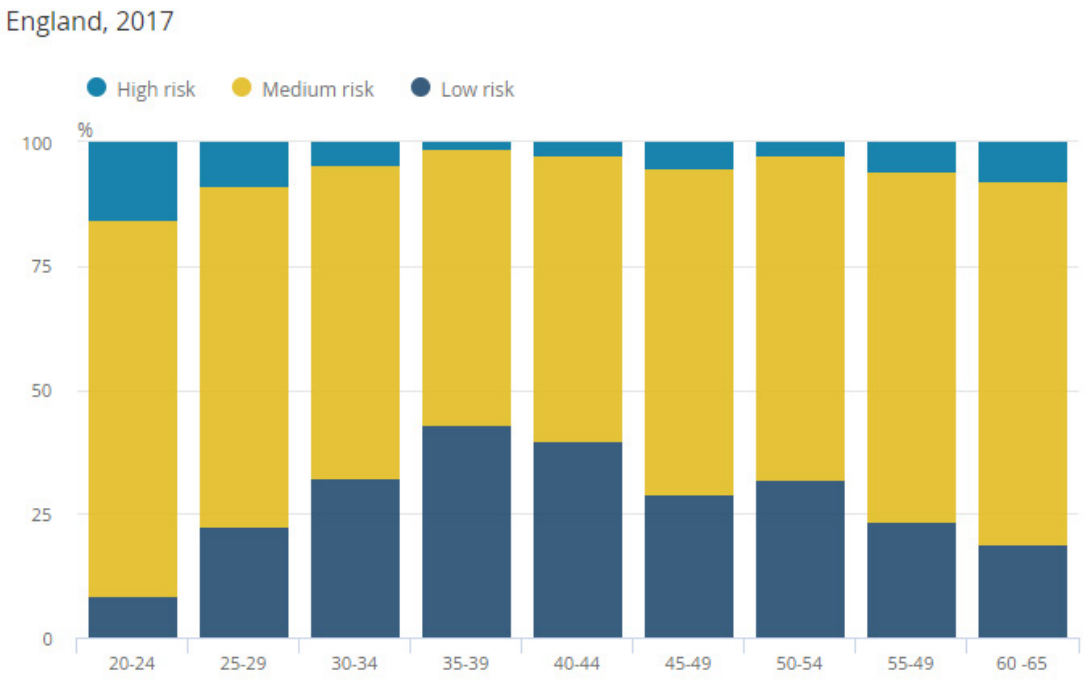


Source: Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019

66. In Japan, an aging population has caused the Government to focus on older workers as a means to solve its demographic challenges. The Ministry for Labour, Health and Welfare highlighted the nation's high elderly employment rates to us while business leaders identified the importance of supporting older workers at the end of long careers, potentially having worked for a single employer throughout.[212] Prime Minister Abe has launched an advisory council for designing a 100-year life society.[213] For British workers, the ONS found that younger workers were most at risk of automation, with over 45 per cent of the high-risk jobs held by people between the ages of 20 and 30 years.[214] This is in part a reflection of the UK's dynamic labour market with people moving frequently between jobs and developing new skills. From the age of 40 upwards, risk of automation again grows for workers (see Figure 8 below).[215] Despite this, a survey from trade union Prospect found that 54 per cent of workers aged 25 and younger were optimistic about tech and only five per cent expressing pessimism.[216]

212 Private discussion with Japanese Ministry for Labour, Health and Welfare, see Annex
213 Council for Designing 100-Year Life Society, Office of the Prime Minister of Japan Press Release, 11 September 2017
214 Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019
215 As above.
216 Prospect Union (AFW0047)

Figure 8: Proportion of main jobs at risk of automation by age band



Source: Annual Survey Population, UK Survey of Adult Skills (PIAAC) and Frey and Osborne

Source: Office for National Statistics, Probability of Automation in England 2011 and 2017, March 2019

67. The ONS's work on automation is based on the tasks and jobs being undertaken by people at different ages; however, it does not measure their potential for retraining and reskilling which is crucial to a long career. There was no consensus from the witnesses from whom we heard during our inquiry on the age groups most likely to be affected. Ian Brinkley, on behalf of the Chartered Institute of Personnel and Development cautioned that we should be most concerned about the impact of automation on older people, due to a lack of job security and opportunities for retraining redeployment.[217] Sir Christopher Pissarides of the London School of Economics argued that older people are less susceptible to automation because the tasks they do are less likely to be automated and there are existing patterns of older people moving roles and scaling down their place in the labour market as they reach the retirement age.[218]

68. In written evidence to us the Department for Business, Energy and Industrial Strategy expressed concern about the ability of older workers to deal with a rise in automation, noting that "some older workers may find it relatively harder to adapt and retrain."[219] There are examples of older workers retraining and developing new skills, such as a growth in the number of people over 50 training with the Association of Accounting Technicians and suggestions that cobots could support older people to stay in work longer.[220] However, we heard concerns that older workers are not being consulted or informed about the impact of automation on the future of their work.[221] Previous trends have shown that

217 Q234 [Brinkley]
218 Q187 [Pissarides]
219 Department for Business, Energy and Industrial Strategy (AFW0008)
220 British Safety Council (AFW0035); Association of Accounting Technicians (AAT) (AFW0005)
221 British Safety Council (AFW0035)

older workers, especially with low-skills have particularly struggled in weak economies and where there has been significant change. There is little sign to date of the Government or business taking action to change this.[222] Businesses and Government have so far done little to support older people to remain in work should they wish to and indeed where they increasingly need to because of changes to the state pension age. There is a risk that these workers will face limited or no access to training and support to help them prepare for how work is changing.

69. Witnesses to our inquiry were optimistic that a rise in automation will not lead to fewer job opportunities for specific groups or areas.[223] In his evidence to us, the Minister was confident that "we are not going to see significant job losses in any sector or area that would have a destabilising effect on the economy" but could not identify any actions that the Government was taking to ensure that this would be the case.[224] **The transition to a more automated workplace and society risks reducing the quality of work, widening existing inequalities and increasing regional disparities. The lack of planning and action in this area is worrying given the role that the Government has in schools and education policy, as well as regional and business policy. *We recommend that the Government supports those most affected and provides local areas with the support and incentives needed to enable this transition.***

Employee Engagement

70. Attempts by business and Government to prepare for jobs changing, workers reskilling and employees staying in work longer in life will only work if employees are aware of the changes and are working with employers to manage the transition. Even when pessimistic about the future of work, workers are optimistic about their own future. As Lauren Crowley of Community told us, this may be an accurate assessment, but it may also be a sign of complacency and workers not considering that the jobs they do might be at risk.[225] Businesses are also performing badly on how they engage and support workers. Deloitte's 2019 Global Human Capital Trends report found that only 22 per cent of British workers were satisfied with their employer's use of technology, while 82 per cent found there was a lack of leadership planning and engagement with workers.[226]

71. For businesses investing in automation and changing how they work, engagement with the workforce needs to take place well before significant changes are considered or begun, rather than at the point that new technology appears in a workplace.[227] Where the impact is significant, there is an opportunity for businesses and workers to consider new models of investing in technology, including more co-operative approaches. Trades Unions have begun to pilot New Technology Agreements between businesses and workers that set out principles for the potential introduction of new technology and bargaining on it; however low union membership in most industries and a decline in collective bargaining mean these are unlikely to cover many affected firms and workers.[228]

222 Centre for Cities (AFW0013)
223 See, for example, Qq163–164 [Pissarides], Q166 [Imafidon, Susskind]; Q196 [Bell]; Q200 [Brinkley]
224 Q290 [Stephenson]
225 Q230 [Crowley]
226 Deloitte, Global Human Capital Trends 2019, p 46
227 Q220 [Brinkley]
228 Prospect Union (AFW0047); and Unite the Union, New Tech Agreement (accessed 11 July 2019)

Skills and Retraining

72. As new technologies enter the workplace and the type of work being undertaken changes, workers will need new skills to be able to adapt.[229] As noted earlier, this is not a new phenomenon, it has been an inevitable part of every industrial revolution through which the UK has gone.[230] In Japan, we heard of the mismatch facing Japanese workers and business, where the supply of skills available did not much the demand for workers in new roles. This has led to high vacancy rates in some sectors that businesses have remained unable to reduce.[231] While the UK's vacancy rate has begun to fall and there is little risk of us not having enough workers to do the jobs,[232] the risk of a mismatch between the skills workers have and that businesses need is a concern that witnesses to our inquiry shared.[233] For workers who find the tasks they undertake affected by automation there are three ways to reskill that could mitigate the change:

a) Develop the skills required to work in the automation or wider technology sectors;

b) Learn to work with automation technology, either in collaborative working environments or by being responsible for operation of automation technology in a business; or

c) Retrain for skills or careers not expected to be so impacted by automation.[234]

73. To reskill to work in the automation sector, we were told of the need for specific STEM skills, especially engineering and manufacturing.[235] As we discussed in Chapter 3 of this report, the Made Smarter Review and North West pilot include commitments to develop skills to work with automation in manufacturing. Work is being undertaken by the industry-and-Government-led Made Smarter Commission to identify what is needed to achieve this.[236] Tetsuo Fujita, Senior Researcher at the Japan Research Institute and Brian Holliday of Siemens identified a need for the teaching of creative and innovative skills, with a focus on communication and teamwork as a means to prepare for the future.[237] Mark Richardson, Ocado's Chief Operating Officer highlighted to us the work that Ocado has done to develop skills in-house as workers need them, but also with a view to improving an individual's future employment prospects.[238] Other technology-focused businesses, such as Google, Sage and Salesforce provide digital skills modules for workers, with Google offering a public-facing 'Digital Garage' for free digital skills training in locations across the UK.[239]

74. How best to deliver skills for the future in our education system is a matter for the Department for Education and is a major part of the Education Select Committee's inquiry

229 Q166 [Imafidon, Susskind]; Q164 [Pissarides]
230 Speech by Andrew G Haldane, Chief Economist, Bank of England, Ideas and Institutions: A Growth Story, 23 May 2018
231 Private roundtable discussion, including Mizuho Research Institute; private discussion with Keizai Doyukai; and private discussion with Japanese Diet Parliamentary Group on the Promotion of Robot Policy. See Annex.
232 Q166 [Susskind]
233 See, for example, Q164 [Pissarides]; and Office for National Statistics, Vacancies and jobs in the UK, August 2019
234 Q170 [Susskind]
235 Q27 [Bouchier]
236 Q17 [Funnell]; Q49 [Holliday]
237 Q54 [Holliday]; and, private roundtable discussion, see Annex
238 Qq143–144 [Richardson]
239 Google Digital Garage, Face to Face Coaching (accessed 28 August 2019)

into the Fourth Industrial revolution.[240] We welcome their work. The responsibility of how to develop new skills for workers affected by automation has a much wider responsibility, spanning Government, academia and employers. Some businesses are already preparing their workers for change. This ongoing approach, on the basis that upskilling and increasing pay is possible, offers a future where we should expect to see robot operators become robot programmers.[241]

75. Witnesses before the Committee agreed that it was right that businesses should be leading on supporting workers to respond to automation, because they are the ones who understand business changes and needs the best.[242] However, we heard from Professor Tony Dundon of the Work and Equalities Institute that there is little incentive for businesses to provide training for their workers beyond the minimum requirement because they risk the investment being lost when workers leave the business.[243] Businesses have a choice of whether to invest in the UK or overseas. Sir Christopher Pissarides recommended that the Government should share some of the cost, through incentives or allowances that enabled investment in learning and development.[244]

76. A reliance solely on business-led training for workers at risk of automation, even with Government support, risks selling short workers in small businesses, the self-employed and the unemployed. In Japan a small but growing cohort of self-employed workers is requiring new policies to ensure they were not left behind.[245] In businesses, training relies on managers and business leaders themselves being able to understand the potential of automation and the impact of technological change, an area in which we know UK businesses suffer.[246] Professor Tony Prescott of Sheffield Robotics accepted that there was a role for universities in supporting the reskilling of workers, an area they had previously failed to support.[247] Lauren Crowley of trade union Community, Kate Bell of the TUC and Ian Brinkley of the CIPD all advocated for the inclusion of trade union support for reskilling workers, building on successful unionlearn programmes and evidence that union support was the most trusted means to engage workers who have had limited or poor experiences of retraining.[248]

77. During previous industrial changes, such as the decline of the UK's coal and steel industries, the Government did not do enough to help support workers to transition to new careers, leaving entire areas without support and pockets of high unemployment. The growth of workplace automation is a threat to UK workers if similar mistakes are made.[249] We welcome that the previous Government engaged directly with CIPD and the TUC to develop a National Retraining Scheme, and with Local Enterprise Partnerships and devolved bodies to deliver Digital Skills Partnerships.[250] However, the evidence we received was that while these are a positive starting point, they are not enough to have a significant impact on delivering a skills shift. Only a handful of Digital Skills Partnerships have been

240 Education Committee, Inquiry into the Fourth Industrial Revolution, Session 2017–19
241 Q237 [Lane]
242 Qq179–180 [Pissarides]
243 Q226 [Dundon]
244 Qq179–180 [Pissarides]
245 Private roundtable discussion, including Nippon Institute for Research, see Annex
246 Q229 [Brinkley]; Q235 [Crowley]; Q261 [Lane]; Business, Energy and Industrial Strategy Committee, Fifteenth Report of Session 2017–19, Small Businesses and Productivity, HC 807
247 Q272 [Prescott]
248 Q229 [Brinkley]
249 Q168 [Imafidon]; Q169 [Pissarides]; Q196 [Bell]
250 Q173 [Imafidon]; Q221 [Brinkley]

established to date, and the National Retraining Scheme remains at a development stage with £100 million of funding nowhere near close enough to deliver for the potentially impacted population at a time when adult skills funding has been cut by 40 per cent.[251]

78. The Government has committed itself to providing Good Work through the Taylor Review, Industrial Strategy and the long-awaited Employment Bill to implement the recommendations of Matthew Taylor and this Committee.[252] If it fails to support businesses and workers to adapt to the rise of automation it risks allowing a reduction in the availability of Good Work. Dr Hayaatun Sillem, Chief Executive of the Royal Academy of Engineering warned that "unless we do proactively think about which groups we need to help to participate in future economic activity, there is a risk it will reinforce inequality and bias in our current workforce. If we are smart and proactive about it, we can do a lot."[253] We agree.

79. **There are already good examples of businesses, research institutions and trade unions who are supporting workers in the transition to a more automated workplace. While businesses should be responsible for retraining workers as jobs change, whether through automation or other developments, there is a role for Government in ensuring that everyone in work or able to work can develop the skills they need to adapt.** ***At a business level, the Government should consider financial incentives for businesses and organisations who invest in learning and development, both for their own employees and for workers more widely. At the national level, the Government should prioritise reskilling to meet the needs of the economy and to ensure demands of new technologies and skills are available to all.***

251 Qq192–193 [Pissarides, Susskind]; Q150 [Ali]; Q227 [Bell]

252 Business, Energy and Industrial Strategy Committee and Work and Pensions Committee, First Joint Report of Session 2017–19, A framework for modern employment, HC 352

253 Q99 [Sillem]

7 Conclusions: The Future of Work

Predicting the Future

80. In its 2016 report on the Future of Jobs, the World Economic Forum cited one popular estimate that two thirds of children entering primary school will end up working in new job types that did not exist at the time they started school.[254] Our scrutiny of the impact of automation on the future of work has not sought to predict the future or attempt to put a number on the jobs that could be lost of changed by the continued growth of automation. Instead, our inquiry has considered how the UK compares to our global competitors, what we can do to boost productivity to a more automated economy, and how workers should be supported through the transition. Throughout our inquiry we have heard from a range of stakeholders who have almost entirely been optimistic about what the future of work could hold, if managed well. Rather than mass-unemployment or the 'end of work', we are convinced that well managed automation is likely to improve the quality of work, create new jobs and boost UK productivity.

81. Shortly before the Committee visited Japan, the TUC published a report into the future of work, which highlighted the potential of technology to improve the quality of work. It found that workers sought a four-day working week if productivity increases made it affordable.[255] A shorter working week is not a new aim. In 1930, John Maynard Keynes predicted that automation would enable a 15-hour working week by 2030.[256] While the average working week has dropped from 50 hours in 1930 to 30 hours today, more than 3.3 million workers are still working close to 50 hours and more than two billion hours of unpaid overtime were worked in 2017, according to the TUC.[257] Attempts to enable workers to undertake four day weeks have proven problematic to implement, as the Wellcome Trust discovered when they cancelled their high profile trial earlier this year.[258] We agree with the CIPD that a four day week is feasible, but not currently practical.[259]

82. Historically, large industrial transitions have seen changes to work but, rather than causing long-term job losses, they have resulted in more of the population in work than before and the quality of working improving. Witnesses before the Committee were optimistic that the same would be true for the so-called Fourth Industrial Revolution.[260] In Japan we learned that the public there do not see problems with automation, but there has been some resistance from established industries and difficulties in managing changing working styles.[261] There is however a risk that the jobs left will be mainly in secure management roles, or low-quality and insecure administration and labouring. For the Japanese consumer, the public may not currently be concerned about who provides their services and products and how they are made, but over time a hollowing out of tasks risks greater inequality. However, it could lead to a resurgence of creative roles and a premium being paid for that work.[262] In the UK, however, we have heard examples

254 World Economic Forum, The Future of Jobs, January 2016, Chapter 1
255 Trades Union Congress, A Future that Works for Working People, September 2018, p 29
256 Speech by Andrew G Haldane, Chief Economist, Bank of England, Labour's Share, 12 November 2015
257 Trades Union Congress, A Future that Works for Working People, September 2018, p 23
258 The dream of a four-day week needs a lot more work, Financial Times, 5 May 2019
259 Q200 [Brinkley]
260 Q168 [Imafidon, Susskind]; Q209 [Bell]; Q211 [Brinkley]
261 Private discussion with Minister Takao Ochi, then State Minister of Cabinet Office, see Annex
262 Private roundtable discussion, including Nomura Research Institute, see Annex.

of how the opposite is true, such as car washes where low pay and worker exploitation makes it cheaper for cars to be cleaned by hand than automated solutions.[263] It is not clear that preserving exploitative employment is a good thing. Indeed, automation can be an opportunity to incentivise businesses and employees towards more rewarding and less exploitative work.

Working Together

83. If the Government is serious about managing the rise of automation across industry and committed to good work, it must learn from the mistakes that have been made in previous industrial shifts.[264] Kate Bell, Head of Policy at the TUC told us that a decade ago it was clear that retail was going to shift away from the high street and towards warehouses, but a lack of planning, consultation and engagement has meant that the impact has been much more negative on the availability and quality of work than it had needed to be.[265]

84. In Japan, there has been a willingness from the Japanese Government, business and trade unions to discuss the fair distribution of the benefits of automation.[266] By contrast, despite the optimistic picture given by the previous Government, all our witnesses were concerned about some aspects of the Government's approach to automation and the future of work. Businesses selling automation products would like more support for encouraging automation adoption. Businesses automating would like more advice on how to adopt automation in the work place. Researchers would like to see more investment and support for collaboration. Workers and HR professionals would like to see plans for reskilling and greater employee engagement. Many of these requests almost align with the Government's Industrial Strategy, but where they don't quite fit with the sectors and challenges the Government is investing in, they have struggled to find support. Opportunities have already been missed, with an advisory service scrapped, a leadership group abandoned, and trades unions left out of sector skills councils.[267]

85. **The Prime Minister has decided to keep an Industrial Strategy as part of the Government's approach to supporting businesses. The potential gains that automation can bring for the UK economy cannot be left to chance, and instead the Government needs to bring forward a strategy to help businesses, workers and researchers use the transition to deliver a change to how we live and work.**

86. **If managed well, the transition to a more automated British workplace should make businesses more productive, improve the supply of high-quality jobs, and support working people to have more leisure time. British businesses working in automation could be world-leading in the field of service robotics, and British universities could be collaborating across the world to provide new technologies to improve how we live. If the transition is managed badly, entire groups and regions could be left behind, British businesses could find themselves uncompetitive, SMEs will continue to form a long tail of unproductive businesses and academics will be working in isolation attempting to catch-up with other nations' technologies.**

263 Q217 [Bell]
264 Q210 [Crowley]
265 Q209 [Bell]
266 Private roundtable discussion, including trade union think tank Rengo Soken, see Annex
267 Q209 [Bell]

87. **The Government needs to take more seriously both the opportunities and risks of automation than it has to date. It should not do so in isolation, instead it should collaborate with all those who want to harness automation to boost productivity and living standards, and it should not delay doing so.** ***We recommend that the Government urgently brings together employers, workers, academia and automation developers to design a UK Robot Strategy on how it plans to promote and manage the transition to a more automated world of work.***

Annex: Visit to Japan

The Committee visited Japan between 24 and 28 September 2018. Over the course of the visit we met with Government departments responsible for the policies affected and driven by automation, the Minister responsible for coordination, Members of the Diet, businesses, NGOs, think-tanks, industry representative bodies and research associations. We were also able to visit the University of Tokyo's Department of Mechano-Informatics to see new automation research, and the Yaskawa Electric Corporation to meet with one of Japan's leading industrial robot manufacturers. We are grateful to all those who met with us during out visit, and to Paul Madden CMG, British Ambassador to Japan, Patrick Bannister and the staff of the British Embassy in Tokyo for their support before during the visit.

During the visit, the Committee held the following meetings and visits:

Ministry for Economy, Trade and Industry (METI)

Presentation and discussion of Japan's industrial policy, support for future industries and automation.

- Mr Toshiyuki Shirai, Director for European Economic Policy
- Mr Yuichi Yokoi, Deputy Director of the Industry Creation Policy Division
- Mr Takuya Kimura, Deputy Director policy for Human Resources / Diversity & Inclusion Economic and Industrial Policy Bureau
- Ms Yuko Kurihara, Principal Deputy Director, Robotics Policy Office, Industrial Machinery Division Manufacturing Industries Bureau
- Ms Hiromi Sakamoto, Deputy Director, Manufacturing Industries Bureau
- Mr Wataru Toyofuku, Deputy Director, Industry Creation Division, Economy and Industry Policy Bureau

Ministry for Health, Labour and Welfare (MHLW)

Presentation and discussion of Japanese policy on the future of work, and adjustments for automation.

- Mr Shin-ichi Akiyama, Deputy Assistant Minister for International Affairs, Minister's Secretariat
- Mr Toshimitsu Takamatsu, Senior Coordinator for Office of Counsellor for Labour Section, Director-General for General Policy and Evaluation

Cabinet Office

Explanation of Japan's macroeconomic challenges and strategy; and the place of automation within this.

- Mr Takao Ochi, State Minister of Cabinet Office
- Mr Miyano, Secretary to Mr Ochi
- Mr Nobuo Kagomiya, Deputy Director-General for Economic and Fiscal Management
- Mr Hirai, Councillor
- Mr Yokoyama, Director

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Presentations and discussion of Japan's "Society 5.0" vision of the future and related R&D policy for automation and the future of work

- Ms Sonoko Watanabe, Deputy Director-General for S&T Policy Bureau
- Ms Mutsuko Yasuda, Director, International Cooperation
- Mr Henda, Deputy Director, Information Division, Research Promotion Bureau

British Embassy Roundtable: Non-Governmental Policy Views

Presentations and discussion with NGOs, think-tanks, industry representative bodies, research associations. Views from outside government on automation and the future of work.

- Ms Reiko Kanda, Executive Vice President, Nippon Institute for Research Advancement (NIRA)
- Mr Kentaro Arita, Senior Economist, Economic Research Department, Mizuho Research Institute Ltd.
- Mr Tetsuo Fujita, Senior Researcher, Economics Department, The Japan Research Institute Ltd.
- Ms Yuki Urasato, Executive Director, Japan Consumer Association
- Ms Emi Kato, Director, Japan Consumer Association
- Dr Hirotoshi Kishi, Chief Consultant, ICT & Service Industry Consulting Department, Nomura Research Institute
- Mr. Nobuyuki Shintani, Rengo Soken

British Embassy Dinner

Open discussion with relevant English-speaking experts and influencers from government, academia, and industry, hosted by HMA Paul Madden

- Prof Atsushi Seike, Executive Advisor for Academic Affairs and Professor of Labour Economics, Keio University (former President of the university) / President, the Promotion and Mutual Aid Corporation for Private Schools of Japan
- Prof Yuko Harayama, Professor Emeritus, Tohoku University / former member of Council for Science, Technology and Innovation
- Dr Masayuki Morikawa, Vice President, Research Institute of Economy, Trade and Industry (RIETI)
- Prof Hiroyuki Chuma, Faculty of Social Innovation, Department of Innovation Studies, Seijo University
- Prof Daiji Kawaguchi, Professor, Faculty of Economics, The University of Tokyo / Principal Investigator of "AI and Human Labour", JST
- Mr Yutaka Manchu, Deputy Secretary-General (Industrial IoT Specialist), Robot Revolution & Industrial IoT Initiative (RRI)
- Ms Mari Inoue, Chief Officer, Robot and Artificial Intelligence Technology Department / World Robot Summit Team, New Energy and Industrial Technology Development Organization (NEDO)
- Mr Yasunori Sota, Manager, International Affairs & Public Policy Department, International Policy Division, Government & External Relations Group, Hitachi Ltd.
- Mr Tsuneo Komatsuzaki, Advisor / ex Director of Intelligent Systems Laboratory, SECOM Co.,Ltd.

NTT Data

Presentation and discussion of automation of taxi services–case study of collaborative project between NTT Data (a technology company) and Daiwa Taxi (a traditional cab company) with the support of Gunma University.

- Mr Takahisa Machida, Manager, Public Division 1, Public Sector 1
- Mr Yasumasa Taikoji, Deputy Manager, Public Division 1, Public Sector 1
- Ms Keiko Yoshida, Deputy Manager, Business Strategy Department, Financial Segment, NTT DATA Corporation

Keizai Doyukai (Japanese Institute of Directors)

Discussion of Japanese business/industry views on automation and the future of work.

- Mr Ichiro Umeda, Chairman of Institute for New Era Strategy
- Mr Katsuya Debari, President & CEO, Odyssey Communications, Inc.
- Mr Tetsuo Narukawa, Director of Mitsubishi Estate Co., Ltd

- Mr Masamichi Mizuta, President and Representative Director, Persol Holdings Co., Ltd
- Ms Yukiko Yoshimaru, Director, Member of the Board, Sekisui House Ltd

Japanese Diet Parliamentary Group on the Promotion of Robot Policy

Discussion with MPs on views of automation and the future of work.

- Mr Kisaburo Tokai MP
- Mr Akira Sato MP
- Mr Asahiko Mihara MP
- Mr Shinsuke Okuno MP
- Mr Masahiro Imamura MP
- Mr Ichiro Miyashita MP
- Mr Katsumi Ogawa MP

University of Tokyo Graduate School of Information Science and Technology, Department of Mechano-Informatics

Presentation on and demonstration of a variety of robots mainly humanoid being developed for healthcare, child education, daily assistance at home, warehouse deliveries.

- Prof Masayuki Inaba
- Prof Kei Okada
- Students of the Graduate School.

Yaskawa Electric Corporation, Kitakyūshū

The Committee undertook a site visit to the Yaskawa Electric Corporation headquarters in Fukuoka Prefecture on Kyūshū, arranged by Mr Yasushi Ichiki, General Manager, Corporate Planning Dept. We met with senior members of the company, undertook a tour of the factory floors and visited the Yaskawa Innovation Centre.

Conclusions and recommendations

Automation adoption

1. The UK's progress on automation, to ensure its industries are globally competitive, has not been fast enough. The UK's problem is too few, not too many, robots. The potential for an increase in automation to help tackle the Productivity Puzzle and improve living standards has not yet been effectively addressed by the Government. We recommend that the Government should develop a UK Robot and AI Strategy by the end of 2020 to improve automation adoption and support British industries. The remainder of this report includes some of the key measures we expect to see in the Government's new strategy. (Paragraph 13)

Automating UK business

2. It is clear to us that the future of manufacturing in the UK depends on higher levels of productivity. Robotics and automation provide possibilities to enhance productivity and therefore support higher production and more jobs in the UK. (Paragraph 15)

3. Some of the barriers to automation identified by UK businesses are real, and we make recommendations throughout this report on how they can be overcome. However, some of the barriers to automation are issues of perception. *We recommend that the Government works with the automation industry and businesses who have introduced automation to make information and case studies on the costs and benefits of automation easily available to businesses.* (Paragraph 18)

4. Made Smarter has the potential to boost UK productivity in SMEs through the adoption of new technology, and while take-up of the North West pilot has been impressive, overall progress has been slow. *We recommend that in responding to this report, the Government provides a timeline for the evaluation of the North West pilot and commit to a fully-funded roll-out of the scheme across the UK based on the results of that work.* (Paragraph 22)

5. A lack of awareness and understanding of automation is harming business productivity, especially for SMEs. The Government's decision to close the Manufacturing Advice Service in 2015 was a mistake and has contributed to making it more difficult for businesses to find help and advice. *We recommend that the Government funds an impartial source of advice for businesses that want to invest in automation. This new service should be commissioned with a focus on ensuring it is fully accessible to SMEs, building on the experience of successful examples like Be the Business.* (Paragraph 27)

Automation and the Industrial Strategy

6. Developing the UK as a leader in service robotics has the potential to make a significant contribution to the delivery of the Government's Grand Challenges. The Government should ensure that a UK Robot Strategy forms part of the Government's Industrial Strategy, and that robotics is considered an integral part of all of the Grand

Challenges it is pursuing. *The Government should ensure that a UK Robot Strategy forms part of the Government's Industrial Strategy, and that robotics is considered an integral part of all of the Grand Challenges it is pursuing.* (Paragraph 30)

7. The lack of focus on automation, beyond AI, in the Government's Industrial Strategy is a missed opportunity. Its absence strengths the case for a UK Robot Strategy, which supports British innovation as well as encouraging automation adoption *We recommend that a UK Robot Strategy includes actions that support UK automation businesses to grow and remain in the UK.* (Paragraph 32)

8. We welcome the Government's support, via the Industrial Strategy Challenge Fund, for reducing the number of dirty, dangerous and demanding jobs which workers may be required face while supporting clean growth. *We recommend the Government should identify new areas of automation for further waves of Industrial Strategy Challenge funding and support British automation businesses to deliver the Grand Challenges.* (Paragraph 35)

9. Having ignored calls to build and support leadership for the automation sector, the Government now has a chance to rethink its attitude. Using the Sector Deals approach, on which it has focused the Industrial Strategy, the Government has a chance to bring together the industry, drive investment in the sector and demonstrate actual support for a sector in which we can be world leading. *We recommend that the Government establish a robotics leadership group, co-chaired by a Minister and an industry leader, to bring together Government, business and academia in support of a Robotics Sector Deal.* (Paragraph 40)

10. We need more robots and not fewer. A tax on them would further discourage take up. We do not believe that a tax on robots is in the interest of businesses or workers in the UK. (Paragraph 41)

11. Incentivising business investment in productivity-boosting technologies such as automation should benefit both individual businesses and the economy as a whole. The UK's lagging rate of automation adoption is undermining efforts to boost productivity and risks leaving Britain behind in the automation revolution. The Government should adopt measures which include prioritising SME adoption of automation. *We recommend that the Government brings forward proposals in the next budget for a new tax incentives designed to encourage investment in new technology, such as automation and robotics.* (Paragraph 44)

12. The regulatory environment for automation is currently working well in the interests of both businesses and the public. There is likely to be significant pressure on regulators and other public bodies to reconsider how automation is managed in light of rapid technological developments *We recommend that the Government ensures that regulators in industries likely to be impacted by automation have the necessary expertise to ensure that innovation is fostered among automation businesses, while maintaining public safety.* (Paragraph 47)

Research and innovation

13. The sale of successful technology businesses to overseas investors is an issue for countries or regions trying to develop their own expertise or competitive advantage in robotics and automation. *We recommend that the Government and Universities should work with spinout businesses to offer an alternative to selling-off, including helping with access to finance, networking and business advice.* (Paragraph 50)

14. Given the success of an industrial automation and robotics focused Catapult in the High Value Manufacturing Catapult, there is an untapped potential for a similar model for service robotics, where the UK has a chance to lead globally by building on academic excellence. *We recommend that the Government works with research institutions to consider establishing a service robotics catapult within the Catapult Network. Based outside of London and the South East, a Catapult would help grow a robotics cluster, ideally near a university or technical hub, to encourage public and private funding and support British robotics businesses and other businesses who would benefits from the diffusion of new technologies.* (Paragraph 52)

15. Businesses and research institutions are not doing enough to ensure women are entering the automation field. Failing to actively work to ensure opportunities for half of the available UK workforce, in a sector where the UK has potential to lead globally, is a major barrier to success. *We recommend that the Government works with business and academia to ensure automation is an attractive career with a diverse pipeline of applications to higher education, research and the wider world of work.* (Paragraph 54)

16. Unless and until Government and business act to create a pipeline of UK researchers and workers who can support the domestic automation industry, we will need to recruit from overseas. *The Government's immigration policy should provide certainty and ensure that as we leave the EU, we can recruit and retain researchers from around the world to support the sector, including where they earn below the £30,000 threshold recommended by the Migration Advisory Committee.* (Paragraph 56)

17. Automation research institutions benefit from international collaboration, and while we welcome commitments to maintain and replicate EU funding when the UK leaves the EU, this is no substitute for the collaboration that comes from joint projects. *We recommend that the Government seeks to ensure that the UK has at least associate membership of EU research projects and can effectively collaborate with neighbouring states.* (Paragraph 58)

18. For the UK to be a world leader in service robotics and automation, it will need to work globally to succeed. *The Government should seek to ensure that our future relationship with the EU and future deals with the rest of the world support new collaboration between institutions, including the free flow of researchers and academics.* (Paragraph 59)

Workers

19. The Government's optimism on the impact of automation on UK jobs is justified only if it is working with industry to ensure that the most at risk sectors and

professions have the support they need to manage this transition. The lack of any proactive research or strategy to deal with this change to how we work suggests an complacency or a faith in the market, which is at odds with the approach in the Industrial Strategy. *We recommend that the Government works with industry to identify the sectors and skills most at risk from automation and develops an action plan for how this transition will be managed.* (Paragraph 63)

20. The transition to a more automated workplace and society risks reducing the quality of work, widening existing inequalities and increasing regional disparities. The lack of planning and action in this area is worrying given the role that the Government has in schools and education policy, as well as regional and business policy. *We recommend that the Government supports those most affected and provides local areas with the support and incentives needed to enable this transition.* (Paragraph 69)

21. There are already good examples of businesses, research institutions and trade unions who are supporting workers in the transition to a more automated workplace. While businesses should be responsible for retraining workers as jobs change, whether through automation or other developments, there is a role for Government in ensuring that everyone in work or able to work can develop the skills they need to adapt. *At a business level, the Government should consider financial incentives for businesses and organisations who invest in learning and development, both for their own employees and for workers more widely. At the national level, the Government should prioritise reskilling to meet the needs of the economy and to ensure demands of new technologies and skills are available to all.* (Paragraph 79)

Conclusions: The Future of Work

22. The Prime Minister has decided to keep an Industrial Strategy as part of the Government's approach to supporting businesses. The potential gains that automation can bring for the UK economy cannot be left to chance, and instead the Government needs to bring forward a strategy to help businesses, workers and researchers use the transition to deliver a change to how we live and work. (Paragraph 85)

23. If managed well, the transition to a more automated British workplace should make businesses more productive, improve the supply of high-quality jobs, and support working people to have more leisure time. British businesses working in automation could be world-leading in the field of service robotics, and British universities could be collaborating across the world to provide new technologies to improve how we live. If the transition is managed badly, entire groups and regions could be left behind, British businesses could find themselves uncompetitive, SMEs will continue to form a long tail of unproductive businesses and academics will be working in isolation attempting to catch-up with other nations' technologies. (Paragraph 86)

24. The Government needs to take more seriously both the opportunities and risks of automation than it has to date. It should not do so in isolation, instead it should collaborate with all those who want to harness automation to boost productivity and living standards, and it should not delay doing so. *We recommend that the*

Government urgently brings together employers, workers, academia and automation developers to design a UK Robot Strategy on how it plans to promote and manage the transition to a more automated world of work. (Paragraph 87)

Formal minutes

Monday 9 September 2019

Members present:

Rachel Reeves, in the Chair

Vernon Coaker Sir Patrick McLoughlin

Mark Pawsey Stephen Kerr

Draft Report (*Automation and the future of work*), proposed by the Chair, brought up and read.

Ordered, That the Chair's draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 87 read and agreed to.

Summary agreed to.

Annex agreed to.

Resolved, That the Report be the Twenty-third Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till 15 October 2019 at 9.45am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Tuesday 5 March 2019

Tom Bouchier, Managing Director, Fanuc UK, **Brian Holliday**, Managing Director, Siemens Digital Factory, **Ian Funnell**, Managing Director, ABB UK — Q1–56

Jeremy Hadall, Chief Engineer - Intelligent Automation, Manufacturing Technology Centre, **Nico Avdelidis**, Chief Operations Officer, InnoTecUK, **Dr Hayaatun Sillem**, Chief Executive, Royal Academy of Engineering — Q57–99

Wednesday 3 April 2019

Mark Richardson, Chief Operating Officer, Ocado, **Vinous Ali**, Head of Policy, TechUK, **Brian Palmer**, Chief Executive Officer, Tharsus — Q100–162

Professor Sir Christopher Pissarides, Regius Professor of Economics, LSE and Co-Chair, Institute for the Future of Work, **Dr Daniel Susskind**, Fellow in Economics, University of Oxford, **Dr Anne-Marie Imafidon**, Stemettes and Trustee, Institute for the Future of Work — Q163–195

Tuesday 30 April 2019

Kate Bell, Head of Rights, International, Social and Economics, Trades Union Congress, **Lauren Crowley**, Head of Equalities, Community, **Ian Brinkley**, Chartered Institute of Personnel and Development, and **Professor Tony Dundon**, Work and Equalities Institute, University of Manchester/ University of Limerick — Q196–235

Professor Tony Prescott, Director of Sheffield Robotics, University of Sheffield, **Professor David M Lane**, Director, Edinburgh Centre for Robotics, and **Professor Nick Jennings**, Vice-Provost (Research and Enterprise), Imperial College London — Q236–274

Wednesday 15 May 2019

Andrew Stephenson MP, Parliamentary Under-Secretary of State, Minister for Business and Industry, Department for Business, Energy and Industrial Strategy — Q275–339

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

AFW numbers are generated by the evidence processing system and so may not be complete.

1 ABB (AFW0014)
2 Association of Accounting Technicians (AAT) (AFW0005)
3 British Automation and Robot Association (AFW0037)
4 British Institute of Facilities Management (AFW0041)
5 British Safety Council (AFW0035)
6 Centre for Cities (AFW0013)
7 The Chartered Institute of Management Accountants (AFW0045)
8 Chartered Institute of Personnel & Development (AFW0023)
9 CMI (AFW0021)
10 Creative Skillset (AFW0003)
11 Department for Business, Energy and Industrial Strategy (AFW0008)
12 Design Council (AFW0016)
13 Ditto AI Limited (AFW0020)
14 EEF, the manufacturers' organisation (AFW0038)
15 GAMBICA (AFW0022)
16 Harris, Miss Camilla (AFW0002)
17 Hedley, Susan (AFW0007)
18 ICAEW (AFW0036)
19 Imperial College London (AFW0025)
20 Institute of Directors (AFW0026)
21 Institute of Marine Engineering, Science and Technology (IMarEST) (AFW0028)
22 Institution of Mechanical Engineers (AFW0032)
23 Investors in People (AFW0018)
24 Liverpool John Moores University (AFW0027)
25 London First (AFW0029)
26 Manufacturing Technology Centre (AFW0006)
27 Ocado (AFW0034)
28 Open University (AFW0024)
29 Pro Bono Economics (AFW0048)
30 Prospect Union (AFW0047)
31 Recruitment & Employment Confederation (AFW0009)
32 Royal Academy of Engineering - Engineering the Future (AFW0040)
33 The Royal Society (AFW0033)

34 The RSA (AFW0039)

35 Siemens plc (AFW0012)

36 techUK (AFW0042)

37 Trades Union Congress (AFW0019)

38 Unite the Union (AFW0010)

39 Usdaw (AFW0017)

40 Work and Equalities Institute, University of Manchester (AFW0015)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website. The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2017–19

First Report	A framework for modern employment	HC 352 (HC 966)
Second Report	Leaving the EU: implications for the civil nuclear sector	HC 378 (HC 881)
Third Report	The safety of Electrical Goods in the UK	HC 503 (HC 920)
Fourth Report	Pre-legislative scrutiny of the draft Domestic Gas and Electricity (Tariff Cap) Bill	HC 517 (HC 865)
Fifth Report	The impact of Brexit on the automotive sector	HC 379 (HC 1018)
Sixth Report	The impact of Brexit on the aerospace sector	HC 380 (HC 1049)
Seventh Report	The impact of Brexit on the processed food and drink sector	HC 381
Eighth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Competition and Markets Authority	HC 985
Ninth Report	The impact of Brexit on the pharmaceutical sector	HC 382
Tenth Report	Carillion	HC 769
Eleventh Report	Pre-appointment hearing with the Government's preferred candidate for Chair of Ofgem	HC 1353
Twelfth Report	Draft National Policy Statement for Geological Disposal Infrastructure	HC 1092
Thirteenth Report	Gender pay gap reporting	HC 928
Fourteenth Report	Electric vehicles: driving the transition	HC 383
Fifteenth Report	Small businesses and productivity	HC 807
Sixteenth Report	The response from business to the Withdrawal Agreement and Political Declaration	HC 384
Seventeenth Report	Industrial Strategy: Sector Deals	HC 663
Eighteenth Report	Executive Rewards: paying for success	HC 2018
Nineteenth Report	The Future of Audit	HC 1718
Twentieth Report	Carbon Capture Usage and Storage: third time lucky?	HC 1094

Twenty-first Report	Energy Efficiency: building towards net zero	HC 1730
Twenty-second Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Financial Reporting Council	HC 2531
First Special Report	Industrial Strategy: First Review: Government Response to the Committee's Second Report of Session 2016–17	HC 337
Second Special Report	Corporate governance: Government Response to the Committee's Third Report of Session 2016–17	HC 338
Third Special Report	Apprenticeships: Government Response to the Second Joint Report of Session 2016–17	HC 450
Fourth Special Report	Leaving the EU: negotiation priorities for energy and climate change policy: Government Response to the Committee's Fourth Report of Session 2016–17	HC 550
Fifth Special Report	Pre-legislative scrutiny of the draft Domestic Gas and Electricity (Tariff Cap) Bill: Government Response to the Committee's Fourth Report	HC 865
Sixth Special Report	Leaving the EU: implications for the civil nuclear sector: Government response to the Committee's Second Report	HC 881
Seventh Special Report	The safety of Electrical Goods in the UK Government Response to the Committee's Third Report	HC 920
Eighth Special Report	A framework for modern employment: Government response to the Second Report of the Work and Pensions Committee and First Report of the Business, Energy and Industrial Strategy Committee of Session 2017–19	HC 966
Ninth Special Report	The impact of Brexit on the automotive sector: Government Response to the Committee's Fifth Report	HC 1018
Tenth Special Report	The impact of Brexit on the aerospace sector: Government Response to the Committee's Sixth Report	HC 1049
Eleventh Special Report	The impact of Brexit on the pharmaceutical sector: Government Response to the Committee's Ninth Report	HC 1426
Twelfth Special Report	Carillion: Responses from Interested Parties to the Committee's Tenth Report	HC 1392
Thirteenth Special Report	Carillion: Government response to the Committee's Tenth Report	HC 1456
Fourteenth Special Report	The impact of Brexit on the processed food and drink sector: Government Response to the Committee's Seventh Report	HC 1461

Fifteenth Special Report	Electric vehicles: driving the transition: Government Response to the Committee's Fourteenth Report	HC 1881
Sixteenth Special Report	Gender pay gap reporting: Government Response to the Committee's Thirteenth Report	HC 1895
Seventeenth Special Report	Small businesses and productivity: Government Response to the Committee's Fifteenth Report	HC 2017
Eighteenth Special Report	Industrial Strategy: sector deals: Government Response to the Seventeenth Report of the Business, Energy and Industrial Strategy Committee	HC 2295
Nineteenth Special Report	The Future of Audit: Government Response to the Committee's Nineteenth Report	HC 2296
Twentieth Special Report	Executive rewards: paying for success: Government Response to the Committee's Eighteenth Report	HC 2306