House of Commons

Business, Energy and Industrial Strategy Committee

Automation and the future of work: Government Response to the Committee's Twenty-third Report of Session 2017–19

First Special Report of Session 2019–21

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Business, Energy and Industrial Strategy Committee

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The current staff of the Committee are Gary Calder (Media Officer), Ian Cruse Committee Specialist), Rebecca Davies (Clerk), Matthew Eaton (Committee Assistant), Alison Groves (Second Clerk), Becky Mawhood (Committee Specialist), James McQuade (Senior Committee Assistant), and Ashleigh Morris (Committee Specialist).

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First Special Report

On 18 September 2019, the Business, Energy and Industrial Strategy Committee published its Twenty-third Report of Session 2017–19, on *Automation and the future of work* (HC 1093). The response from the Government was received on 12 February 2020 and is appended below.

Appendix: Government Response to the BEIS Select Committee's Twenty-third Report

Introduction

The Government thanks the House of Commons BEIS Select Committee for its report on *Automation and the future of work* (HC1093), published on 18 September 2019, and welcomes the Committee's recommendations.

The Government agrees with the Committee that growth across our economy in the adoption of technologies that support automation and other smart and digital technologies will play a crucial role in securing our future growth and prosperity and improving our productivity and that the UK has the potential to be a global leader in the new field of Smart Robotics—where widespread adoption would bring significant benefits in terms of productivity and competitiveness in a range of sectors. Of course, automation has always been key to productivity growth—for example car production lines—and is therefore essential to preserving jobs over the longer term. More broadly, the technologies enabling automation—such as Smart Robotics, Artificial Intelligence, and Internet of Things are helping the UK meet its ambition for Net Zero, and solve the Grand Challenges facing our society.

These advances in technology and wider societal trends are changing how, when and where we work. But as a country that celebrates innovation and entrepreneurship and embraces technological advancement, our labour market is well-positioned to seize the range of opportunities offered by new technologies, emerging business models and changing ways of working. The Government is absolutely committed to ensuring that everyone can enjoy the rewards that automation will bring and that the labour market continues to work for all.

Government considers automation (of tasks) to be an outcome of the implementation of a broad suite of technologies and approaches deployed in a variety of business settings, including: physical and digital automation in an industrial manufacturing context, automation software such as robotic process automation, certain artificial intelligence (AI) technologies, and where AI intersects with physical robotics—robotics and autonomous systems (RAS), sometimes also referred to as intelligent or smart robotics. Inevitably it is also a continuous and evolutionary process, rather than a defined end-state.

Government notes that the Committee's stated focus for this inquiry is physical automation and agrees on the importance of this issue. In Government's own evidence

we highlighted how robotics deployment through industry results in significant economic and productivity gains. This is supported by academic research into robotics use since the 1990s: across 17 developed countries between 1993–2007, increased robot use represented 16% of labour productivity growth (in line with the effect that the steam engine had in Britain during 1850–1910). Moreover between 1993–2016, robotics contributed 10% to the increase in GDP per capita in OECD countries. Government recognises, however, that in the course of exploring this area it was necessary for the Committee to examine a wider set of issues relating to automation in the wider sense and has taken a similar approach its response here.

Focussed on the manufacturing sector, the 2017 independent, industry-led Made Smarter Review considered robotics and automation as part of a suite of industrial digital technologies that includes artificial intelligence, industrial internet of things and additive manufacturing. As recognised in the Committee's report, the Review identified that it is the combination or convergence of a number of technologies that will deliver maximum benefits and that technologies need to meet company requirements in overcoming challenges or meeting opportunities. Exploiting these combined technologies could add £455bn to the UK economy over the next decade, create 175,000 new jobs and reduce CO2 emissions by 4.5%. The Review also pointed to the key barriers to industrial digitalisation: adoption, innovation, leadership and skills. To date, the Government's response to the Review has been focussed on actions that help to overcome these barriers, as detailed below.

More widely than manufacturing, recent developments in emerging technologies that can support automation, such as AI and RAS, are beginning to open up new sectors of our economy to 'intelligent automation'. AI presents enormous opportunities for our economy. One recent study by McKinsey found AI could be a significant driver of productivity, adding 22% to GDP by 2030. Another study this year by Microsoft estimated organisations currently using AI are outperforming those that are not by 11.5%, up from 5% a year ago. The global RAS market is also experiencing rapid growth, driven by these new applications in service and consumer robots. For example, Tractica estimate that global robotics revenue could increase fivefold from $49 billion in 2018 to $249 billion by 2025. Service and consumer robots are forecast to represent over 90% of that market, with key applications including self-driving vehicles, agricultural and logistics robots.

That is why, since 2014 when the RAS 2020 Robotics and Autonomous Systems Strategy was published, Government [through UKRI] has committed to invest £447m in projects related to RAS [with universities and industry pledging a further £227m]. Mode-specific applications of RAS, like self-driving cars, have also received significant Government attention, including the Centre for Connected and Autonomous Vehicles—a recognised world-leader in regulation for self-driving cars backed by a £250m R&D and testbed Government funding package.

Most recently, Government has strengthened its focus on RAS through with the launch of the Robotics Growth Partnership and a national ambition to "put the UK at the cutting edge of the smart robotics revolution ambition, turbo-charging economic productivity and unlocking benefits across society". The Partnership, which will bring Government together with RAS sector representatives from academia and industry, will act as both advisor to Government as well as being tasked with playing a role in helping realise the over-arching ambition. Notably, one of its Co-Chairs, Professor David Lane, was also co-

author of the original RAS 2020 strategy, highlighting our continuing engagement with key leaders in the field. A new body, its programme of work is currently being formulated in close consultation with stakeholders including key parts of Government, UKRI, sector representatives and potential end-users of RAS technologies.

Government's work on physical RAS builds on the strong foundations established through the AI Sector Deal, published in 2018. Worth up to £950m, it sets out actions to promote the adoption and use of AI in the UK and delivers on the recommendations of the independent AI review, 'Growing the AI industry in the UK', led by Professor Dame Wendy Hall and Jérôme Pesenti. Their review, published in October 2017, engaged widely with businesses, academia, investors and other stakeholders on ways to boost the UK's emerging AI sector at home and across the world. It also set out proposals to improve the institutions that support AI in the United Kingdom, to build a skilled workforce, and to stimulate access to data.

Automation Adoption

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. (Paragraph 13)

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)

The Government recognises the importance, in order to maximise the benefits to the UK, of strong leadership to support the development and adoption of new automation-linked technologies across our economy.

We also agree that, unlike with the last wave of industrial robotics where the UK failed to take the lead, with collective Government and sector leadership and focus, the Fourth Industrial Revolution presents a new opportunity for UK to be world-leading in RAS. Government is responding to this in part through the recent establishment of the new Robotics Growth Partnership. Co-chaired by two RAS sector representatives (from both academic and industrial backgrounds) and co-sponsored by a senior official in each of BEIS and UKRI, it has been tasked by Government with developing a 'sector action plan' to strengthen the Partnership and to drive RAS forward in the UK. Insofar as they could apply specifically to the RAS sector, Government and the Partnership will be taking into careful consideration the specific recommendations made here by the Committee and the valuable wider body of evidence that the Committee received and published, to help inform the new programme of work that is currently being formulated. Government also recognises a degree of convergence, most notably between certain types of AI and RAS, and therefore invests considerable effort in ensuring join-up wherever relevant—between policy teams, within UKRI as principal innovation funder, and also between the Robotics Growth Partnership and AI Council (with Partnership co-chairs Paul Clarke and David Lane also sitting on the AI Council).

However, as set out earlier in this response and supported by the evidence received by the Committee, physical automation of workplace tasks is dependent on very different technologies in different contexts. They have significant variability in technological

maturity, levels of adoption (between sectors, and within sectors between businesses of different sizes and profiles), and the types of roles they could augment or automate. These differences can be considered in the broad context of rules-based manufacturing robots and 'intelligent robots' with the ability to make autonomous or semi-autonomous decisions on their actions in increasingly complex environments, potentially shared with human beings. Moreover, the Made Smarter Review pointed to a suite of converging technologies, rather than just physical automation, as offering the most benefit to the productivity of the UK manufacturing sector.

Government therefore believes that a unified over-arching workplace physical automation strategy does not necessarily represent the most effective policy approach. We believe that more targeted leadership is required that more closely addresses the specific barriers and opportunities companies face. Government's approach should instead be seen as providing strategic leadership across (amongst others) RAS and AI as cross-cutting enabling technologies, with initiatives such as Made Smarter and the Centre for Connected and Autonomous Vehicles targeted at sector verticals.

The need for strong leadership in the area of industrial digitalisation was one of the key findings highlighted by the independent, industry-led Made Smarter Review. The Government has worked closely with industry to establish a national Made Smarter Commission, bringing Government together with industry leaders and industry associations. The Commission's leadership helps develop a vision for the future of the UK manufacturing sector and provides governance for the wider Made Smarter programme, including an adoption pilot in the North West of England.

Through the £20m North West Pilot, the Made Smarter programme is addressing the challenges for SMEs in adopting industrial digital technologies. The Pilot works with local North West manufacturing SMEs to help them exploit digital technologies, including robotics and automation, in order to access new opportunities and solve specific manufacturing challenges. We expect that the Made Smarter North West Pilot will add up to £115m to the North West economy and increase productivity across the region by up to 25% by 2030.

The AI Sector deal has also made strong progress against its commitments (outlined here in 'AI Sector Deal, one year on at https://www.gov.uk/government/publications/artificial-intelligence-sector-deal/ai-sector-deal-one-year-on), including in relation to showing strong leadership through the announcement of the AI Council in May 2019. The AI Council is an expert committee of independent members from industry, public sector and academia, providing high-level expertise and priorities. Chaired by Tabitha Goldstaub and comprising 22 leaders from a broad range of backgrounds and expertise, the Council will lead the dialogue between industry, academia and the Government on the future of AI strategy and policy. Following the first meeting of the Council in September 2019, three working groups have been established: skills; data; and narrative and perception.

Automating UK business

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)

We recognise the Committee's view that perception constitutes an important barrier to firms automating. The Government is working with industry through a range of different mechanisms to address this.

The Made Smarter Review had input from over 200 organisations, including robotics and automation companies. The Government is supporting Made Smarter with up to £167m in funding, and it is the UK's key industrial digitalisation initiative.

The national Made Smarter Commission forms a partnership between Government and industry and offers representation from manufacturers and technology providers, including robotics and automation companies. The Commission's role is to provide leadership for the UK manufacturing industry's movement to greater digitalisation across the areas of adoption, innovation and skills.

The Commission recognises that there are significant barriers to the adoption of industrial digital technologies, including automation. The Commission also understands that perception plays a key role in determining the extent to which businesses engage with new technologies.

Through the £20m Made Smarter North West Pilot, the Government is collating case studies that show the impact of technology, including robotics and automation, on manufacturing SMEs. These are available on the Made Smarter website (https://www.madesmarter.uk/). The pilot is being fully evaluated and this will provide us with information on the impact of these technologies at a firm and regional level.

Turning specifically to RAS, Government recognises that end-user perceptions are frequently identified as a key barrier to adoption of these newer technologies. The Government-backed Knowledge Transfer Network was brought together in 2014 to address this challenge. Its purpose is to link ideas and opportunities with expertise, markets and finance, and it currently manages 18 targeted networks of businesses, universities, funders and investors. Collectively, KTNs run over 400 events per year, bringing in-depth knowledge in a range of sectors with the ability to cross boundaries. The technology-focused Robotics and AI Special Interest Group helps connect a community of 1,200 robotics innovators and end-users to each other and into other KTN groups such as agri-food, health, energy, space and the built environment. To highlight one example, in March 2019 the KTN hosted over 500 delegates in Manchester for the UK's first biannual Robotics and AI showcase, with 37 exhibitors and over 50 speakers.

This activity complements that of the RAS Network, established in 2015 with a £25 million capital investment from government to establish eight RAS centres of excellence and 4 Centres for Doctoral Training (CDTs) across the UK. Its mission is to provide academic leadership in RAS, expand collaboration with industry and integrate and coordinate activities across the network and with, currently, 29 partner universities across the UK. The Network has received strong support by laboratories, partners and international collaborators, including the Science Museum, Royal Academy of Engineering, Institution

of Engineering and Technology, the research institute of Remote Applications in Challenging Environments and the Institute of Mechanical Engineers. It organises networking and strategic events such as the annual UK Robotics Week, symposia, workshops, public engagement and exhibitions. It aims to strengthen the relationship with industry by supporting interdisciplinary mobility, secondments, developing proof-of-concept (PoC) projects and running design challenges.

In addition, part of our developing programme of work with the Robotics Growth Partnership includes further engagement with the business end-user community to better understand their views specifically on deploying RAS within their businesses, beginning with an event later this month in partnership with the Whitehall & Industry Group.

On AI more generally, in June 2019 the Government published 'A guide to using artificial intelligence in the public sector'[1] which included a set of case studies to help the Public Sector address some of the questions around how AI technologies can be used to help deliver better Public Services and/or make the Civil Service more productive. In September 2019, the Office for AI, in partnership with the World Economic Forum, also published draft guidelines for AI procurement[2] which further seek to help overcome some of the perceived barriers to adoption of the technology.

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)

Government thanks the Committee for their recommendation.

The Made Smarter North West Pilot is a 30-month programme designed to test the best approaches to working with SMEs to drive increased adoption of a suite of industrial digital technologies, including robotics and automation. This Pilot could add up to £115m to the North West economy and increase productivity by up to 25% by 2030.

Evaluation is built into the Pilot at both the 18-month mark and at the end of the programme. The Pilot is also producing case studies, including fully evaluated case studies, that will be available before the end of the programme.

National rollout of adoption support through Made Smarter is subject to the availability of funding as well as consideration of the impact achieved, and the lessons learned through the North West Pilot.

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)

We agree with the Committee's emphasis on the value of advice for SMEs in order help them benefit from technologies that can improve their productivity.

1 https://www.gov.uk/government/collections/a-guide-to-using-artificial-intelligence-in-the-public-sector
2 https://www.gov.uk/government/publications/draft-guidelines-for-ai-procurement/draft-guidelines-for-ai-procurement

As well as through the trusted gov.uk website, the network of 38 Growth Hubs, supported with over £68 million in core funding from Government, provides access to information and advice for SMEs across England to help them start, grow and scale-up and signposts businesses to further support where available. In 2018, Growth Hubs supported over 130,000 businesses.

Additionally, the Business Support Helpline provided trusted and impartial advice to 31,500 businesses in 2018, of which 65% were entrepreneurs and start-ups.

The Government is also providing up to £18.6 million of funding to the business-led Be the Business initiative to help SMEs become more productive and competitive. Be the Business is an independent charity led by Sir Charlie Mayfield and backed by some of Britain's most high-profile business leaders. It helps SMEs to improve their performance by helping them to assess their current levels of productivity via its online benchmarking tool, and to become more competitive through place-based peer networks, mentoring with expert business leaders and executive education training delivered by leading business schools.

Business Basics is an innovative £9 million, four-year programme focussed on firm-level productivity. The aim of the programme is to develop evidence on the most effective ways of encouraging SMEs to adopt proven technology and business practices that can boost productivity. To do this the programme funds private and public organisations to develop new ideas and run trials. This will help address the evidence gap and establish what works when encouraging SMEs to use more technology, with the results of the trials being made available to support local and national policymaking and innovation.

Government is also dedicated to making finance markets work better for small businesses, whether they are starting up, scaling up or looking to stay ahead of the competition. With a specific focus on the manufacturing sector, the Government is also investing up to £167m in Made Smarter to support for UK manufacturers in benefiting from industrial digitalisation. This includes the £20m Made Smarter Pilot in the North West that works alongside support offered through Growth Hubs and Be the Business to provide local manufacturing SMEs with advice and intensive support, including mentoring, leadership and management training, digital road-mapping, student placements and small match-funded grants.

Through seven centres across the UK, the Government is also investing over £600m in the High Value Catapult Network to support manufacturers in introducing technology, including robotics and other automation tools, into their businesses.

Automation and the Industrial Strategy

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)

We recommend that a UK Robot Strategy includes actions that support UK automation businesses to grow and remain in the UK. (Paragraph 32)

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)

We agree that the UK has the potential to be a world-leader in the emerging service robotics sector. We have strengths in key areas underpinning the new generation of robotics and autonomous systems including software, AI, sensing technologies, design and engineering. We also have a good reputation for innovation in regulatory design and implementation, and world-leading research and technologies in specific applications such as self-driving cars and drones. We also agree with the Committee's view that service robotics have the potential to make a significant contribution across society's grand challenges.

This is supported by our long-term ambition to reach 2.4% of GDP in public and private R&D spending by 2027, reinforced in the 2019 Queen's Speech which reaffirmed this with a commitment to significantly boosting public R&D funding and to provide a framework that gives long-term certainty.

We highlight some notable areas of activity below:

Clean Growth: A wide range of robotic applications are in the market and more are under development, from offshore energy, oil rig decommissioning, nuclear to retrofitting domestic insulation. The Energy Technologies Institute is a £400m industry and government funded research institute into low carbon energy system planning and technology development to address UK energy and climate change targets. A range of robotic solutions are emerging in the food and farming to improve efficiency, manage seasonal labour shortages and reduce carbon.

The Future of Mobility: CCAV works across the UK Government to support the safe development and deployment of connected and automated vehicles (CAVs). CAVs have the potential to transform the way we travel, making road transport safer, smoother and more accessible to those with mobility issues. CCAV is working to develop the domestic and international legal frameworks to support CAV deployment. Government has committed £250m for CAV R&D and testbed investment, through to 2022, match funded by industry.

Healthy Ageing: Robotics are already in use in hospitals, surgery units and for social care in the UK. New advances show the way for increased safety, care quality and speed. A notable UK success story is CMR Surgical highlights the potential of robotics. Even in the relatively niche area of laparoscopic surgery, they are targeting a global growth ambition and in September 2019 announced a $240m fundraising round, valuing the company over £1bn.

Artificial intelligence and Data: The AI Sector Deal outlined a range of support for these burgeoning technologies. The UK has become a beacon for global AI talent (TechNation, 2018) and with our world-leading universities, public institutions such as the NHS and the Alan Turing Institute, businesses and other parties, we are supporting data-driven innovation while improving how we grow, attract and retain the best talent.

Manufacturing: The Government is providing up to £147m investment for a Manufacturing Made Smarter Industrial Strategy Challenge Fund programme, leveraging £216m in industry commitment. The Challenge supports the UK development of innovative solutions to manufacturing challenges, including through robotics and automation. This aims to raise UK manufacturing productivity by 30% and to improve resource efficiency, and a first £30m competition as part of this challenge has just been completed.

Agri-food: Government is keen to stimulate investment in automation technologies across the Agri-Food chain to help improve productivity, provide safer work environments, reduce waste and improve product quality. Through the 2013 AgriTech Strategy, Government committed £160m to stimulate businesses and academia on productivity projects through the Agri-tech Catalyst programme. More recently, the first 31 projects of the £90m Transforming Food Production were announced in June 2019, combining AI, robotics and earth observation to improve supply chain resilience in the agri-food sector and plans for post CAP Future Farming arrangements were announced, including R&D funding schemes to facilitate collaboration and pioneer innovative and efficient farming techniques.

Hazardous Environments: Government welcomes the Committee's support for the £93 million Robots for a Safer World programme. Launched in 2017 and matched by £68m of industry investment, it aims to transform how we deliver industrial and public services in extreme environments, such as nuclear and offshore energy, deep mining and space. This investment in industry and research will boost productivity, make us more resilient, and create safer, high-quality work for people.

The funding is now fully allocated and has to date provided funding to over 240 project partners from over 120 unique organisations, working across 80 projects. This is being delivered through 4 industry-inspired academic hubs (£44m); 41 R&D projects (£30m), 15 feasibility studies and 20 demonstrators (£18m).

Some notable activities supported include:

- Astroscale, in collaboration with the Satellite Applications Catapult and a British supply chain, will be testing their In-Orbit Demonstrator next year, a solution to capture space debris and redundant satellites and de-orbit them safely. Their UK operations have grown from 2 to over 25 employees in 2 years, based at Harwell.
- Underwater vision specialist Rovco, which has grown from 3 to over 30 employees in less than 3 years and raised over £4m of private investment.
- Newcastle-based Team Tao which won a $200,000 Moonshot Award at the grand final of the Shell Ocean Discovery XPrize competition. UKRI supported Team Tao to accelerate their designs and develop innovative solutions.

- Robotics and Artificial Intelligence for Nuclear (RAIN) Hub, which, in collaboration with Game Changers, hosted an event in September 2019 for 350 delegates from Sellafield, supply companies and academia. Amongst others, the event aimed to demonstrate the current use of robotics at Sellafield, invite their workforce to help shape the future role of robotics in nuclear decommissioning and to showcase next generation robotics developments (including from the RAIN hub).

UKRI supports a wide range of innovators. We are pleased to report that one of the UK's innovative SMEs highlighted by the Select Committee, Small Robot Company, received grant funding to support its growth from UKRI through the Emerging and Enabling competition in January 2018, and more recently the ISCF Transforming Food Production programme.

In addition to support to the technology sector through the AI and Data Grand Challenge and the AI Sector Deal, the Committee's report references the role of the Future Sectors team in supporting emerging sectors. This team is now working with the Robotics Growth Partnership to develop a programme of work to support the emerging RAS sector. This includes a specific focus on commercialisation, which Government recognises is a key challenge. For this, Government is providing a range of business growth and financial support, principally through Growth Hubs and the British Business Bank. The KTN network provides bespoke sector and technology support for RAI businesses to help support their growth. The Catapult network has supported nearly 6,000 SMEs and over 4000 industry collaborations. But inevitably, in a competitive, fast-changing and global marketplace, we are always looking where we could do more.

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)

Government agrees with the Committee on the need for a robotics leadership group and that this is arguably overdue. That is why, as set out earlier in this response, the Government announced the first steps in establishing the Robotics Growth Partnership in July.

The Partnership's Co-Chairs are now working with Government and key wider stakeholders on an approach to strengthening and scaling up the Partnership as part of a phased process, with the aspiration of growing it into a fully-fledged sector partnership. The Partnership will lead work to develop a response to Government's commission for a sector action plan to help unlock the potential of the RAS sector.

This will build on the strong foundations already established by the AI Sector Deal and Made Smarter programmes. Both have leadership groups (AI Council, Made Smarter Commission) comprising sector thought leaders bringing their experience and energy to help ensure the UK has the vision and strategic insight to achieve our potential.

Following publication of the Industrial Strategy White Paper in 2017, the RAS sector expressed an interest in a Sector Deal but due to concerns at the time surrounding clear and representative leadership within the sector this was not taken further. However, Government is clear proposals are an iterative process and whilst the AI Sector Deal

already drives investment and research into the RAS sector, we welcome continued discussion with the sector, potentially via the new Robotics Growth Partnership, on the best mechanisms for supporting growth in the sector.

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. (Paragraph 44)

Other parts of this response outline in detail Government's approach to supporting the adoption of automation and wider productivity tools by UK businesses, including through Made Smarter, the British Business Bank, AI Sector Deal, Annual Investment Allowance, Be the Business and the Business Basics scheme.

Specifically on tax incentives, Government's R&D tax reliefs also support businesses to invest in and develop cutting-edge technologies. Support for businesses through R&D tax reliefs rose to £4.4 billion in 2016–17, up by 14% from the previous year, supporting almost £32.8 billion of R&D expenditure. The UK offers a more generous R&D tax relief for SMEs, which provided £2.2 billion in 2016–17. Over half of the government's R&D support through tax reliefs goes to innovative SMEs. Government keeps all tax reliefs under review and they are the responsibility of HM Treasury.

Research and Innovation

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.

The UK already has some of the most business-friendly regulations in the world and is ranked 9th in the world for the ease of doing business.

The Government's 'Regulation for the Fourth Industrial Revolution' White Paper, published in June 2019, aims to maintain our world-leading regulatory environment through the development of an agile approach to regulation. The White Paper includes a number of commitments to ensure that innovation is supported. These include: the establishment of a Regulatory Horizons Council to identify the implications of technological innovation; accelerating regulatory change through a Regulators' Pioneer Fund; having a Regulators' Innovation Network to help foster a culture of experimentation across regulators and share best practice; a stronger focus on cooperation between regulators; the development of metrics on how regulators can measure the support they provide to foster innovation; and providing support, advice and best practice on public engagement techniques to shape regulatory frameworks where technologies pose complex issues, for example, those relating to moral and ethical considerations.

Trustworthy Autonomous Systems

In October 2019, Government announced a new £34m Trustworthy Autonomous Systems programme, led by the Engineering and Physical Sciences Research Council. This recognises that while autonomous systems are active across industrial sectors in specific, controlled conditions, their use in uncontrolled environments raises real challenges. Government believes that for society to benefit from autonomous systems, people need to trust them to function as expected for their purpose. Systems need to be designed and tested to ensure that they work consistently, and they need to be developed within a legal, ethical and social context.

The programme will bring research in logic, autonomy, intelligence and engineering (including robotics and vehicles) together with sciences and humanities research across psychology, sociology, economics, ethics, philosophy, law, political science, international studies, innovation management and science and technology studies. The engagement of multiple disciplines, regulators and the public is key to ensuring that autonomous systems are developed to be robust in real world situations.

In October 2019, UKRI invited proposals for a new £11.7m hub, to start in June 2020. The hub will support new research directions and application areas, while additional research 'nodes' (call to come, December 2019) will undertake fundamental, creative and multidisciplinary research in key areas, such as trust, responsibility, resilience, security, functionality, verifiability and legality.

New application areas: Self-driving cars and drones

Government actively seeks to support emerging technologies and future sectors with commercial applications. The UK is recognised as a world leader in self-driving vehicle regulation. In June 2018, the UK passed its first legislation relating to automated vehicles, the Automated and Electric Vehicle Act 2018, which set rules on how insurance claims should be handled for highly automated vehicles. KPMG ranked UK second in the world for policy and regulation for CAVs (https://home.kpmg/xx/en/home/insights/2019/02/2019-autonomous-vehicles-readiness-index.html).

CCAV and the UK Law Commissions have a three- year review of driving legislation underway to identify where existing law could hamper innovation and the safe deployment of self-driving vehicles and make recommendations. CCAV has also recently launched the world's first safety and security assurance process, CAV PASS, bringing industry and academia views, including international.

In September 2019, Government announced a £300 million investment programme into Future Flight, helping to develop new commercial flight systems, including drones, and support investment into electric and hybrid aviation. The Civil Aviation Authority aims to support safe use of drones, and in 2019 launched an Innovation Gateway (http://www.caa.co.uk/innovation) to support commercial drone innovators with regulatory challenges.

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)

The UK has an open economy that welcomes inward investment, which can strengthen UK skills, expertise and competitive advantage. The UK's automotive sector is a prime example of the beneficial impact of overseas investment. From the perspective of the founders and staff of growing businesses, joining a larger group may be seen as wholly positive, offering reward for their past efforts and new opportunities as part of a larger group. For example, an overseas owner may offer a route into new markets that would otherwise be difficult to access.

That said, we recognise legitimate concerns relating to inward investment. These apply to several sectors of the economy, beyond robotics and automation. There may be security or national interest concerns, where acquisitions by overseas firms aim to gain access to technologies or assets or where investment may lead to transfer of assets or operations over time to be closer to the acquirer's base.

Helping spinout businesses with access to finance, networking and business advice is valuable—as outlined earlier—and the UK has a rich network of incubators and accelerators that also offer valuable support. These activities help businesses to scale and make connections with investors who will support successive funding rounds. The Government would argue, however, that these steps should not be seen as "an alternative to selling-off." These measures help UK companies to be more successful, which in turn makes them more attractive to overseas investors.

In the government's view, the key measure to ensure that spinout businesses remain in the UK as they scale up is to greatly increase the provision of growth capital. Government's support for companies to set up and scale in the UK has been outlined earlier in this response.

Through the Connecting Capability Fund £100m has been allocated to universities in England to work together to pool their capability, ideas and resources—to scale their collective offer, making it easier for business and investors to access emerging IP opportunities. This can help potential spin-out companies tap into investment funding including that provided through BBB initiatives and regional funds.

Access to finance: As well as accessing Government's Start-Up Loans programme, UK spin-out companies can benefit from the broader support of the BBB and its new subsidiary to support long-term investment in innovative companies: British Patient Capital (BPC). BPC will invest £2.5 billion over 10 years to attract £5 billion of private sector finance to support innovative UK SMEs with high growth potential. In its first year, BPC[3] has established itself as the largest domestic investor in venture and venture growth capital in the UK with £334m to 12 funds. Supported by recent research[4] showing UK venture capital funds ahead of those in the USA, Government is extending Enterprise Investment Scheme (EIS) and Venture Capital Trusts (VCTs) to realise over £7 billion of new investment into high growth businesses over the next 10 years. A further £200m has been made available to March 2020 to support high growth businesses as the UK leaves the EU and will be provided through the BBB's venture capital and growth finance funding partners.

3 On 21 October 2019, British Patient Capital published its annual results https://www.britishpatientcapital.co.uk/media/british-patient-capital-full-year-results-for-the-period-ending-31-march-2019/

4 Published on 24 October 2019 and available at https://www.british-business-bank.co.uk/uk-venture-capital-returns-comparable-with-those-in-us-finds-latest-research-by-the-british-business-bank/

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)

We welcome the recommendation set out in the report and can agree to consider the future shape of the network in more detail as part of the mid-term review process in 2020. However, at this stage we are unable to agree to the specific recommendation given the constraints set out below.

RAS companies already currently interact extensively with the existing Catapult, especially the High Value Manufacturing, Offshore Renewable Energy and Satellite Applications Catapults. There are also existing regional clusters of expertise, for example around the Edinburgh Centre for Robotics and Bristol Robotics Lab.

However, before developing a new Catapult, there is an extensive scoping process which establishes the need for new intervention. Catapults are established where UK has strong research capabilities and business activity which can capitalise on research, where there is evidence of market failure or significant commercial risk, and where there is a policy imperative for government to invest in developing unique capability. Before we are able to accept a recommendation based on establishing a new Catapult, we would need to go through a rigorous scoping process in line with these criteria.

More broadly, in 2017 as part of preparation for securing a second 5-year funding package for the Catapult Network, an independent review of the network delivered a number of recommendations which were reflected in new grant funding agreements and governance/ performance management measures. A mid-term review in 2020 will assess whether the current network is achieving the objectives set out and providing value for money for the UK taxpayer, and will provide a key opportunity to consider the future shape of the network.

Additionally, the current 5-year funding package is fully allocated and does not include budget for the creation of any new Catapults so any addition to the network would be dependent on new budget.

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)

Making the most of our world leading science and technology will be vital to the UK's continued prosperity and an important part of this is making sure that we have access to all of the science, technology, engineering and maths talent we need to realise that ambition.

Government is keen to ensure that all people with the ability to do so are encouraged and supported to pursue STEM studies and careers, regardless of gender, ethnicity or other characteristics. It is particularly important to foster a diverse and inclusive research and innovation environment in fields where, historically, women and other groups have been underrepresented.

The low numbers of women in the digital technologies workforce and indeed in the academic population across the engineering and physical sciences (currently estimated to be 18% female according to Higher Education Statistical Agency 2017/18) is a well recognised issue. This lack of gender diversity presents challenges to both the people and the research undertaken in the field of automation, such as ensuring that the design of algorithmically controlled (autonomous or automated) systems is fair and transparent.

Government is already working closely with industry and academia to bring diverse talent into sectors related to automation. UKRI will shortly publish its vision and action plan 2020–25 for Equality, Diversity and Inclusion. It will set out a five-year programme to drive change to embed equality, diversity and inclusion at all levels across the research and innovation sectors, both as an employer and as a funder of research. The programme will encompass a range of routes to support diversity in the research and innovation workforce, including inspiring a wider range of groups to consider research, improving working environments, support for career development and promotion, and through funded support.

The vision will build on existing UKRI work to improve diversity in STEM by inspiring a wider range of students to consider STEM research and innovation careers, for example through the STEM ambassadors scheme—a nationwide network of over 30,000 volunteers who act as role models. 44% of whom are women, and the Women in Innovation Awards—through which women with pioneering inventions are involved in a programme of engagement with schools.

The Engineering and Physical Sciences Research Council is committed to embedding equality, diversity and inclusion, ensuring that the activities supported and research funded drives change in communities like automation and supports a system that is inclusive for all. EPSRC as part of UKRI, has been working to further equality, diversity and inclusion in engineering and physical sciences research through a range of activities such as improving gender diversity in our advisory boards, improving our peer review process to ensure fairness and working in partnership with key stakeholders to improve participation of underrepresented groups in the disciplines it is responsible for.

Further information is available at https://www.ukri.org/files/about/dps/epsrc-dp-2019 https://www.ukri.org/files/about/dps/ukri-dp-2019/

BEIS leads on programmes such as Engineering: Take a Closer Look (https://www.engineering.gov.uk) that showcase the best of UK engineering and seek to inspire the next generation of engineers.

Government established the Office for AI to oversee implementation of the AI and Data Grand Challenge and AI Sector Deal. The Office is working with partners including but not limited to UKRI, AstraZeneca, Google, Rolls-Royce, Office for Students and the Alan Turing Institute on several programmes to increase the diversity of the sector.

These include:

- 2,500 places for AI and data conversion courses starting next year, including up to 1,000 government-funded scholarships for female, black and disabled students

- Up to 200 places on a new AI Masters programmes to be funded by industry
- 16 UKRI funded AI Centres for Doctoral Training located across the country.

A prestigious new AI Fellowship scheme, run in conjunction with the Alan Turing Institute, to attract and retain top AI talent in the UK, for which it received £47m at Budget

In the Digital Strategy, published in March 2017, Government committed to enabling people in every part of society—irrespective of age, gender, physical ability, ethnicity, health conditions, or socio-economic status—to access the opportunities of the internet. In line with the Strategy, the Government has brought together businesses, local government, charities and training providers through the Digital Skills Partnership to improve digital skills across the spectrum—and to tackle this in a coordinated and coherent way. Six Local Digital Skills Partnerships have been set up, all working collaboratively with both regional and national partners to design, develop and deliver innovative digital skills provision.

Government has also formed the AI Council, an expert committee of independent members from industry, public sector and academia, providing high-level expertise and priorities. The Council's first meeting was held on 9 September, creation of a working group aimed at increasing the diversity of people studying and working in AI was agreed as an early priority.

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)

The Government remains committed to ensuring that our future immigration system supports skilled talent across all sectors and that world leading talent is attracted to, and retained within, the UK.

The Home Secretary commissioned the Migration Advisory Committee to consider salary thresholds and how a new points-based immigration system could be designed to attract the skilled and talented workers we need for the economy to continue to prosper. As part of this commission, the MAC was asked to consider the impact of exemptions from minimum salary thresholds.

The Migration Advisory Committee published their report on Tuesday 28th January. The Government would like to thank the Migration Advisory Committee for their report which we will carefully consider before setting out further detail on the UK's future immigration system.

We recognise that science, research and innovation are important to ensure the continuing prospering of the UK economy and are at the heart of the modern Industrial Strategy. The Prime Minister recently announced that the Tier 1 (Exceptional Talent) visa will be replaced by the Global Talent visa on the 20th February. This new scheme has no salary threshold and builds upon the Exceptional Talent visa by uncapping the route; expanding the list of eligible science fellowships to benefit from accelerated entry to the UK and ensuring that researchers, and their families, who are absent from the UK to undertake activities directly related to their research are not prevented from qualifying for settlement due to these absences. In addition, the Global Talent Visa includes a new UKRI Endorsed

Funder fast-track route for scientists, researchers and their teams.

These changes are the first step in delivering on the Government's election manifesto commitment to actively recruit leaders in their field to come to the UK. We are continuing to work closely with the scientific community in developing these proposals.

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)

The Government recognises the importance of international collaboration to the automation research community. The Government's priority is securing the best outcome for UK research and innovation (R&I) and creating the best possible environment for collaborations and international partnerships to flourish.

The Political Declaration envisages the possibility of UK participation in EU programmes like Horizon Europe and makes clear the UK's intention to seek association to the Euratom R&T programme. The Prime Minister has recently committed to protect, preserve and enhance our cooperation with EU Science and Research funding programmes.

The regulations for future EU programmes are still being developed. The UK has played a constructive role in the development of Horizon Europe and Euratom R&T and has aimed to influence the Programmes in line with UK interests.

If we seek association to Horizon Europe and the Euratom Research and Training Programme, the terms would need to represent a fair deal for the UK and be in the best interests of both the EU and UK.

If association does not prove possible, we are prepared to explore all avenues to maintain our international collaborations in R&D, including continued participation in ITER (an international collaboration on science and research between the EU, USA, Russia, Japan, China, South Korea and India)

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)

The UK's science and research base is among the best in the world, with four universities ranked in the global top 10 and 18 in the top 100. We're determined to build on this, and to continue to succeed as a global science superpower after Brexit.

The UK is committed to science, research and innovation and this commitment is at the heart of the Government's Industrial Strategy. International collaboration and frameworks for research and innovation are crucial to research output, growth and quality. As we move beyond the current programme, the Government remains committed to creating mutually beneficial opportunities for collaboration with European and international partners in service robotics and automation.

The Political Declaration sets out a joint ambition from both the UK and EU to continue to cooperate and exchange dialogue in areas of shared interest, including in areas such as culture, education, science and innovation.

We value the strong collaborative partnerships that we have across the EU and we recognise the importance of mobility in supporting science, research and innovation. BEIS and Home Office officials continue to work closely with the research sector to ensure that our visa arrangements are closely aligned to the sector's needs.

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)

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)

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)

The Government is determined that the UK reaps the full benefits of automation and agrees with the Committee that any near-term disruption it may have on the workforce needs to be mitigated. We want to ensure that everyone can enjoy the rewards that automation will bring and that the labour market continues to work for all.

The Government believes reskilling the workforce to meet future needs of the economy is vital. We will continue to prioritise this through:

- Establishing a new Skills and Productivity Board, which was announced in October 2019. This board will provide the government with expert advice on how to ensure the courses and qualifications on offer to students are high quality, are aligned to the skills that employers need for the future and will help increase productivity. The Board will inform how the Government supports our Further Education system, including our technical education reforms and the introduction of new employer co-designed T levels as an alternative to A levels.

- The Get Help to Retrain service, announced in July 2019. This will make up the Government's National Retraining Scheme, which is being developed to support eligible adults—particularly those whose jobs could change because of new technologies such as AI and automation—to kick start a new career. The service is now available in six major cities and regions across England and being rolled out in stages so that it can be fully tested and developed further, before being made available nationwide in 2020.

We also recognise that technology and automation have the potential to change business models and the way that we work. This is one of the reasons why the Government published the Good Work Plan in December 2018 to improve the quality of work in the future. This commits to a range of policy and legislative changes to ensure that all workers can access fair and decent work, that both employers and workers have the clarity they need to understand their employment relationships, and that the enforcement system is fair and fit for purpose. We will continue to work closely with businesses, industry associations and educational institutions to smooth this transition.

Through the Industrial Strategy we have set out an ambitious set of initiatives to support sectors and skills most at risk from automation, as well as to ensure that employers today, and in the future, have the skills needed to thrive. We have agreed eleven Sector Deals—including AI, automotive, construction, aerospace and rail. The AI Sector Deal, worth up to £950m and led by the Office for AI, is already delivering pioneering skills and data initiatives to create the jobs and markets of tomorrow. This includes £100m funding, matched by Industry, for an additional 1000 AI PhD places over the next five years based at 16 Centres for Doctoral Training at universities across the country.

The Government notes the Committee's recommendation to consider financial incentives for businesses and organisations who invest in learning and development, both for their own employees and for workers more widely. Most employers fund the work-related training of their employees, although sometimes the employee might pay for the training themselves and subsequently have the costs reimbursed.

Our current tax rules mean employers can deduct this expenditure as a business expense and employees do not pay tax or National Insurance contributions on the benefit. In certain circumstances, the rules also gives certain employees and former employees an exemption from any charge to tax in respect of costs met by their employer or former employer for certain retraining courses—enabling them to acquire skills or knowledge which might help them to obtain further employment or to become self-employed. The government keeps all tax reliefs under review and makes changes as part of the Budget process.

The Government is also absolutely committed to reducing regional inequalities. We have invited all Mayoral Combined Authorities and Local Enterprise Partnerships in England to develop Local Industrial Strategies, aimed to increase productivity and the earning power of the area. We have published 7 Local Industrial Strategies to date. As part of the West Midlands Local Industrial Strategy, it set out how it intends to support young people and adults to get the skills they need as the local economy changes. This included focusing £10m of the newly devolved Adult Education Budget on training for low paid, low skilled employees, and how the £36m Advanced Manufacturing Training Centre in Warwickshire will be a flagship facility for advanced apprenticeship programmes for young people and adults in emerging skills and technologies.