HOUSE OF LORDS

Select Committee on Digital Skills

Report of Session 2014–15

Make or Break: The UK's Digital Future

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The Select Committee on Digital Skills

The Select Committee on Digital Skills was appointed by the House of Lords on 12 June 2014 "to consider and report on information and communications technology, competitiveness and skills in the United Kingdom".

Membership

The Members of the Select Committee on Digital Skills were:

Lord Aberdare
Baroness Garden of Frognal (resigned 4 November 2014)
Lord Haskel
Lord Janvrin
Lord Lucas
Baroness Morgan of Huyton (Chairman)
Earl of Courtown
Lord Giddens
Lord Holmes of Richmond
Lord Kirkwood of Kirkhope
Lord Macdonald of Tradeston
Baroness O'Cathain

Declaration of interests

See Appendix 1

A full list of Members' interests can be found in the Register of Lords' Interests:
http://www.parliament.uk/mps-lords-and-offices/standards-and-interests/register-of-lords-interests

Publications

All publications of the Committee are available at:
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Q in footnotes refers to a question in oral evidence.

SUMMARY

This report is a call to action for the incoming Government in May 2015.

The world is being transformed by a series of profound technological changes dominated by digital—a 'second machine age'. This is already having a significant impact on the UK; over the next two decades some economists have estimated that 35% of current jobs in the UK could become automated. Digital technology is changing all our lives, work, society and politics. It brings with it huge opportunities for the UK, but also significant risks.

This demands an ambitious approach which will secure the UK's position as a digital leader. We recommend that the new Government establishes a single and cohesive Digital Agenda.

The potential value in doing so is significant; the Government estimated that the digital sector alone was worth an estimated £105 billion in gross value added to the UK in 2011. A report by the National Institute of Economic and Social Research in 2013, meanwhile, found that the size of the digital economy was almost double official estimates. Whatever the difficulties in quantifying the value, it is clear that digital is already a substantial driver for growth and will become much more so. Digital technology is transforming much more than just one sector of the economy—the whole economy has become digitised. It would therefore be a mistake to take the 'digital sector' as our sole focus of interest. Digital technology is pervasive across all aspects of life, so much so that the 'digital economy' is becoming synonymous with the national economy. The UK cannot afford to miss the opportunity or shirk the challenges this presents.

The impact of new digital technology is all encompassing—from public transport to agriculture and from household goods to financial services. Analysis of 'Big Data' is transforming healthcare and medicine, as well as consumer and public services. The 3D printing of organs assists surgeons, whilst robotic arms can be controlled by the mind. We are becoming more reliant on technologies for personal use—from social media and entertainment, to older people and those with long-term conditions now able to monitor their health from home.

Everyday activities—such as shopping, using a telephone and banking—increasingly require interaction with technology. Digital skills (the skills needed to interact with digital technologies) are now necessary life skills. Individuals and businesses alike will need skills to protect themselves online. It is not acceptable for any group to be excluded from access to digital technologies. We must aspire for the vast majority of the population to achieve the level of digital literacy needed to fully participate in society.

All of this will require universal access to the internet to engage with vital public and personal services. That is why we conclude that the Government should define the internet as a utility service, available for all to access and use.

Clusters of rapidly growing technology firms in London, Manchester, Edinburgh and other cities need producers of digital technology in sectors such as artificial intelligence, robotics, gaming and cybersecurity. There are, however, skill requirements that spread much further than these high-tech sectors. The entire workforce will need to embrace technological change and acquire new and differing levels of digital skills.

Digital technology will also challenge traditional methods of delivering education, meaning schools and teachers will have to adapt. New models of learning—such as increased online learning and employer-designed short courses—need to keep pace with evolving technology and digital change. Changing demands from firms, consumers, students and communities mean that apprenticeships, vocational qualifications and degrees need to deliver more general—and also specific—digital capabilities. Adults need more opportunities to learn throughout their lives to adjust to a world changing in ways as yet unknown. Education needs a greater emphasis on providing every citizen with adaptable digital skills. The incoming Government, devolved administrations and grant-giving bodies should agree an agenda of change for further and higher education that addresses the magnitude of the challenge; and re-examine investment in science and research.

There is widespread support for the expansion of apprenticeship programmes, but the UK's interests and ambitions need increased scale. There are not enough apprenticeships in digital subjects or apprenticeship schemes with digital featuring as an important element of content. Apprenticeships need to be seen as a viable alternative to higher education and the more traditional education routes.

The UK enjoys similar advantages in this emerging digital age to those which it had in past paradigm shifts. We are known for our inventors and innovators, engineers and entrepreneurs, outstanding creative talents, educators and scientists. Current and previous Governments have already facilitated some important decisions. From investment in science and research facilities such as the Hartree Centre and the Rutherford Appleton laboratory, to Tech City UK in London and MediaCityUK in Salford, there has been a range of essential policy initiatives—but we can and should do more. The countries ranked higher than the UK (including Switzerland, Singapore, the USA, Finland, Germany, Japan, Hong Kong and the Netherlands) have invested heavily in digital 'foundations', including up-skilling the population in technical expertise and digital capability, and driving universal access and usage.

Policymakers are redefining the role of cities in rebalancing our economy and the widespread devolution of policies and resources are taking shape. Recent efforts have also focused on identifying and encouraging local specialisms and clusters. There is scope to foster world-leading technology clusters in a number of UK regions with the right encouragement and coordination from Government, working with leading regional bodies, businesses and universities. This could give the UK a real competitive advantage in the global economy.

There is, however, still a real concern that the UK will be left behind in this new digital era; we are at a tipping point. Digital businesses can locate anywhere in the world, and if we fail to provide the right conditions for them to flourish in the UK, we will become a branch economy, much less prosperous and influential than we could be. In the short time that we have conducted this inquiry there have been frequent reminders of the pace, scale and breadth of technological change in our daily lives. There have been numerous job losses in traditional industries and cyber-attacks on organisations ranging from US Central Command to Sony Pictures. Permission has been granted in the UK to test driverless cars, Amazon are experimenting with delivering packages via drones and Asda have installed 3D scanners and printers in high street supermarkets. These examples serve as reminders that change is accelerating and the entire population is affected by the digital revolution.

Since May 2014 in the UK, thousands of digital businesses have been started and many jobs created. At the same time there have been increasing numbers of initiatives from both within and outside the Government, with more reports, strategies and announcements. The engagement of the third sector has been particularly important. But as we heard repeatedly and consistently, all this activity needs joining up; with clear leadership from the centre.

The current Government and its predecessor were not idle, but their efforts have lacked sufficient coordination. Governments can make much happen: improve general and technical skill levels across the UK; apply our research and science to commercial applications; increase awareness of cybersecurity and online safety; and support clusters of technology emerging across the country. These must all be spelt out in the Digital Agenda. Sometimes the Government will need to convene, sometimes to champion or advocate, sometimes to explain, sometimes to reassure and sometimes to stand back. At times there will be a need for investment, although we recognise the constraints on public finances; at other times it will require the pooling and reallocation of resources. We are not calling for extra funding in all areas, but rather, the smarter use of existing money.

We need a proactive Government, able to coordinate and join-up initiatives across sectors, places and organisations, with enough ambition to address head-on the national culture change required to meet the new digital age. We need a Government that will put the change required at the top of its priority list, be restless about progress, and above all make sure that the narrow concerns of individual departments do not undermine the focus of the Government as a whole (as has happened frequently in the past). The Government will not be able to deliver on its own; it must facilitate partnerships across all sectors.

The UK is at a critical juncture. No one is certain where this transformation leads or ends, but it is fast moving and all-encompassing. The incoming Westminster Government with the devolved administrations must therefore give priority to promoting a cohesive Digital Agenda which ensures that the UK survives and thrives in these radical and increasingly competitive times. The new digital age offers huge opportunities as well as significant risks; it can make the UK, or break it.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The core pre-conditions

Hard infrastructure

1. We are concerned about the pace of universal internet coverage and the delivery of superfast broadband. In particular, we find it unacceptable that, despite Government efforts, there are still urban areas experiencing internet 'not-spots', which is hampering universal coverage and the UK's international competitiveness. (Paragraph 34)

2. We agree with our witnesses who urged that the Government should define the internet as a utility service that is available for all to access and use. This is the bedrock of digital competitiveness. (Paragraph 43)

Soft infrastructure

3. We consider that the Government has a responsibility to accelerate the attainment of digital literacy across the population. Future governments must have the ambition to achieve this to realise the UK's economic potential. It must not stop there; changing technologies demand constant updating of expertise. The Government is responsible for ensuring the UK's population keeps pace with the best in the world. (Paragraph 52)

4. The paucity of women in digital and STEM (science, technology, engineering and mathematics) is holding back UK competitiveness. We agree with our witnesses that increasing the numbers of women could reap significant benefits. Girls have to be engaged earlier and across all education levels. The perception of digital and STEM jobs and subjects as male-orientated must be addressed. (Paragraph 60)

Cyber risk management

5. The rise of the digital economy brings new risks to individuals, businesses and national security. These risks include loss of assets and lack of confidence in digital technologies, resulting in unwillingness to use them. (Paragraph 71)

6. We agree with our evidence that the best way to defend against cyber risks and deter attacks is to ensure we train and deploy enough people with the relevant skills and expertise. Everyone will need a minimum level of ability in managing the risks associated with the digital economy. Resilience in the face of cyber-attacks must be built in across the economy. (Paragraph 72)

7. If the internet is to be viewed as a utility that is accessible to all, cybersecurity must, by extension, be considered an intrinsic part of our critical national infrastructure. We are concerned that there is an inadequate level of awareness amongst the population regarding online safety and personal risk management. Whilst we acknowledge that attempts have been made to increase awareness, such as through the Government's Cyber Streetwise campaign, these have not broken through. Given its importance, we believe that there needs to be a culture shift driven by the Government to ensure that the nature of the threat is better understood by the public. (Paragraph 78)

8. Individuals and small and medium-sized enterprises (SMEs) are at particular risk from cybersecurity issues due to a lack of awareness. (Paragraph 83)

Fostering and developing talent

Digital ability levels

9. When analysing the different levels of digital skills required, we find the UK Digital Skills Taskforce's three-band definition ('digital citizens', 'digital workers' and 'digital makers') to be useful, along with the UK Forum for Computing Education's application of the definitions to the workforce. (Paragraph 87)

Medium- and high-level skills

10. There is a shortage of medium- and high-level digital skills in the UK. This needs immediate attention if the UK is to remain competitive globally. To keep ahead of the international competition, the UK must ensure it has the necessary pool of digitally-skilled graduates and others at the higher level (the 'digital makers'), to support and drive research and innovation throughout the whole economy. The long-term solution to the shortage of medium- and high-level skills requires action at all levels of the 'talent pipeline'—primary, secondary, further and higher level education. (Paragraph 92)

Future-proofing our young people

11. Creativity is a strength of the UK's economy. Digital education that fosters creativity and innovation, providing students with the opportunity to test and experiment with technology, will help support this. (Paragraph 97)

12. Those who are not numerate and literate have limited access to and use of digital technologies. The UK has a long-standing systemic weakness in numeracy and literacy. It is imperative we continue to increase national levels of these core subjects to enable the UK to seize the opportunities that digital offers. (Paragraph 100)

13. We agree with our evidence that digital and technology skills should be considered complementary to numeracy and literacy. Digital literacy is an essential tool that underpins other subjects and almost all jobs. (Paragraph 105)

14. We welcome the introduction of the new computing curriculum in England as a major step towards giving the UK a competitive edge, but there are serious challenges delivering its content. Many teachers are not confident or equipped to deliver the new curriculum. (Paragraph 108)

15. New and existing teaching staff need significant contact with industry to see the latest technologies in action and subsequently pass such knowledge on to young people. (Paragraph 115)

16. The UK is taking significant steps to prepare school pupils for the future digital workforce, but we risk being let down by inconsistent training for teachers. Leadership and coordination from the Government in teacher training is essential. (Paragraph 116)

17. There is an urgent requirement for comprehensive industry input into the further education system. The Government should encourage strong partnerships between industry and colleges. Training delivery must be revamped. Further education colleges need to move up a gear and provide industry-designed and endorsed short courses that are going to lead to a job. (Paragraph 125)

18. General digital skills could be improved by including a digital element in all further education courses, as well as more specific courses for digital and technology occupations. We welcome the introduction of the National College for Digital Skills in London. More provision like this would be positive—perhaps one linked to each major cluster in the UK. (Paragraph 126)

19. The qualification and accreditation framework requires greater consistency and longevity. Employer trust in the system will be strengthened by industry-designed and endorsed certificates, delivering the necessary high standards. (Paragraph 130)

20. Skills funding is not presently targeted sufficiently to improve the capacity of the UK's workforce and grow its economy. Provision is cumbersome and slow to adapt. There is a clear opportunity for the Government here; to join-up industry, further education and funding. The Government's proposals to improve further education will not have the desired effects without an overhaul of the funding system. (Paragraph 135)

21. Apprenticeships can help plug the short- and medium-term skills gap. We believe 16–19 year-olds must be targeted by employers, teachers, and careers guidance professionals to enable them to choose and take up good apprenticeships. There is also a need to tackle negative perceptions of vocational education among schools, teachers, head teachers and parents. (Paragraph 142)

22. Including a digital element in all apprenticeship schemes, as well as offering more digital apprenticeships for specific technology occupations and sectors (taking into account the predicted changes to the labour market), could improve general digital skills. (Paragraph 143)

23. Industry needs to be encouraged to offer more apprenticeships. Industry and the Government need to work together to set ambitions for apprenticeship numbers over the next five years, working to match apprenticeships with predicted workforce shortages. (Paragraph 149)

24. Spending on overall research and development has fallen, meaning that the UK's position as a global leader in this field is threatened. This has a negative knock-on effect on the high-level talent pipeline. (Paragraph 153)

25. Universities need to be encouraged to work in partnership with industry, to make sure relevant courses are aligned with employer needs. (Paragraph 158)

26. We believe that greater transparency and availability of destination data would enable prospective students to make a more informed choice about future study at higher education level. (Paragraph 159)

27. The current careers guidance structure is outdated and does not support the needs of the future digitally-skilled workforce. It would be more appropriate to talk about 'employment' guidance. Industry has a vested interest in this; if

employers want to close the skills gap and recruit the best individuals, they must have greater involvement. (Paragraph 173)

28. We believe that a radical rethink is required to inject imagination into employment guidance. An employment guidance service needs strong central leadership which coordinates local schemes. (Paragraph 174)

29. Parents and teachers play a critical role in influencing future employment options and choices; both, however, suffer from a lack of awareness that must be addressed. For teachers, part of tackling this awareness could be achieved through increased industry exposure. (Paragraph 180)

Filling the immediate skills gap

30. Continuing Professional Development and a move to short, sharp, relevant interventions later in life are imperative for the UK's workforce to remain competitive. The development of skilling throughout life needs a fundamental rethink. The Government must be at the forefront of this change. (Paragraph 189)

31. The role of business, industry and the Government needs to be examined to deliver a cultural shift towards preparing learners to learn for themselves. (Paragraph 192)

32. The third sector should be supported to use its existing networks and increase the provision of relevant digital courses. (Paragraph 197)

33. Universities could better serve prospective students by adding the option of shorter, more flexible provision to its existing course. This could be done via targeted skills funding. Universities should ensure that all graduates are digitally competent. (Paragraph 200)

34. Immediate industry involvement to enhance the education and training agenda is vital to make sure the UK's workforce can adapt to the requirements of the new world. We recognise the Government's efforts to engage business and industry in education, but these efforts do not go far enough and are geographically inconsistent. Over the next five years the new Government has a responsibility to ensure industry-education partnerships flourish. (Paragraph 204)

35. Current immigration and visa rules do not support the urgent short-term need for talent. We agree with the House of Lords Science and Technology Committee who, in their report 'International Science, Technology, Engineering and Mathematics (STEM) students', recommended that the Government "immediately reinstate the previous post-study work route". (Paragraph 217)

36. Even if the previous post-study visa work route was reintroduced, an incoming Government could not rely solely on high-skilled immigration as the main mechanism to reduce the skills shortage in the short term. Greater emphasis is needed on cultivating home-grown talent, with a longer-term immigration policy that would still allow the UK access to the best global talent, especially to graduates. (Paragraph 218)

The business environment

Connecting and supporting business

37. Barriers holding back SMEs from reaching their full potential include their low awareness of the opportunities presented by digital technology, limited access to the necessary talent pool and skills, and challenges in accessing adequate finance. The Government has a responsibility to coordinate and facilitate the right conditions for business; but the development of knowledge and support needs to be driven by local and other networks, for example through Chambers of Commerce, UK online centres and Local Enterprise Partnerships. (Paragraph 239)

Regional ecosystems and clustering

38. The role for the Government and local leaders lies in early identification of emerging clusters and in providing targeted support. (Paragraph 252)

39. The strength of the UK is an aggregation of the power of its regional economies. To be competitive we must nurture regional specialisms. We do not know where our next big industry will come from. In this digital age the UK must be agile enough to give timely support to business opportunities. (Paragraph 255)

40. In our view there is a gap in the structural support for university-regional partnerships. Innovate UK is well-placed to identify, fund and coordinate regional opportunities for academia-industry partnerships and could do more. (Paragraph 268)

41. Research Councils are also well-placed to identify strengths in local universities and connect them with the regional area. Individual Research Councils should be given more power to do so. (Paragraph 269)

42. Growth within different areas of the UK cannot be Government-directed, nor should it be. Much expertise lies with local authorities and Local Enterprise Partnerships (LEPs). Light-touch coordination from the central Government would help facilitate reciprocal learning. It is the Government's role to intervene if local structures, including LEPs, are not working. (Paragraph 277)

Making it happen

A leading Government

43. The Government should act as the 'conductor of the orchestra' and play an enabling role, focused on business and education. Although the Government is tackling many issues through a range of initiatives, their efforts would be more effective if they were better coordinated. The Government needs to take responsibility for leading the UK through the seismic changes brought about by changing technologies. (Paragraph 297)

44. **Recommendation 1:** The Government should develop an ambitious 'Digital Agenda' for the UK: at its heart should be the Government's vision for the UK to keep up with the best leading digital economies across the board in five years' time. (Paragraph 299)

45. **Recommendation 2:** This Digital Agenda should be the responsibility of a Cabinet Minister in the Cabinet Office, who would assume ultimate responsibility for driving the Digital Agenda across all Government departments. (Paragraph 300)

46. **Recommendation 3:** The responsible Cabinet Minister should evaluate the UK's Digital Agenda on a regular basis, seeking to drive the UK's digital competitiveness. The Minister should report to Parliament annually against the measures within the Digital Agenda. We recommend an initial progress report to Parliament by summer 2016. We note that a similar practice is already undertaken by the Scottish Government. (Paragraph 301)

47. **Recommendation 4:** Our Committee has completed its work with the production of this report, but it has highlighted an issue of critical importance that will need continuing oversight; we urge the Liaison Committee to consider how best to integrate such a commitment into the future work of select committees in the House of Lords. (Paragraph 302)

A Digital Agenda for the UK

48. **Recommendation 5:** In its response to this report we invite the incoming Government to comment on the focus of our illustrative Digital Agenda and to commit to designing its own, with specific detail on how it intends to meet its objectives. (Paragraph 304)

The UK's Digital Agenda (paragraphs 305–322)

Access to digital technologies

49. Objective 1: The population as a whole has unimpeded access to digital technology.

50. This includes:

    (a) facilitation of universal internet access: the internet is viewed as a utility; and

    (b) removing 'not-spots' in urban areas.

Skill levels

51. Objective 2: The population as a whole has the right skill levels to use relevant digital technologies.

52. This includes:

    (a) a culture of learning for life, with responsibility shared between the Government, industry and the individual;

    (b) a commitment to meet the target set in the Government's Digital Inclusion Strategy, that by 2020 everyone who can be digitally capable, will be;

    (c) a commitment to increase significantly the number of girls studying STEM subjects at further and higher education, including vocational education;

(d) a target for 10% of the workforce to have high-level digital skills by 2020; and

(e) facilitation of a bigger role in skills development for industry.

Risk management and cybersecurity

53. Objective 3: Recognition of the risk and benefits of cybersecurity; the UK has a sufficient talent pool with the knowledge and abilities to keep its hard and soft infrastructure secure.

54. As part of this:

(a) cybersecurity is placed higher on the public agenda;

(b) cyber-education starts at the school level (and is extended to broader society and those not in formal education); and

(c) both individuals and businesses—especially SMEs—are targeted.

Schools and teachers

55. Objective 4: No child leaves the education system without basic numeracy, literacy and digital literacy.

56. As part of this:

(a) digital literacy is taught as a core subject alongside numeracy and literacy, embedded across all subjects and throughout the curriculum;

(b) more focus is placed on building links with employers (including somebody from industry on the governing body of every school); and

(c) delivery of the new computing curriculum is seen as a priority. In particular more investment in training new teachers and speed and urgency to train existing teachers, involving the third sector and industry.

Further education and apprenticeships

57. Objective 5: A world-leading further education system for digital skills, brought about by a comprehensive employer-led review of the further education offer.

58. This review could be commissioned at the start of the new Parliament, to be completed within six months, and conducted by the Tech Partnership. The review could examine what is needed for the future of further education, including:

(a) a consistent and agile offer across providers;

(b) facilitation of strong partnerships between industry and further education;

(c) more apprenticeships across the board—and more digital apprenticeships. All apprenticeships should include a digital skills element;

(d) an accreditation and qualification system that is fit for purpose; and

(e) a revamped skills funding system to promote short, flexible courses and apprenticeships.

Higher education and research and development

59. Objective 6: A responsive higher education system and world-leading research and development.

60. This includes:

(a) a higher education system that works with industry to align courses to employer requirements; and

(b) a review of spending on research and development aimed to ensure the UK is comparable with other leading economies.

Employment guidance

61. Objective 7: A central, online employment guidance resource. Parents and teachers are more fully aware of the opportunities offered by digital technology.

62. As part of this:

(a) access to the employment guidance resource is through social media and other channels; and

(b) change is brought about by a wholesale review.

Business involvement and support

63. Objective 8: The right conditions for industry set by the Government.

64. This includes:

(a) facilitation of industry involvement across the board;

(b) an awareness campaign about the need to improve digital skills among SMEs; and

(c) information, advice and guidance for businesses readily available through local networks.

Regional ecosystems and clustering

65. Objective 9: Regional and sub-regional strengths are recognised and encouraged. Regions build on their local specialisms, facilitated by the Government.

66. This includes:

(a) a higher education system that is closely linked with industry and regional economies; and

(b) Government intervention when a Local Enterprise Partnership or locality is weak.

Make or Break: The UK's Digital Future

CHAPTER 1: INTRODUCTION

Impetus behind the inquiry

Major technological change

1. The House appointed this ad hoc Committee to "consider information and communications technology, competitiveness and skills in the United Kingdom". The twenty-first century has already witnessed remarkable technological breakthroughs and has been considered to be a revolutionary period of history—a 'second machine age'.[1] This revolution has been driven by the development of digital technology and is taking place on a global scale—affecting everyone—at a pace that is historically unprecedented.[2]

2. Many of the giants of the digital revolution, such as Google, YouTube, Facebook and eBay, were either relatively small or non-existent at the turn of the century. The first iPhone was introduced in 2007, a mere eight years ago. Innovations in robotics and medical diagnostics have had lifesaving impacts (see Box 1) and driverless cars are now a reality.[3] We are facing a tsunami of technological change, driven by the digital revolution, affecting virtually all areas of our lives.

Box 1: Transformative health technologies

- Regenerative medicine—restoring function by replacing or restoring human cells, tissues or organs—has many potential benefits: a cure for chronic back pain; broken bones encouraged to grow back; and missing teeth regenerated.[4]
- Remote treatment technologies and self-monitoring could be transformational for healthcare: "… new medical-technology devices could help keep patients at home rather than in costly institutions, such as assisted-living facilities or nursing homes—leading to potentially big savings for the health care system".[5]

1 See: Erik Brynjolffson and Andrew McAfee, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies* (New York: W. W. Norton & Company, 2014)

2 Deloitte, London Futures: *Agiletown: the relentless march of technology and London's response* (November 2014): http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [accessed 30 December 2014]

3 For instance, see: HM Government, 'Driverless cars: 4 cities get green light for everyday trials': https://www.gov.uk/government/news/driverless-cars-4-cities-get-green-light-for-everyday-trials [accessed 17 December 2014]

4 Research Councils UK (RCUK), *Regenerative medicine*: http://www.rcuk.ac.uk/RCUK-prod/assets/documents/documents/RegenerativeMedicineTimeline.pdf [accessed 16 January 2015]

5 McKinsey & Company, 'Spurring the market for high-tech home health care': http://www.mckinsey.com/insights/health_systems_and_services/spurring_the_market_for_high-tech_home_health_care [accessed 15 January 2015]

- Rehabilitation robotics can support rehabilitation after a stroke and even replace lost limbs;[6] robotic arms attached to the human body and controlled by the mind are becoming increasingly commonplace.[7]
- Artificial intelligence entities can learn how to make health diagnoses and treatment recommendations.[8]
- Diagnostic robots can assist with the identification of illnesses such as autism, and even help with therapy.[9]

The digital economy

3. Estimates of the value of the digital economy vary.[10] The Government estimated that the digital sector alone contributed around £105 billion in gross value added (GVA) to the UK in 2011.[11] The Organisation for Economic Co-operation and Development (OECD) found that in 2012, information industries accounted for approximately 6% of total value added and 4% of total employment in the OECD area.[12] Research by McKinsey & Company found that the internet accounted for 3.4% of gross domestic product (GDP) in 13 countries studied in 2011 (6% of GDP in the UK), and 21% of GDP growth in the five years preceding 2011 in mature (most developed) countries.[13] It is clear that whatever the precise figure, the digital opportunity is huge.

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6 Department of Health, *Research and development work relating to assistive technology 2012–13* (July 2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/336321/2012–13.pdf [accessed 15 January 2015]; University of Southampton, 'Rehabilitation and Health Technologies Research' Group: http://www.southampton.ac.uk/rht/research/neurorehabilitation/upper_limb_neurorehab.page [accessed 15 January 2015]

7 'Paralysed woman's thoughts control robotic arm', *BBC News* (17 December 2012): http://www.bbc.co.uk/news/health-20731973 [accessed 15 January 2015]

8 For instance, see: 'The Robot Will See You Now', *The Atlantic* (20 February 2013): http://www.theatlantic.com/magazine/archive/2013/03/the-robot-will-see-you-now/309216 [accessed 15 January 2015]

9 'How robots are helping children with autism', *The Guardian* (1 February 2015): http://www.theguardian.com/lifeandstyle/2015/feb/01/how-robots-helping-children-with-autism [accessed 3 February 2015]

10 A report by the National Institute of Economic and Social Research (NIESR) in 2013 found that the digital economy had 270,000 active digital companies in the UK, compared to estimates of 167,000. See: NIESR, *Measuring the UK's Digital Economy with Big Data* (2014): http://niesr.ac.uk/sites/default/files/publications/SI024_GI_NIESR_Google_Report12.pdf [accessed 18 December 2014]. The Office for National Statistics (ONS) has recently consulted on measuring the digital economy. See: ONS, 'Consultation on Measuring the Digital Economy': http://www.ons.gov.uk/ons/about-ons/get-involved/consultations-and-user-surveys/open-consultations/2014/consultation-on-measuring-the-digital-economy/index.html [accessed 16 January 2015]. A recent article in The Economist emphasised how far away measures like gross domestic product (GDP) are from capturing the benefits of the internet. See: 'Hidden in the long tail', The Economist (10 January 2015): http://www.economist.com/news/finance-and-economics/21638142-consumers-reap-benefits-e-commerce-surprising-ways-hidden-long [accessed 16 January 2015]. See also: Erik Brynjolffson and Andrew McAfee, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies* (New York: W. W. Norton & Company, 2014)

11 HM Government, *Information Economy Strategy* (June 2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206944/13-901-information-economy-strategy.pdf [accessed 6 January 2015]

12 Organisation for Economic Co-operation and Development (OECD), *Measuring the Digital Economy: A New Perspective* (2014): http://www.oecd.org/sti/measuring-the-digital-economy-9789264221796-en.htm [accessed 16 January 2015]

13 McKinsey & Company, *Internet matters: The Net's sweeping impact on growth, jobs and prosperity* (May 2011): http://www.mckinsey.com/insights/high_tech_telecoms_internet/internet_matters [accessed 10 December 2014]

4. Historically, the UK's economy has performed well. The UK is currently one of the leading global digital economies (see Box 2), ranked 9th[14] in the World Economic Forum's (WEF) Global Competitiveness Index for 2014–15.[15] The UK has also ranked highly on digital indices[16], meaning that, up to now, the UK's infrastructure environment, public and private sector digital services, and education—along with other measures—have been amongst the best in the world. This adds up to a great opportunity for the UK.

5. International comparisons, however, show that in some areas the UK is lagging behind, especially in providing resources for science[17] and skills training.[18] The countries ranked higher than the UK (including Switzerland, Singapore, the USA, Finland, Germany, Japan, Hong Kong and the Netherlands) have invested heavily in digital 'foundations', including up-skilling the population in technical expertise and digital capability, and driving universal access and usage. Yet no one in the world has fully grasped the digital opportunity; it is there for the taking. Booz & Company estimated that if the UK had ranked 1st across the board[19] in 2011 it could have increased its GDP by up to a further £63 billion;[20] we believe that recognising the pervasive nature of digital technology is fundamental to the UK grasping this opportunity.

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14 Placing the UK behind Switzerland, Singapore, the USA, Finland, Germany, Japan, Hong Kong and the Netherlands.

15 World Economic Forum (WEF), *The Global Competitiveness Report 2014–2015* (2014): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014–15.pdf [accessed 6 January 2015]. The Framework includes 12 pillars: institutions; infrastructure; macroeconomic environment; health and primary education; higher education and training; goods market efficiency; labour market efficiency; financial market development; technological readiness; market size; business sophistication; and innovation.

16 15th on the WEF's Networked Readiness Index (as of 30 January 2015), which measures individual, business, and Government usage and 'readiness', as well as market, political and regulatory, and infrastructure environments: http://www.weforum.org/issues/global-information-technology/the-great-transformation/network-readiness-index [accessed 30 January 2015]. This is down six positions since the Index was published in the Global Information Technology Report 2014: http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf [accessed 30 January 2015]; 12th on the Booz & Company Digitization Index in 2012, which measures digital foundations: affordable, fast and robust broadband network of infrastructure, public- and private-sector digital services, and residents with a high level of education. See: Booz & Company, "This Is for Everyone"—The Case for Universal Digitisation (November 2012): http://www.go-on.co.uk/wp-content/uploads/2013/12/The-Booz-Report-Nov2012.pdf [accessed 30 January 2015]; and 4th on the 2014–15 Web Index produced by the World Wide Web Federation: http://thewebindex.org/wp-content/uploads/2014/12/Web_Index_24pp_November2014.pdf [accessed 3 February 2015]. This is down one position from previous years.

17 As explained in paragraph 151, the WEF showed that the UK ranked 14th in 2014 for company spending on research and development (R&D).

18 Ranking 19th for higher education and training. See: WEF, *The Global Competitiveness Report 2014–15* (2014): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014–15.pdf [accessed 30 January 2015]

19 As defined by the Booz & Company Digitization Index. See footnote 16 above.

20 HM Government, *Information Economy Strategy* (June 2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206944/13-901-information-economy-strategy.pdf [accessed 6 January 2015]; Booz & Company, *"This Is for Everyone": The Case for Universal Digitisation* (November 2012): http://www.go-on.co.uk/wp-content/uploads/2013/12/The-Booz-Report-Nov2012.pdf [accessed 16 January 2015]; and McKinsey & Company, Internet matters: The Net's sweeping impact on growth, jobs and prosperity (May 2011): http://www.mckinsey.com/insights/high_tech_telecoms_internet/internet_matters [accessed 10 December 2014]

Box 2: The digital economy

The whole economy has become digitised. It would be a mistake to take the 'digital sector' as our sole focus of interest. As digital is pervasive across most aspects of our lives, so the 'digital economy' is becoming synonymous with the national economy. Digital skills—the skills needed to interact with digital technologies—are life skills, necessary for most aspects of life.

6. It is increasingly the case that even tiny enterprises cannot proposer without using the internet—or would be unlikely to survive for very long. Customers expect businesses to provide an online service; quotes, invoices and receipts are routinely sent electronically. In order to file a tax return, businesses are expected to log on and use the internet.

7. As well as the workplace, everyday tasks increasingly require interaction with technology: delivery drivers use iPads; shoppers can 'click and collect' goods (order online and pick up in-store later); doctor, dentist and hospital appointments can be booked online; and internet banking is routine for many. Gone is the need to remember or carry around train and bus timetables—live travel information can be accessed from mobile devices while waiting at the station or stop. Paying for meals in restaurants via mobile phones is now possible; and tenants of an office block in Sweden have had microchips implanted under their skin that allow them entry and access to office machinery.[21] Every day the media carries stories of new digital advances.

The labour market and automation

8. The digital revolution is changing the labour market fundamentally. For instance, advanced robots are gaining enhanced senses and dexterity, allowing them to perform a broader range of non-routine manual tasks. This is likely to change the nature of work across industries and occupations. With the improved sensing available to robots, jobs in transportation and logistics are now, for the first time, fully automatable. The autonomous cars being developed by Google, for example, theoretically could make bus and taxi drivers, along with many logistics occupations, redundant.

9. In addition, the potential scope of automation now extends to cognitive, as well as manual work. According to a recent study, approximately 35% of the UK workforce is susceptible to automation over the next two decades.[22] The research indicates that the jobs least at risk from computerisation are in areas such as: senior management and financial services; computers, engineering and science; education; legal services; community services; the arts and media; and health care. The jobs most at risk are in: office and administrative support work; sales and services; transportation; construction and extraction; and production (manufacturing).[23]

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21 'Office puts chips under staff's skin', *BBC News* (29 January 2015): http://www.bbc.co.uk/news/technology-31042477 [accessed 2 February 2015]

22 Deloitte, London Futures: *Agiletown: the relentless march of technology and London's response* (November 2014): http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [accessed 30 December 2014]

23 Deloitte, *London Future: Agiletown: the relentless march of technology and London's response* (November 2014): http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [accessed 16 January 2015]. While automation in the past has been confined to rule-based repetitive tasks, "The ability to collect and analyse Big Data allows machine learning (ML) algorithms to perform some cognitive tasks more efficiently and effectively than labour, making possible—and desirable—the automation of some knowledge work." (page 6)

Implications for inequality

10. The benefits of recent technological innovations have not been widely shared. There is evidence that the level of automation that has occurred already is one contributing factor in new inequalities that are emerging.[24] A recent report by the Resolution Foundation[25] predicted that living standards for many low-to-middle income households in Britain were likely to be lower by 2020 than they were in 2008.[26]

The skills requirement

11. While the industrial revolution created vast employment opportunities for low-skilled workers, as the artisan shop was replaced by the factory system, the digital revolution so far has mainly created jobs for highly-skilled workers in entirely new occupations and industries. 'Big Data'[27] architects, iOS[28] developers, digital marketing specialists and data scientists are all jobs that barely existed five years ago. Furthermore, video and audio streaming, internet auctions and social networking services are all new industries that have emerged in response to recent technological developments.[29] Most of the jobs in these occupations and industries share one common characteristic: they are substantially more skills-intensive than the jobs they replace.

12. Over the coming years the UK will witness a transformation of unprecedented magnitude as workers will have to move to new occupations and industries. It is unknown whether there will be net job loss on a large scale or whether new jobs will be created in other areas—both familiar jobs and others no one has yet been able to foresee. In the past, workers have adapted to technological revolutions by acquiring new skills. To manage the coming transition successfully, an overhaul of the skills of the entire population is crucial.

13. The labour market disruption ahead may be greater than anything we have seen in the past. In this context, the task of this Committee has been to evaluate whether the UK risks falling behind, or whether it is ready to embrace these technologies; will this digital revolution make or break the UK?

The role of the Government

14. It is clear that immediate and extensive action is called for; the country must place itself in the vanguard of technological transformations.

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24 Erik Brynjolffson and Andrew McAfee, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies* (New York: W. W. Norton & Company, 2014)

25 The Resolution Foundation is a non-partisan and award-winning think-tank that works to improve the living standards of those in Britain on low to middle incomes. See: http://www.resolutionfoundation.org [accessed 2 February 2015]

26 Resolution Foundation, *Gaining from Growth—the final report of the Commission on Living Standards* (October 2012): http://www.resolutionfoundation.org/wp-content/uploads/2014/08/Gaining_from_growth_-_The_final_report_of_the_Commission_on_Living_Standards.pdf [accessed 13 January 2014]. "A typical low income household in 2020 is set to have an income 15 per cent lower than an equivalent household in 2008, a return to income levels not seen since 1993. A typical middle income household in 2020 is set to have an income 3 per cent below that of 2008, a return to income levels last seen in 2001." (page 11)

27 Big Data refers to extremely large data sets that may be analysed computationally to reveal patterns, trends and associations, especially relating to human behaviour and interactions.

28 iOS is an operating system used for devices manufactured by Apple—for example, iPhones and iPads.

29 Oxford Martin School, University of Oxford, Technology Shocks and Urban Evolutions: Did the computer revolution shift the fortunes of U.S. Cities? (2014): http://www.oxfordmartin.ox.ac.uk/downloads/academic/Technology%20Shocks%20and%20Urban%20Evolutions.pdf [accessed 15 January 2015]

15. The incoming Government in 2015 will have a major role, especially in providing resources for science, infrastructure, education and skills training. In evidence to the Committee, the Minister of State for Skills and Equalities, Nick Boles MP, described the 'everythingness' of digital change. We agree. The five years after May 2015 will be critical for the UK. There is an urgent need to clarify the role of the incoming Government in helping to manage this change positively: a comprehensive Digital Agenda for the UK is fundamental to this.

The Committee's inquiry

16. As this Committee was an ad hoc appointment, it ceased to exist on the production of this report. We were set a tight timetable to complete this report by 5 March 2015.

17. We issued our call for evidence in July 2014 and took oral evidence from 59 witnesses during 20 sessions held between July and November 2014. We received 111 pieces of written evidence and visited the following stakeholders: Guardian Media Group and Google Campus (September 2014); the BBC Blue Room and BBC Research and Development (October 2014); the Hartree Centre, Warrington (October 2014); and Imperial College London (November 2014).

18. During the oral evidence sessions, each witness was asked to provide a key suggestion as to what recommendations this Committee should make to the Government. Our witnesses provided excellent suggestions, which have subsequently been collated into a single volume and can be found on our website.[30]

19. Within our remit of considering information and communications technology, competitiveness and skills in the UK, this report focuses on:

    - The core pre-conditions: hard infrastructure; soft infrastructure; and cyber risk management (Chapter 2);
    - Fostering and developing talent: digital ability levels; medium- and high-level skills; future-proofing our young people; and filling the immediate skills gap (Chapter 3);
    - The business environment: connecting and supporting business; and regional ecosystems and clustering (Chapter 4); and
    - Making it happen: a leading Government; and a Digital Agenda for the UK (Chapter 5).

20. The Members of the Digital Skills Committee who carried out the inquiry are listed in Appendix 1, which shows their declared interests. We are grateful for the written and oral evidence that was submitted to the inquiry; the witnesses who provided it are shown in Appendix 2. We are also grateful to our two specialist advisers, Dr Carl Frey and Mr Andy Westwood, for their assistance.

21. The call for evidence is shown in Appendix 3. The evidence received is published online.[31]

30 The full list of key suggestions made by witnesses is available online at: http://www.parliament.uk/documents/lords-committees/digital-skills/key-suggestions-from-witnesses.pdf

31 Evidence published online is available at: http://www.parliament.uk/digital-skills-committee

CHAPTER 2: THE CORE PRE-CONDITIONS

22. While we recognise that there are many areas—including investment in science and cutting edge technology[32]—which will enable the UK to make the most of the digital opportunity, in our view there are three core pre-conditions to enable the UK to realise success: hard infrastructure, soft infrastructure and cyber risk management. Hard infrastructure is the physical equipment, pipes and cables necessary to run the digital economy.[33] Soft infrastructure is developing a population and workforce with the abilities and skills to use the hard infrastructure.[34] Straddling both hard and soft infrastructure is cyber risk management; defined as the protection of the UK's hard and soft infrastructure. This includes cybercrime, cybersecurity, online security and business and personal risk.

23. We were struck by the large number of witnesses who told us that skills delivery is not joined-up, and is not prioritised by the Government—in contrast to the good work of the Government Digital Service (GDS)[35] in delivering the Government's 'digital by default' agenda (see Chapter 5, paragraph 293). Although hard infrastructure has seen much investment over recent years—for example, over £1 billion of Government subsidy for broadband[36]—soft infrastructure has not received an equivalent funding priority or attention. Evidence stressed that the importance of investing in soft infrastructure should not be underestimated, as "just building it [hard infrastructure] will not guarantee it is used".[37] Go ON UK[38] summarised this point as:

> "… the full economic value of the Government's existing £1 billion investment in improving and upgrading the UK's broadband infrastructure will surely be constrained without a corresponding increase in the number of citizens with the knowledge and understanding to take advantage of this new physical infrastructure".[39]

24. Despite this relative lack of funding, we were told that investment in online skills had already reaped high returns.[40] In paragraph 44 we explain that if soft infrastructure was given an equivalent investment priority as that given to hard infrastructure, there would be significant potential for growth. An increase in the number of people with the right skills and knowledge means more will be able to make use of the hard infrastructure and digital technologies.

32 WEF, *The Global Information Technology Report 2014* (2014): http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf [accessed 30 January 2015]. "… fully leveraging ICTs is not dependent on small or medium-sized economies, but instead depends on undertaking the right investments and creating the right condition for it." (page xiii)

33 This includes broadband coverage, broadband speeds, mobile phone coverage and mobile phone functionality (4G/5G—see footnote 50).

34 Other definitions of soft infrastructure include, for example, intellectual property rights, but these are not within the scope of our inquiry.

35 The Government Digital Service is leading the digital transformation of Government, making public services 'digital by default', and simpler, clearer and faster to use. See: HM Government, 'Government Digital Service': https://www.gov.uk/government/organisations/government-digital-service [accessed 28 January 2015]

36 Q 134 (Iain Wood)

37 Q 137 (Iain Wood). For example, TalkTalk pointed out that although three quarters of the UK population had access to the superfast broadband network, take-up stood at just 9%. See written evidence from TalkTalk (DSC0105)

38 Go ON UK is a charity responsible for helping people and businesses get online. See: http://www.go-on.co.uk [accessed 2 February 2015]

39 Written evidence from Go ON UK (DSC0079)

40 Q 134 (Iain Wood)

Part I: Hard infrastructure

"It would be really rather ironic if at the end of this we had 95% coverage across the whole of Cornwall and Northern Ireland but only 85% coverage across the whole of the city of London".[41]—Sean Williams, Group Director Strategy, Policy and Portfolio, BT

Box 3: Key Statistic: Hard infrastructure

- The UK has significantly increased its superfast broadband[42] coverage in recent years from 55–60% in 2013 to 70–75% in 2014.[43]

25. There was varying evidence on the state of the UK's hard infrastructure. Some witnesses told us that the UK's infrastructure was relatively good, particularly when compared with international competitors.[44] Others suggested that the UK was beginning to fall behind in a number of respects.[45]

26. We heard from Dominic Field of Boston Consulting Group that the UK's hard infrastructure was "in relatively good shape".[46] According to Ofcom's 2014 European Broadband Scorecard, the UK compared favourably in terms of internet infrastructure, with 95% of all households having access to current generation broadband services;[47] this was equal with the top five performing countries in the European Union (EU) (France, Germany, Italy, Spain and the UK).[48] In terms of superfast broadband, the UK also saw improved performance (see Box 3 above). The UK had the highest level of coverage of the top five EU countries, overtaking Germany (which had 65–70% coverage).[49]

27. Paul Willmott from the consultancy firm McKinsey & Company was also positive about the UK's hard infrastructure. In particular, Mr Willmott focused on broadband and 4G[50] broadband penetration, claiming that the UK was "in the top tier globally on those metrics".[51]

28. The Government's evidence highlighted a number of actions it was taking to improve hard infrastructure (see Appendix 5) and noted that the UK performed comparatively well at an international level across a range of

41 Q 85
42 "Super-fast [or 'next generation'] broadband is generally taken to mean broadband products that provide a maximum download speed that is greater than 24 Mbit/s [megabits per second]. This threshold is commonly considered to be the maximum speed that can be supported on current generation (copper-based) networks." Source: Ofcom, *Review of the wholesale local access market* (March 2010), page 8: http://stakeholders.ofcom.org.uk/binaries/consultations/wla/summary/wlacondoc.pdf [accessed 3 February 2015]
43 Written evidence from Go ON UK (DSC0079). See also: Ofcom, *The European Broadband Scorecard* (March 2014): http://stakeholders.ofcom.org.uk/binaries/research/broadband-research/scorecard/European_Broadband_Scorecard_2014.pdf [accessed 4 December 2014]
44 For instance, Q 80 (Dominic Field) and written evidence from Cornwall and Isles of Scilly Local Enterprise Partnership (LEP) (DSC0054)
45 For instance, written evidence from Communications Consumer Panel (CCP) (DSC0068) and Innovate UK (DSC0070)
46 Q 80
47 See footnote 43.
48 Written evidence from Go ON UK (DSC0079). See also: Ofcom, *The European Broadband Scorecard* (March 2014): http://stakeholders.ofcom.org.uk/binaries/research/broadband-research/scorecard/European_Broadband_Scorecard_2014.pdf [accessed 4 December 2014]
49 *Ibid.*
50 The 'G' in 1G, 2G, 3G and 4G stands for the 'generation' of the mobile network. The higher number before the 'G' means more power to send out and receive more information. O2 and Vodafone launched their 4G networks in the UK in August 2013. 4G has internet speeds up to five times faster than 3G.
51 Q 71

external indicators:[52] 9th in the world in the Networked Readiness Index 2014;[53] top of the EU5[54] for take-up of superfast broadband, with nine connections per 100 people, and usage amongst those connected more than twice that in other major EU countries;[55] and the lowest priced broadband amongst the EU5 and the USA.[56]

29. The evidence showed, however, that wider international comparisons provided a less complimentary picture; for example, when compared to South Korea, which announced in January 2014 its plans to deliver a national 5G wireless network offering speeds of 1 gigabits per second (Gbps) by December 2020.[57] Marcus Mason from the British Chambers of Commerce noted that the UK had "begun to lag behind on 4G" and that the development of 5G could be an opportunity for the UK to take the lead.[58] In addition, since the Networked Readiness Index was published in 2014, the UK's position has fallen by six places to 15th.[59]

30. The UK was also thought to be falling behind in broadband speed.[60] A report by Digital Business First[61] claimed that 10 million UK premises (homes and businesses) were currently unable to access superfast broadband services (and were limited to only standard broadband, or in some cases, no broadband at all).[62] Data from Ookla's Net Index Explorer[63] found that in in January 2015, London's average download broadband speed ranked 26th out of 33 other European capital cities.[64] With an average speed of 25.44 megabits per second (Mbps), London's score contrasted drastically with Bucharest (which came 1st), which had average speeds of 80.14Mbps (see Appendix 6). The data showed London had a speed more than 10Mbps slower than the European average of 36.4Mbps. Hyperoptic[65] noted that London had dropped four

52 Written evidence from HM Government (DSC0084)
53 WEF, 'Networked Readiness Index 2014' (published in Global Information Technology Report 2014): http://widgets.weforum.org/global-information-technology-report-2014 [accessed 4 December 2014]
54 Collectively, France, Germany, Italy, Spain and the UK are sometimes referred to as the 'EU5'.
55 Ofcom, *Infrastructure Report: 2013 Update* (October 2013): http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/infrastructure-report/IRU_2013.pdf [accessed 4 December 2014]
56 Ofcom, *International Communications Market Report* (December 2013): http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr13/icmr/ICMR_2013_final.pdf [accessed 4 December 2014]
57 Written evidence from Go ON UK (DSC0079)
58 Q 71
59 Correct as at 9 February 2015: WEF, 'Networked Readiness Index': http://www.weforum.org/issues/global-information-technology/the-great-transformation/network-readiness-index [accessed 9 February 2015]. Down six positions since the Index was published in the *Global Information Technology Report 2014:* http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf [accessed 30 January 2015]
60 Q 71 (Marcus Mason), written evidence from Bath Spa University (DSC0004), David Chan (DSC0007), Elix-IRR (DSC0046), Here East (DSC0048), Cornwall and Isles of Scilly LEP (DSC0054), CCP (DSC0068), The City of London Corporation (DSC0090) and Federation of Small Businesses (DSC0103)
61 Digital Business First is a campaign that was set up by business leaders in Oxford. Its central message is that enabling a faster, more connected infrastructure for the UK is the best way to promote growth and jobs. See: http://www.digitalbusinessfirst.com [accessed 2 February 2015]
62 Digital Business First, *The UK's Enduring Broadband Deficit: A divided nation: time for an effective plan* (March 2014): http://media.wix.com/ugd/aba692_b90320e5f53c426a82fe8edb699c3dfa.pdf [accessed 4 December 2014]
63 Based on millions of recent test results from Ookla Speedtest (see: http://www.speedtest.net), this index compares and ranks consumer download speeds around the globe. The value is the rolling mean speed in Mbps over the past 30 days. Only tests taken within 300 miles of the server are eligible for inclusion in the index.
64 Ookla, 'Net Index Explorer': http://explorer.netindex.com/maps# [accessed 16 January 2015]. Data correct as of 16 January 2015. Any European cities not included is due to lack of data.
65 Hyperoptic is the UK's leading fibre-to-the-home provider. See: https://hyperoptic.com/web/guest/home [accessed 2 February 2015]

places in the league table, having been 22nd out of 33 in 2009 with average speeds of 7.1Mbps. Although London's speed increased by 270.3%, this did not keep up with other European cities.[66]

31. On a global scale, the UK's broadband speeds were described in The Times in early 2015 as being "stuck in the slow lane".[67] A report by Akamai (a US cloud computing[68] company) found that the UK's average broadband speed was 10.7Mbps in the third quarter of 2014—ranking the UK 19th in the world for average speeds and 12th in Europe. This result contrasted with South Korea, which had over double the average speed of 25.3Mbps. Whereas Ireland experienced a 10% jump in speed since the last quarter (ranking 7th globally), the UK's result was 3.7% lower than the previous measurement.[69]

Internet 'not-spots'

32. There is an issue in urban areas, where "the economics of deploying fibre [broadband] can be just as challenging as in rural areas".[70] This was described as "not-spots"[71] and also "white areas" or "white spots".[72] In these circumstances, businesses were still having difficulty connecting to fixed and mobile broadband, including in areas such as Essex and Doncaster.[73] Mr Mason pointed out that this could hamper business growth, both in trading internationally and in developing e-commerce business.[74]

33. The Government has made significant efforts in this area. In December 2014, the Government announced a legally binding agreement with mobile operators: to make a guaranteed £5 billion investment to improve mobile infrastructure by 2017; and to guarantee voice and text message coverage from each operator across 90% of the UK's geographic area by 2017, "halving the areas currently blighted by patchy coverage as a result of partial 'not-spots'". This will also result in cutting total 'not-spots', where there is currently no mobile coverage, by two-thirds.[75] We believe it is important that the UK does not become complacent.

34. **We are concerned about the pace of universal internet coverage and the delivery of superfast broadband. In particular, we find it unacceptable that, despite Government efforts, there are still urban**

66 Hyperoptic, 'London's 'digital economy' hindered by poor broadband infrastructure': https://www.hyperoptic.com/web/guest/press [accessed 10 December 2014]

67 'British broadband speeds fail to hit promised target', *The Times* (13 January 2015): http://www.thetimes.co.uk/tto/business/industries/technology/article4321317.ece [accessed 19 January 2015]

68 Cloud computing is the practice of using a network of remote servers hosted on the internet to store, manage and process data, rather than a local server or a personal computer.

69 Akamai, State of the Internet (2014): http://www.akamai.com/stateoftheinternet [accessed 19 January 2015]

70 Supplementary written evidence from BT (DSC0104). Fibre broadband ('fibre') is seen as the future of broadband. Fibre broadband uses fibre optic cable and is capable of delivering very high-speed internet connections (significantly faster than conventional broadband services).

71 Written evidence from EE (DSC0026) and Northern Ireland Government (DSC0125)

72 Q 85 (Sean Williams) and supplementary written evidence from BT (DSC0104). "Not-spots" (or "white areas" or "white spots") indicate regions where there is no broadband infrastructure and where no such infrastructure is likely to be developed in the near future (taken to mean three years). Definition taken from: Olswang, 'EU guidelines on State aid for broadband networks': http://www.olswang.com/articles/2012/07/eu-guidelines-on-state-aid-for-broadband-networks [accessed 7 December 2014]

73 Q 71 (Marcus Mason)

74 *Ibid.*

75 Department for Culture, Media & Sport (DCMS), 'Government secures landmark deal for UK mobile phone users': https://www.gov.uk/government/news/government-secures-landmark-deal-for-uk-mobile-phone-users [accessed 20 January 2015]

areas experiencing internet 'not-spots', which is hampering universal coverage and the UK's international competitiveness.

The internet as a utility

35. The OECD noted the internet "directly supports two key engines of long-term economic growth—knowledge accumulation and technological advancement".[76] In addition, as "the internet economy gains momentum, the economic landscape changes", with the internet now "widely considered a fundamental infrastructure in OECD countries, in much the same way as electricity, water and transportation networks", and referred to as a "general purpose technology".[77]

36. We were attracted to this approach, but as yet the UK is behind many other OECD countries as it does not view the internet as a fundamental part of the nation's infrastructure.

37. In Chapter 1 we outlined the importance of the internet to everyone's lives—at work and at home. Later in this Chapter we show the personal and economic benefit of online skills; which will only be secured with universal access to the internet. As Lucy Hastings from Age UK said: "… access to the internet should be treated as a utility service".[78] We agree. The Government should make it its ambition to ensure universal access for the entire population. If this could be achieved, the UK would be well-placed to achieve significant growth.

38. Elix-IRR[79] said that the Government could help support increased access through municipal wireless networks, something that other countries have already started doing: "Universal free Wi-Fi in large cities would support the development of digital capabilities … Cape Town and Singapore are just two of the cities that currently do this for economic and social benefit".[80]

39. Cape Town has a Universal Broadband Network Strategy (see Box 4), and recognises that "Access to the internet is critical for economic development. A lack of access effectively shuts out people from participation in the formal economy and the global information highway."[81] The scheme, however, has drawn criticisms for not being ambitious enough. According to The Atlantic, "It offers too little data—and, with a completion date of 2030, [is] too late."[82]

40. Estonia—often cited as the most connected OECD country—is a member of the Freedom Online Coalition[83], as is the UK. Estonia considers internet

76 OECD Digital Economy Papers No. 242, *Skills and Jobs in the Internet Economy* (October 2014): http://www.oecd-ilibrary.org/science-and-technology/skills-and-jobs-in-the-internet-economy_5jxvbrjm9bns-en [accessed 19 January 2015]

77 *Ibid*. Also see Q 224 (Andreas Schleicher)

78 Q 142

79 Elix-IRR is an independent management consulting firm providing advice on strategy, transformation, change and execution. See: http://www.elix-irr.com [accessed 22 January 2015]

80 Written evidence from Elix-IRR (DSC0046)

81 City of Cape Town, 'City's broadband achieves major milestone': https://www.capetown.gov.za/en/Pages/Citybroadbandachievesmajormilestone.aspx [accessed 19 January 2015]

82 CityLab, 'Cape Town's Universal Wi-Fi Program Isn't Ambitious Enough': http://www.citylab.com/tech/2014/08/cape-towns-universal-wi-fi-program-isnt-ambitious-enough/379262 [accessed 19 January 2015]

83 The Freedom Online Coalition is a partnership of 24 governments, working to advance internet freedom. Coalition members work closely together to coordinate their diplomatic efforts and engage with civil society and the private sector to support internet freedom—free expression, association, assembly and privacy online—worldwide. See: https://www.freedomonlinecoalition.com [accessed 2 February 2015]

freedom "to be an undivided part of human rights".[84] The Public Information Act (2000) in Estonia guarantees that "Every person shall be afforded the opportunity to have free access to public information through the Internet in public libraries."[85]

Box 4: Universal WiFi in Cape Town

"The City's fibre optic cables provide the backbone of wireless networks now being tested in Khayelitsha and Mitchells Plain. Once the technical model has been finalised, this will bring internet connectivity and other telecommunications services to over a million people living in areas which the private sector has not serviced adequately until now.

"This project builds on the success of the City's SmartCape project, which provides free internet access at 102 public libraries throughout the metro. Today the SmartCape project has expanded to provide Wi-Fi internet access in public buildings, and has over 300,000 users.

"This service, in contrast with other cities, will see Wi-Fi services provided in underserviced communities in a sustainable manner. It is envisaged that we will have a Mesh Network which will provide extensive Wi-Fi coverage beyond just a limited number of hot spots and directly into most people's homes."[86]

41. The Independent Library Report called for the Government to make funding available to "enable local authorities to extend [free] WiFi access, computer facilities and workforce training for all public libraries in England".[87] While we note that there are fewer libraries than previously, with more closures planned, we were struck by the idea that increased WiFi access would "meet user needs" and "encourage a wider demographic" into libraries.[88] In the UK many more local institutions—such as schools—could extend the range of their WiFi access to the local community.[89] For example, the Vice Principal of George Spencer Academy, Paul Hynes, told us that the school was in the position to "push out our wireless network to the local community".[90]

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84 Permanent Mission of Estonia in Geneva, 'Human Rights and Estonia': http://www.genf.vm.ee/estonian_foreign_policy/aid-1636 [accessed 20 January 2015]. Indeed, Sir Tim Berners-Lee, inventor of the World Wide Web, has called for the internet to be recognised as a basic human right in the UK. See: Web Index: http://thewebindex.org/blog/recognise-the-internet-as-a-human-right-says-sir-tim-berners-lee-as-he-launches-annual-web-index [accessed 3 February 2014]

85 Ministry of Justice, 'Public Information Act 2000': http://www.legaltext.ee/text/en/X40095K2.htm [accessed 20 January 2015] (section 33)

86 City of Cape Town, 'City's broadband achieves major milestone': https://www.capetown.gov.za/en/Pages/Citybroadbandachievesmajormilestone.aspx [accessed 19 January 2015]

87 DCMS, *Independent Library Report for England* (December 2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388989/Independent_Library_Report-_18_December.pdf [accessed 22 December 2014]

88 *Ibid.*

89 This would be similar to BT Openzone: people with BT Broadband have a router which as well as giving the customer broadband access is also transmitting the BT Openzone signal. In effect, all customers of BT provide WiFi access by using part of their bandwidth.

90 Q 161. Supplementary written evidence from the school provided further details: "Our system involves the school having a transmitter on an existing mast (cost approx. £800) and each transmitter can distribute wireless internet access to up to 100 receivers (cost approx. £45 each) that are placed on the houses of the people who are part of the scheme. These could be the homes of our own disadvantaged students who we have provided a device for (all free of charge) or members of our community that pay for the service. The system does away with the need for a landline connection which for the first time makes home internet access a possibility for any households that find themselves unable to get a landline." See: Supplementary written evidence from George Spencer Academy (DSC0127)

42. The evidence highlighted other good initiatives across the UK. The City of London Corporation, for example, said it provided "a free Wi-Fi network covering approximately 85% of the Square Mile's public areas", with usage "increasing by 11% per month".[91] In December 2014, Greater Manchester announced its plans to install mobile internet on all trams and bus services across its Metrolink network at the start of 2015, set to be completed by the spring.[92] This is a welcome initiative, and one that we hope will be replicated throughout the UK.

43. **We agree with our witnesses who urged that the Government should define the internet as a utility service that is available for all to access and use. This is the bedrock of digital competitiveness.**

Part II: Soft infrastructure

Digital inclusion

> "The possible benefits to the Government, to businesses and to our society are so considerable that we must make this investment."[93]—UK Digital Skills Taskforce[94] and TeenTech CIC

Box 5: Key Statistic: Digital inclusion

- Universal digitisation, including universal digital access, could be worth up to £63 billion in additional annual GDP growth.[95]

44. Evidence from Go ON UK and others showed that inclusive access to the internet and digital technologies maximised the UK's potential for future economic growth, as well as enabled workers to participate more fully in the future labour market. Appendix 7 provides Go ON UK's definition of "basic" digital skills. Research by Go ON UK with Booz & Company showed universal digitisation (including universal access) could be worth up to £63 billion in additional annual GDP.[96] Furthermore, the value of a minimum level of online skills and access to online services for individuals (who were

91 Written evidence from The City of London Corporation (DSC0090)

92 'Work on kitting out all Metrolink trams with free wi-fi internet to start in January', *Manchester Evening News* (16 December 2014): http://www.manchestereveningnews.co.uk/news/greater-manchester-news/work-kitting-out-metrolink-trams-8295876 [accessed 30 December 2014]

93 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

94 The UK Digital Skills Taskforce, chaired by Maggie Philbin (former Tomorrow's World presenter, technology broadcaster and CEO of TeenTech), was commissioned by the leader of the Labour Party, the Rt Hon Ed Miliband MP, to report on the state of the UK's digital skills. The independent Taskforce engaged with hundreds of organisations to look at what needed to be done to nurture home-grown talent to meet the needs of the UK's modern economy. Their aim was to gather practical suggestions and understand what people working within education and industry felt needed to change, based on real-world experience. See: http://www.ukdigitalskills.com [accessed 10 February 2015]

95 Booz & Company, *"This Is for Everyone": The Case for Universal Digitisation* (November 2012): http://www.go-on.co.uk/wp-content/uploads/2013/12/The-Booz-Report-Nov2012.pdf [accessed 16 January 2015]. "The U.K. could have increased its 2011 GDP by up to £63 billion if it had achieved global digital leadership, as defined by the Booz & Company Digitization Index … The index is calculated by quantifying 23 key metrics, which provide either direct or proxy indicators for the maturity of the country's digital foundations and digital usage. Based on 10 years of historical data, the Booz & Company Digitization Index has been stress tested for statistical significance and correlation with changes in GDP. A more detailed description of the methodology, which has been peer-reviewed by the academic community and was included in the 2012 WEF report on digitisation, can be found in Booz & Company's 'Maximizing the Impact of Digitization'." (page 9)

96 Q 141 (Iain Wood), written evidence from Elix-IRR (DSC0046), Go ON UK (DSC0079) and TalkTalk (DSC0105). See also: Booz & Company, *"This Is for Everyone": The Case for Universal Digitisation* (November 2012): http://www.go-on.co.uk/wp-content/uploads/2013/12/The-Booz-Report-Nov2012.pdf [accessed 15 December 2014]

previously offline) was estimated at £1,064 per year.[97] This increased to £3,568 a year for those individuals who progressed to more advanced skills (such as the daily use of digital technologies in their job).[98] Part I of Chapter 3 discusses in more detail the different levels of digital skills required (see paragraphs 84–87).

45. It is important that the core package of digital skills extends beyond a minimum level, to the skills required for almost all jobs. Many entry-level jobs require some degree of interaction with digital technologies—whether this be carers, personal services, sales and sales-related jobs, transport and machine operators, delivery drivers, or cashiers. For instance, as Dr Lisa Payne told us: "It is a new requirement that low-skill manual employees such as cleaners need digital skills, for instance to manage their holiday requests and other HR [human resources] activities through websites."[99]

46. To maximise the UK's full economic potential, the entire population (including all school pupils—see paragraphs 109–116) will need to have access to the internet and digital technologies, and the ability to use them. The evidence identified, however, that digital inclusion (see Box 6) was a persistent problem in the UK—specifically, for those with disabilities, older people and those from lower socio-economic backgrounds.

Box 6: The Government's definition of digital inclusion

The Government's Digital Inclusion Strategy provides the following definition:

"Digital inclusion, or rather, reducing digital exclusion, is about making sure that people have the capability to use the internet [and wider technology] to do things that benefit them day to day …

"Digital inclusion is often defined in terms of:

- "Digital skills—being able to use computers and the internet. This is important, but a lack of digital skills is not necessarily the only, or the biggest, barrier people face.
- "Connectivity—and access to the internet. People need the right infrastructure but that is only the start.
- "Accessibility—services should be designed to meet all users' needs, including those dependent on assistive technology to access digital services. Accessibility is a barrier for many people, but digital inclusion is broader."[100]

47. Caution is necessary when using statistics to discuss digital inclusion (and by the same token, digital exclusion), because the term is difficult to quantify. The National Institute of Adult Continuing Education (NIACE),[101] for

97 Written evidence from Go ON UK (DSC0079)
98 *Ibid.*
99 Written evidence from Dr Lisa Payne (DSC0031)
100 Cabinet Office, 'Government Digital Inclusion Strategy' (April 2014, updated November 2014): https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy [accessed 3 December 2014]
101 Founded in 1921, the National Institute of Adult Continuing Education (NIACE) is an educational charity in England and Wales, dedicated to promoting adult learning. See: http://www.niace.org.uk [accessed 22 January 2015]

example, said: "The exact statistics for digital exclusion differs according to source and definition".[102]

48. Nevertheless, we heard evidence that a significant number of people in the UK are at risk of exclusion: an estimated 20% of the population (9.5 million people) lacked a minimum level of digital skills.[103] Of this group, 49% were disabled, 63% were over 75 and 60% had no formal qualifications.[104] Furthermore, 37% of social housing tenants lacked basic digital skills, whilst 33% of people with registered disabilities had never used the internet.[105] Appendix 12 shows the overall percentage of internet non-users across the UK, broken down by region.

49. We were told that increased access to digital and online skills improved chances of employment—for example, by enabling people to apply for the 164,000 UK job vacancies[106] which were only posted online. As a consequence, Frog Education[107] noted that the expertise, skills and potential output of the older generation (an example of a digitally excluded group) were not being exploited.[108]

50. The economic benefits of improving online access amongst the population were contrasted with the estimated cost for delivery. It was argued by the UK Digital Skills Taskforce and TeenTech CIC that the potential benefits of equipping 100% of the UK adult population were "so considerable that we must make this investment".[109]

51. Additional benefits of reducing digital exclusion included enhanced access to information and services across a broad range of areas, including health, consumer issues and finance.[110] Respondents stressed that technology could be used to the benefit of those with disabilities by removing or ameliorating impairment,[111] and for older people by keeping them socially engaged from their home.[112]

52. **We consider that the Government has a responsibility to accelerate the attainment of digital literacy across the population. Future governments must have the ambition to achieve this to realise the UK's economic potential. It must not stop there; changing technologies demand constant updating of expertise. The Government is responsible for ensuring the UK's population keeps pace with the best in the world.**

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102 Written evidence from NIACE (DSC0088)
103 Q 113 (Rachel Neaman), Q 136 (Iain Wood), written evidence from Tinder Foundation (DSC0077), Go ON UK (DSC0079) and TalkTalk (DSC0105)
104 Written evidence from Tinder Foundation (DSC0077)
105 Written evidence from HM Government (DSC0084)
106 164,000 is 25% of the overall number of UK job vacancies. Source: ONS, 'Labour Market Statistics, August 2014': http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/august-2014/index.html [accessed 3 December 2014]
107 Frog Education is an education technology solution provider that works with primary and secondary schools around the world to help them engage students and raise education attainment. See: http://www.frogeducation.com [accessed 2 February 2015]
108 Written evidence from Frog Education (DSC0071)
109 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
110 Written evidence from Go ON UK (DSC0079)
111 Written evidence from Association for Learning Technology (ALT) (DSC0057)
112 Written evidence from Institution of Engineering and Technology (IET) (DSC0049)

Women

"… often there are more iPads in the room than there are women. It is shameful."[113]—Iain Wood, Public Affairs Manager, TalkTalk

Box 7: Key Statistic: Women

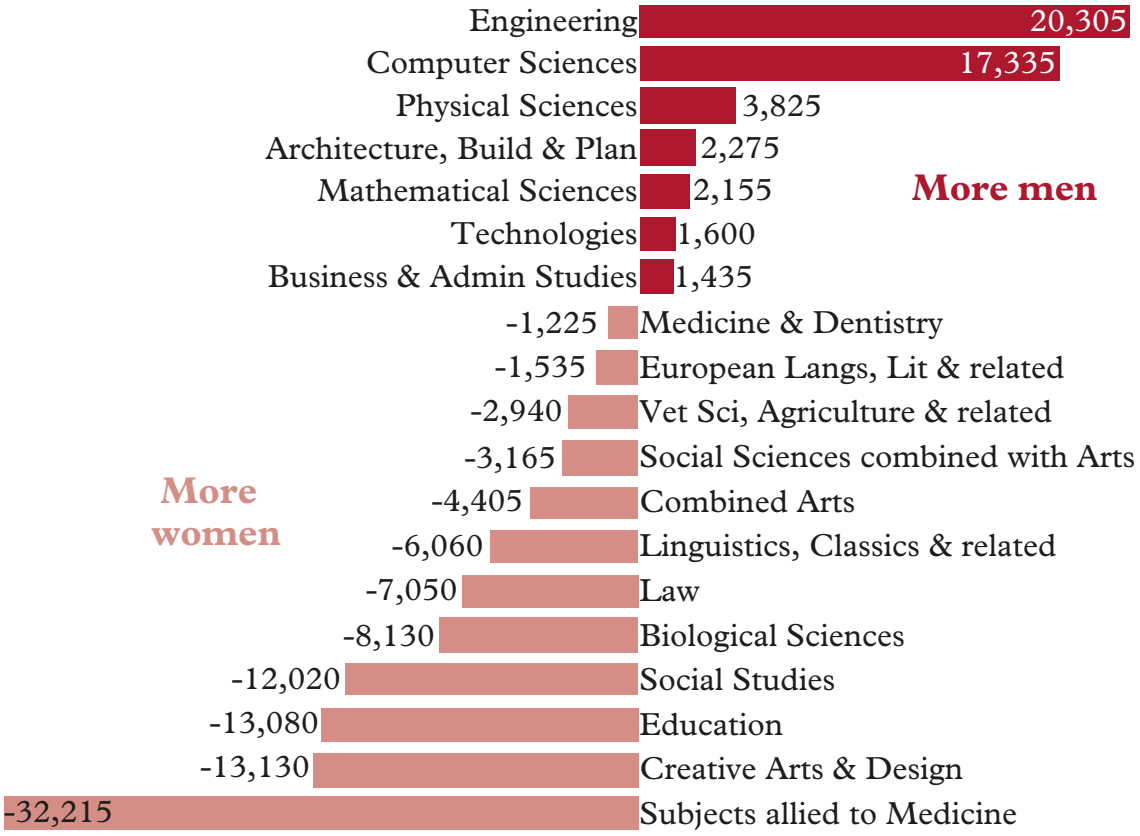
- Increasing the number of women working in information technology (IT) could generate an extra £2.6 billion each year.[114]

53. Women make up under 30% of the information and communications technology (ICT) workforce, comprising around 20% of computing graduates and under 10% of app[115] developers.[116] Elix-IRR saw this as drastically holding back the UK from fulfilling its economic potential.[117] Mr Mason said that businesses must be made to realise that whilst there is a social imperative, "there is also a very strong talent pipeline imperative", and if you can "crack the issue" of getting more girls into those types of career, there could be huge business benefits.[118]

54. Some witnesses considered that the lack of women was wider than digital, as women make up only 6% of the engineering workforce[119] and only 15.5% of the science, technology, engineering and mathematics (STEM) workforce.[120] This is an education and careers guidance issue—for instance BCS, The Chartered Institute for IT (BCS)[121], noted that of 4,000 students who took computer science at A level, less than 100 were girls.[122] The University and Colleges Admissions Service found that in 2014, "17,300 more men than women enter computer science, and 20,300 more men enter engineering [see Chart 1 below]. In both these areas men make up over 85 per cent of acceptances".[123]

113 Q 133
114 Centre for Economics and Business Research, *Women in IT: closing the gender gap* (April 2014): http://www.nominet.org.uk/sites/default/files/Women_in_IT_closing_the_gender_gap_report_Cebr.pdf [accessed 13 February 2015]
115 A mobile 'app' (application) is a computer programme designed to run on smartphones, tablet computers and other mobile devices.
116 Written evidence from Confederation of British Industry (CBI) (DSC0074) and supplementary written evidence from Microsoft (DSC0006)
117 Written evidence from Elix-IRR (DSC0046)
118 Q 74
119 Women's Engineering Society, 'Useful Statistics': http://www.wes.org.uk/statistics [accessed 15 December 2014]
120 Written evidence from Elix-IRR (DSC0046)
121 BCS, The Chartered Institute for IT (BCS), champions the global IT profession and the interests of individuals engaged in that profession for the benefit of all. See: http://www.bcs.org [accessed 22 January 2015]
122 Written evidence from BCS (DSC0051)
123 University and Colleges Admissions Service, 'More women than men in two thirds of subject areas': https://www.ucas.com/sites/default/files/analysis_note_2015_01.pdf [accessed 22 January 2015]

Chart 1: Difference in the number of acceptances between men and women by each subject group at higher education level in 2014[124]



55. A report by the Office for National Statistics (ONS) on graduates in the UK labour market in 2013 found that on average, men earned £3 more an hour than women; partly explained by the subjects male and female graduates studied. The report found that out of the top five subjects associated with the highest average gross annual earnings, "four of them were subjects which male graduates are more likely to have studied than female graduates: Engineering, Physical/Environmental Sciences, Maths/Computer Science and Architecture".[125]

56. We received extensive evidence to show significant efforts were needed to increase the number of women taking STEM subjects at school and moving into STEM careers in general.[126] This would increase the pool of talent and subsequently reap higher returns.[127]

57. Professor Judy Wajcman from the London School of Economics (LSE) summarised:

> "… the kind of innovation we are getting relies on the whole on young

124 Source: University and Colleges Admissions Service, 'More women than men in two thirds of subject areas': https://www.ucas.com/sites/default/files/analysis_note_2015_01.pdf [accessed 22 January 2015]

125 ONS, *Graduates in the UK Labour Market 2013* (November 2013): http://www.ons.gov.uk/ons/dcp171776_337841.pdf [accessed 15 December 2014]

126 Q 74 (Marcus Mason), written evidence from Fiona Scott Lazareff (DSC0028), British Sky Broadcasting (DSC0036), , Here East (DSC0048), NMI Systems & Software Leaders Network (NMI) (DSC0062) and Samsung Electronics UK (DSC0092). See also QQ 15–25 (Professor Judy Wajcman's opening remarks)

127 Written evidence from Elix-IRR (DSC0046). See also: WISE, *Women in Science, Technology, Engineering and Mathematics: from Classroom to Boardroom* (2012): http://www.wisecampaign.org.uk/files/useruploads/files/wise_stats_document_final.pdf [accessed 20 January 2015]

> men with narrow engineering degrees thinking about the future … I say, 'If we had a more diverse workforce, would we not be able to think of and tap talent for lots of different things?' If we want a creative industry, we need a diverse workforce".[128]

58. We were told that one of the main causes for the difficulty in attracting women to digital and STEM occupations is that they are seen as largely male-dominated roles:[129] "Crucially, tech roles are far too often seen as jobs for the boys."[130] Part of this is due to a perception of what digital and STEM jobs are.[131] In reality, the range of jobs is huge. Table 1 below gives examples of non-traditional STEM jobs. There are many more.

128 See QQ 15–25 (Professor Wajcman's opening remarks)
129 Written evidence from British Sky Broadcasting (DSC0036), Humber LEP (DSC0060), Prospect (DSC0064), Innovate UK (DSC0070) and CBI (DSC0074)
130 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
131 Written evidence from Philip Virgo (DSC0034), IET (DSC0049), Knowledge Transfer Network (KTN) (DSC0056) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

Table 1: Examples of non-traditional STEM professions

Profession	Description
Computer animator	Computer animation is the process used for generating animated images by using computer graphics. It can include: computer visualisation; computer animation arts; software development for games and effects; 3D animation; and digital effects.[132]
Cosmetic chemist	A cosmetic chemist formulates cosmetic products such as shampoo, skin cream and so on. Initial experiments can be simulated on digital technologies using data about the raw materials, before experimenting in laboratory conditions.[133]
Forensic scientist/ engineer	Forensic skills are used in areas including archaeology, the food and pharmaceutical industries, criminal justice, and at disaster scenes. A forensic scientist applies science to law enforcement or the failure of products or processes. Digital forensics is the analysis of digital evidence such as mobile phones, tablets and digital photographs. Forensic engineering is the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing personal injury or damage to property.[134]
Architect	Architects now use digital tools to generate and evaluate design and fabricate complex assemblies. Computer modelling and simulation is used alongside analogue constructions in order to foster all aspects of digital fabrication.[135]
Electrical engineer	An electrical engineer on the railway will use the latest design software systems and state of the art technology to develop train design. They will also work on live dynamic testing simulated on the computer and in test facilities.[136]

132 Bournemouth University, 'National Centre for Computer Animation': http://ncca.bournemouth.ac.uk [accessed 29 January 2015]

133 University of the Arts London, 'MSc Cosmetic Science': http://www.arts.ac.uk/fashion/courses/integrated-masters/msc-cosmetic-science [accessed 29 January 2015]; and Chemists Corner, 'How to become a Cosmetic Chemist': http://chemistscorner.com/how-to-become-a-cosmetic-chemist [accessed 21 January 2015]

134 Open University, 'Digital Forensics': http://www.open.ac.uk/postgraduate/modules/m812 [accessed 29 Janury 2015]; Annual Reviews, 'Forensic Chemistry': http://www.annualreviews.org/doi/abs/10.1146/annurev-anchem-060908–155251 [accessed 22 January 2015]; and Veritech, 'White Paper: Digital Photograph Use in Forensic Accident Reconstruction': http://www.veritecheng.com/white-paper-forensic-accident-reconstruction [accessed 22 January 2015]

135 London Metropolitan University, 'Digital Architecture and Manufacturing (MA)': http://www.thecass.com/courses/postgraduate/ma-digital-architecture-and-manufacture [accessed 2 February 2015]

136 Network Rail, 'Electrical and electronic engineering': https://www.networkrail.co.uk/careers/schemes/graduate/programmes/electrical-and-electronic-engineering [accessed 3 February 2015]

59. Our witnesses talked about the need to increase the visibility of women in digital jobs and make greater use of female role models.[137] The UK Digital Skills Taskforce and TeenTech CIC said: "Most people have heard of Bill Gates and Mark Zuckerberg but struggle to cite a female role model … it is hardly surprising that we have digital skills shortages given that we are failing to make the most of the talents of almost half of the potential workforce."[138] Whilst it is easy to name prominent male figures in the technology sector, this is not the case for women. British Sky Broadcasting highlighted its one day workshop, 'IT's not just for the boys', which was solely for female graduates.[139] Sue Husband of the Skills Funding Agency told us that businesses were using female role models in schools because they "see that there is half their talent pool that they are not accessing".[140] There were also suggestions made about the influencing role of parents and the media; we cover these in more detail in Part II of Chapter 3 under careers guidance (see paragraphs 160–180), as the issue extends beyond women.

60. **The paucity of women in digital and STEM (science, technology, engineering and mathematics) is holding back UK competitiveness. We agree with our witnesses that increasing the numbers of women could reap significant benefits. Girls have to be engaged earlier and across all education levels. The perception of digital and STEM jobs and subjects as male-orientated must be addressed.**

Part III: Cyber risk management

"… as we have seen an increase in digital, we have also seen an increase in attack."[141]—Nick Coleman, Global Head of Security Intelligence, IBM Services

"What we are facing is almost a tsunami of electronic attacks."[142]—Stephanie Daman, CEO, Cyber Security Challenge

Box 8: Key Statistics: Cyber risk management

- There were 44 million reported cyber-attacks in the UK in 2011 alone.[143]
- Cybercrime is estimated to cost the UK economy £27 billion a year.[144]

137 Q 13 (Oliver Quinlan), Q 24 (Professor Wajcman), Q 50 (Hugh Milward, Mike Warriner), Q 74 (Angela Morrison), Q 167 (Paul Hynes), Q 199 (Gary Warke, Angela Harrington), written evidence from London Borough of Camden (DSC0058), Humber LEP (DSC0060), CBI (DSC0074) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

138 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

139 Written evidence from British Sky Broadcasting (DSC0036)

140 Q 247

141 Q 174

142 Q 184

143 National Audit Office (NAO), *The UK cyber security strategy: Landscape review* (February 2013): http://www.nao.org.uk/wp-content/uploads/2013/03/Cyber-security-Exec-Summ.pdf [accessed 17 December 2014]

144 Detica, *The Cost of Cyber Crime: A Detica report in partnership with the Office of Cyber Security and Information Assurance in the Cabinet Office* (February 2011): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60943/the-cost-of-cyber-crime-full-report.pdf [accessed 15 December 2014]

Cybersecurity: the pace and scale of the challenge

61. The frequency of cyber-attacks has more than matched broader technology development. Nick Coleman from IBM Services noted that whilst developments such as cloud and Big Data analytics were allowing us to do new things, they were also creating a challenge for security.[145] Stephanie Daman of Cyber Security Challenge[146] highlighted that today, "everything is based on something that is connected to the internet … everything at the bottom has an internet layer", and unless that internet layer was properly secure, no one would have confidence in using it, ultimately resulting in a negative impact on the UK's prosperity.[147]

62. A report carried out by Detica for the Government in 2011 estimated that cybercrime costs the UK economy £27 billion a year, a figure which it estimated was likely to be growing.[148] This amounted to a cost of approximately £21 billion for businesses, £3.1 billion for citizens and £2.2 billion for the Government.[149] Her Majesty's Chief Inspector of Constabulary's 'State of Policing' report for 2013/14 found:

> "Cyber crime is not an emerging threat; it is here now, and is already a large and growing problem. The 'National Strategic Assessment of Serious and Organised Crime 2014' published by the National Crime Agency on 1 May 2014 commented that 'based on the limited research evidence at present, the costs of cyber crime could reasonably be assessed to be several billion pounds per year.'"[150]

63. During an interview on the 'cyber war' games to be held between the UK and USA in early 2015, the Prime Minister, the Rt Hon David Cameron MP, said that cyber-attacks were one of the "biggest modern threats" faced by the UK—with eight out of 10 large companies in the UK experiencing some form of cyber-attack.[151]

64. The last few years have seen more sophisticated and targeted attacks for a number of different motives from a variety of sources. In the main, Mr Coleman said that this was principally a concern for "our critical assets and protecting them", ranging from the energy sector to the UK's banking system, and ensuring that they continued to run as expected and without disruption.[152]

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145 Q 173

146 Cyber Security Challenge is a series of national competitions, learning programmes, and networking initiatives designed to identify, inspire and enable more EU citizens resident in the UK to become cybersecurity professionals. See: http://cybersecuritychallenge.org.uk/about-us/overview [accessed 2 February 2015]

147 Q 174

148 Detica, *The Cost of Cyber Crime—A Detica report in partnership with the Office of Cyber Security and Information Assurance in the Cabinet Office* (February 2011): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60943/the-cost-of-cyber-crime-full-report.pdf accessed [15 December 2014]

149 'UK cyber crime costs £27bn a year—government report', *BBC News* (17 February 2011): http://www.bbc.co.uk/news/uk-politics-12492309 [accessed 17 December 2014]

150 Her Majesty's Chief Inspector of Constabulary, *State of Policing: The Annual Assessment of Policing in England and Wales 2013/2014* (November 2014): http://www.justiceinspectorates.gov.uk/hmic/wp-content/uploads/state-of-policing-13-14.pdf [accessed 20 January 2015]

151 'US and UK to stage cyber war games, says Cameron', *BBC News* (16 January 2015): http://www.bbc.co.uk/news/uk-30842597 [accessed 19 January 2015]

152 Q 174

65. With the increase in malware[153] and cyber-attacks, and an increased reliance on digital technology and data, it is crucial that the appropriate safeguards are in place to defend the UK's hard and soft infrastructure. We heard that this would be a challenge for everyone; for citizens in the way that they consumed services, and for business and the Government in understanding what the risk meant to their organisations.[154] Moreover, Iain Wood from TalkTalk warned that the UK had to start addressing some of these concerns; which was not going to be done by treating skills or infrastructure in isolation.[155]

66. As a consequence, the evidence stressed that the UK needed individuals with the skills, knowledge and talent in the cybersecurity field to achieve this.[156] Professor John Vivian Tucker and Dr Victoria Wang said:

> "Cyber security is essential to the safety of the nation … Having cross-cutting knowledge, skills and capability to strengthen all our security objectives was stated in the [Government's National Security] strategy as one of the four objectives in the next five years. This means that individuals would need to be taught how to protect themselves online; and businesses and organisations would need to be aware of the vulnerabilities in their systems and the threats that they face".[157]

67. We were told, however, that there was a skills gap in the cybersecurity profession. Ms Daman told us: "At the moment, in my view … we do not have a sufficient number of properly skilled people".[158] For Ms Daman, this gap was a result of cybersecurity not being taught in schools, resulting in a "lost generation" of youngsters who ended up teaching themselves and were left unaware of the career opportunities.[159] She argued, therefore, that this skills gap should be addressed at the school level; not only would this "serve the wider digital skills agenda", it would also build a "pool of people" who could then be upskilled into the cybersecurity profession.[160] This could only be achieved if teachers were given the right resources. We were told that at present, "it is very patchy in the schools", which was seen as largely due to teachers not knowing what and how to teach in relation to cybersecurity.[161]

68. In further and higher education, Hugh Boyes from the Institution of Engineering and Technology (IET) said that one of the big gaps was in how coding was taught. He agreed that at present, the core skills and knowledge tended to be taught as an add-on, rather than integral to courses. As a consequence, he said that these courses needed to teach not just how to code, "but how to defensively code", so as to reduce risk.[162] At present, cybersecurity is not taught as part of the curriculum; Oxford Cambridge and RSA Examinations told us one reason for this was: "… fast moving areas like cyber security are unlikely to have text books, as they would be out of date before they are published".[163]

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153 Malware is software that is specifically designed to disrupt or damage a computer system.
154 Q 56 (Antony Walker) and Q 173 (Nick Coleman)
155 Q 140
156 Q 173 (Nick Coleman), written evidence from McAfee (DSC0022), CompTIA (DSC0082), HM Government (DSC0084) and BT (DSC0091)
157 Written evidence from Professor John Vivian Tucker and Dr Victoria Wang (DSC0023)
158 Q 174
159 Q 175
160 Q 191
161 Q 177 (Stephanie Daman)
162 Q 178
163 Written evidence from Oxford Cambridge and RSA Examinations (OCR) (DSC0014)

69. To combat this, the Open University told us of a newly launched Massive Open Online Course (MOOC)[164] (see paragraphs 190–192) on cybersecurity developed with Government support.[165] If text books cannot be up-to-date, there is a need for education to move to online courses for cybersecurity.

70. Mr Coleman told us that this was not just a school-based challenge, but one that applied to the whole of society.[166] We heard that there were different levels of skills and everyone would need some of those skills at a personal level. Mr Boyes pointed out that a large proportion of the population was outside the school system: "… they are outside formal education and they are often not aware of the threats that the new technology brings with it".[167]

71. **The rise of the digital economy brings new risks to individuals, businesses and national security. These risks include loss of assets and lack of confidence in digital technologies, resulting in unwillingness to use them.**

72. **We agree with our evidence that the best way to defend against cyber risks and deter attacks is to ensure we train and deploy enough people with the relevant skills and expertise. Everyone will need a minimum level of ability in managing the risks associated with the digital economy. Resilience in the face of cyber-attacks must be built in across the economy.**

Online safety and personal privacy

73. Part of the cybersecurity debate related to the increased importance of online safety and personal privacy; protecting your 'online identity' and ensuring children used technology (such as the internet) safely.[168] For instance, polling for TalkTalk demonstrated that 25% of respondents had already been a victim of some sort of virus or online scam, with 75% expecting it to get worse. Mr Wood noted that "the vast majority" of parents wanted more information about how to keep their children safe online.[169]

74. In tackling issues around online safety, Mr Wood argued that we must "not presume that there is a one size fits all solution", particularly as what motivated the early adopters to get online would not necessarily apply to the harder to reach people.[170] Angela Morrison from Direct Line Group highlighted the role of industry in educating people to be safe online: "We absolutely work together [with education] … We have a cyber security module so that we make children aware of cyber security, because they do not understand it but they need to because their entire lives are online these days".[171]

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164 A MOOC is an online course aimed at unlimited participation and open access via the internet. In addition to traditional course materials such as videos, readings and problem sets, MOOCs provide interactive user forums that help build a community for learners.

165 Department for Business, Innovate & Skills (BIS), 'Government supports UK's next generation of cyber security professionals': https://www.gov.uk/government/news/government-supports-uks-next-generation-of-cyber-security-professionals [accessed 20 January 2015]

166 Q 178

167 Q 177

168 Q 73 (Angela Morrison), Q 81 (Sean Williams), written evidence from UK Computing Research Committee (DSC0011), Association of Information Technology in Teacher Education (ITTE) (DSC0050), RCUK (DSC0055) and Science Council (DSC0096)

169 Q 140

170 Q 133

171 Q 73

75. If the ambition is for universal internet access and digital literacy, this must be matched with increased cybersecurity awareness for all. Mr Boyes, for example, noted how there had been a culture shift in health and safety in the UK over the last 20 to 30 years, with safety now featuring high on the agenda. He argued that cybersecurity needed to transition to that status, "where everybody in an organisation is doing it".[172]

76. Greater awareness is needed amongst the population in general. Although there was an acknowledgment of Government cybersecurity initiatives—such as Get Safe Online and Cyber Streetwise (see Appendix 5)—the evidence suggested that these were not in the public consciousness.[173] It may be that there is space for an independent voice in promoting such initiatives because despite advice being made available, the public did not view it as trustworthy.[174]

77. The computer security software company McAfee told us that despite considerable investment in cross-cutting public awareness campaigns, "many … have been poorly targeted and conceived", and did not have the impact desired.[175] Instead, McAfee argued that the Government should have relied more on industry to assist with delivery. For example, McAfee explained that as a single organisation it reached over 15 million people and 60% of the retail market. Given the number of people who use computers, tablets and mobile devices, it would make more sense for the Government to partner with industry in order to reach a much wider audience.[176] Awareness is particularly pertinent given the National Audit Office's (NAO) findings that 80% of cyber-attacks could be prevented through "simple computer and network 'hygiene'".[177] There must be a culture shift in the way the UK views cybersecurity. It must be looked at in a different way—as intrinsic to all online activities.

78. **If the internet is to be viewed as a utility that is accessible to all, cybersecurity must, by extension, be considered an intrinsic part of our critical national infrastructure. We are concerned that there is an inadequate level of awareness amongst the population regarding online safety and personal risk management. Whilst we acknowledge that attempts have been made to increase awareness, such as through the Government's Cyber Streetwise campaign, these have not broken through. Given its importance, we believe that there needs to be a culture shift driven by the Government to ensure that the nature of the threat is better understood by the public.**

Small and medium-sized enterprises and cyber risk management

79. Small and medium-sized enterprises (SMEs) are also at risk. Antony Walker from techUK told us: "Awareness is a critical issue for many businesses. Far too many companies are simply not aware of the relatively simple steps that they can take to protect themselves."[178] Mr Walker argued that whilst some

172 Q 180
173 Q 182 (Stephanie Daman)
174 Q 186 (Stephanie Daman)
175 Written evidence from McAfee (DSC0022)
176 *Ibid.*
177 NAO, *The UK cyber security strategy: Landscape review* (February 2013): http://www.nao.org.uk/wp-content/uploads/2013/03/Cyber-security-Exec-Summ.pdf [accessed 17 December 2014]
178 Q 56

work was being done, the Government—working with industry—could do more to help address the issue; primarily through increased education.[179]

80. Witnesses referred to initiatives aimed at supporting SMEs in regard to cybersecurity.[180] The Government's Cyber Essentials scheme (part of the Cyber Streetwise campaign) is a new Government-backed and industry supported scheme to guide businesses in protecting themselves against cyber threats.[181] The scheme provides free information, clarifying good basic cybersecurity practice and encouraging organisations to adopt the requirements appropriate to their business. It is aimed at organisations of all sizes—including SMEs—and is not just limited to the private sector. Ms Daman suggested that initiatives such as these were not being marketed properly. Her view was that "we are not getting the word out sufficiently, because the material is there", with the assumption that awareness should not be an issue with such material readily available.[182]

81. Such material is not sufficiently comprehensive, however, as the initiatives tend to be restricted to self-analysis and self-checking.[183] We heard that if SMEs were to go beyond this, obtaining advice would be costly. Mr Boyes said: "Unless we can find some way of getting that advice to them [SMEs] at an affordable price, they will not take it."[184]

82. There are a number of challenges facing SMEs in relation to digital technology, but these are considered in more detail in Part I of Chapter 4 (see paragraphs 219–239).

83. **Individuals and small and medium-sized enterprises (SMEs) are at particular risk from cybersecurity issues due to a lack of awareness.**

179 Q 56
180 Q 187 (Stephanie Daman, Hugh Boyes)
181 Cyber Street, 'Cyber Essentials': https://www.cyberstreetwise.com/cyberessentials [accessed 5 December 2014]
182 Q 187
183 Q 187 (Hugh Boyes)
184 *Ibid.*

CHAPTER 3: FOSTERING AND DEVELOPING TALENT

Part I: Digital ability levels

"There is a lack of appreciation of the importance of digital skills to all jobs."[185]—Research Councils UK (RCUK)

84. To enable the UK to be at the forefront of working with and producing technologies, there are skill requirements that spread much further than digital literacy. The UK Digital Skills Taskforce in its recent review of the digital economy provided a helpful framework of the different skill levels that would be required "across the labour market and citizenry in general",[186] defining three broad tiers of digital skills.

85. The UK Forum for Computing Education (UKForCE)[187] used this framework to analyse of the 361 Standard Occupation Codes (SOCs),[188] which cover the entire estimated 30 million people employed in the UK (see Box 9).[189]

Box 9: Digital skill level categories

'Digital muggle': 2.2 million people (7% of the workforce); "… no digital skills required—digital technology may as well be magic".

'Digital citizen': 10.8 million people (37% of the workforce); "… the ability to use digital technology purposefully and confidently to communicate, find information and purchase goods/services".

'Digital worker': 13.6 million people (46% of the workforce); "… at the higher end, the ability to evaluate, configure and use complex digital systems. Elementary programming skills such as scripting are often required for these tasks".

'Digital maker': 2.9 million people (10% of the workforce); "… skills sufficient to build digital technology (typically software development)".[190]

185 Written evidence from RCUK (DSC0055)

186 UK Digital Skills Taskforce, *Digital Skills for Tomorrow's World: Interim Report* (July 2014): http://www.ukdigitalskills.com/wp-content/uploads/2014/07/Binder-9-reduced.pdf [accessed 8 December 2014]. See also written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

187 Hosted by The Royal Academy of Engineering, the UK Forum for Computing Education (UKForCE) is an independent committee, acting as a single voice for the computing community on 5–19 computing education issues. It brings together key stakeholders to share the vision of improving computing education across all education jurisdictions of the UK. See: http://ukforce.org.uk [accessed 2 February 2015]

188 The Government published an estimate of the number of full-time and part-time workers. These Standard Occupation Codes (SOCs) ranged from chief executives to manual workers, such as shelf packers and farm labourers. The process UKForCE following to conduct its analysis included: adding a fourth (lower) tier of skills (see Box 9); taking a view for each SOC on what fraction of people undertaking that occupation would require a set of digital skills falling into each of the four bands; converting this fraction into an absolute number of people in each SOC requiring skills in each band (application of the fraction to the total number of people within the SOC published by the Government); and aggregating the people falling into each band across the entire set of SOCs. See: UKForCE Submission to Maggie Philbin's Digital Task Force: http://ukforce.org.uk/ukforce/ukforce-submission-to-maggie-philbins-digital-task-force [accessed 11 December 2014]

189 ONS, 'Labour Market Statistics, June 2013': http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/june-2013/sty-uk-employment.html [accessed 6 January 2015]

190 UKForCE, 'Submission to Maggie Philbin's Digital Task Force': http://ukforce.org.uk/ukforce/ukforce-submission-to-maggie-philbins-digital-task-force [accessed 11 December 2014]. See also written evidence from UKForCE (DSC0078)

86. This analysis demonstrates that almost everyone in the workforce will soon need as a minimum the skills identified in the 'digital citizen' band to do their job. Over half of the workforce will require skills significantly beyond those necessary at the lower level, with at least 10% of them as experts ('digital makers').[191] Of high-level skills ('digital makers'), both the Confederation of British Industry (CBI) and NIACE said that the UK economy would need at least 300,000 recruits to invent and apply new technologies.[192]

87. **When analysing the different levels of digital skills required, we find the UK Digital Skills Taskforce's three-band definition ('digital citizens', 'digital workers' and 'digital makers') to be useful, along with the UK Forum for Computing Education's application of the definitions to the workforce.**

Part II: Medium- and high-level skills

88. We received extensive evidence showing the UK has a significant medium- and high-level skills shortage now, holding the digital economy back from reaching its full potential.[193] This evidence ranged from individuals, industry and third sector organisations, to educational institutions and the Government.

89. The UK Digital Skills Taskforce and TeenTech CIC also highlighted how technological developments had created new skills needs and, with those, new opportunities. For example, a report by e-skills UK[194] for SAS[195] projected that there could be 132,000 job opportunities in Big Data over the next five years.[196] Increasing the number of digital 'workers' and 'makers' at the medium- to high-level could therefore drive the UK to a leading position in the global economy.

90. Over time, this need for skilled workers will grow, with the digital workforce alone expected to increase by 39% by 2030.[197]

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191 Written evidence from UKForCE (DSC0078) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

192 Written evidence from CBI (DSC0074) and NIACE (DSC0088)

193 QQ 15–25 (Professor Wajcman's opening remarks), Q 69 (Marcus Mason), Q 136 (Iain Wood), Q 206 (Dinah Caine), Q 232 (Chris Jones), written evidence from British and Irish Association of Law Librarians (DSC0020), McAfee (DSC0022), Trustworthy Software Initiative (DSC0024), Fiona Scott Lazareff (DSC0028), Digital Youth Academy and Pera Training (DSC0029), Dr Lisa Payne (DSC0031), Philip Virgo (DSC0034), Recruitment & Employment Confederation (REC) (DSC0035), British Sky Broadcasting (DSC0036), City & Guilds (DSC0044), Elix-IRR (DSC0046), Here East (DSC0048), IET (DSC0049), Cornwall and Isles of Scilly LEP (DSC0054), RCUK (DSC0055), KTN (DSC0056), NMI (DSC0062), Prospect (DSC0064), Open University (DSC0065), learndirect (DSC0066), QA Limited (DSC0069), CBI (DSC0074), UKForCE (DSC0078), Go ON UK (DSC0079), CompTIA (DSC0082), HM Government (DSC0084), NIACE (DSC0088), BT (DSC0091), Samsung Electronics UK (DSC0092), Creative Skillset (DSC0095), UK Music (DSC0097), UK Digital Skills Taskforce and TeenTech CIC (DSC0101), Dynamo North East (DSC0107), iRights (DSC0108), Welsh Government (DSC0123), Northern Ireland Government (DSC0125) and Scottish Government (DSC0128)

194 e-skills UK was the Sector Skills Council for the tech industries. The work of e-skills UK is being taken forward by the Tech Partnership. See: https://www.thetechpartnership.com [accessed 2 February 2015]

195 SAS is a leader in business analytics software and services, and the largest independent vendor in the business intelligence market. See: [accessed 2 February 2015]

196 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101). See also: e-skills UK, *Big Data Analytics: An assessment of demand for labour and skills*, 2012–2017 (January 2013): http://www.sas.com/offices/europe/uk/downloads/e-skills-bigdata-report.pdf [accessed 11 December 2014]

197 Science Council, *The current and future UK science workforce* (September 2011): http://www.sciencecouncil.org/sites/default/files/UK_Science_Workforce_FinalReport_TBR_2011.pdf [accessed 11 December 2014]

91. In addition to the UK's domestic skills shortage, the Guardian Media Group during our visit in September 2014 (see Appendix 8) told us that there was a strong draw for talent from the large technology companies in the USA (for example, Google, Microsoft, IBM and Facebook), indicating that the UK's most highly-skilled workers were being attracted abroad. We discuss the issue of immigration in Part IV of this Chapter, in paragraphs 205–218.

92. **There is a shortage of medium- and high-level digital skills in the UK. This needs immediate attention if the UK is to remain competitive globally. To keep ahead of the international competition, the UK must ensure it has the necessary pool of digitally-skilled graduates and others at the higher level (the 'digital makers'), to support and drive research and innovation throughout the whole economy. The long-term solution to the shortage of medium- and high-level skills requires action at all levels of the 'talent pipeline'—primary, secondary, further and higher level education.**

Part III: Future-proofing our young people

Broadening skillsets

93. Our evidence was unanimous that employers were looking for an ever widening skillset. In addition to high levels of numeracy and literacy, employers were looking for a mix of technical, creative and social skills.[198]

94. The Government's Industrial Strategy[199] incorporates the need to integrate these skills within business, and a broader skillset will be important for the future workforce to remain responsive to industry needs, as industry adapts to the growth of automation. Indeed, a recent report from Deloitte found that "jobs requiring creativity and social skills are not susceptible to automation", nor are jobs which "require a high level of perception and manipulation".[200] Consequently, there is a need for integrating topics such as creativity, social and business skills, and entrepreneurship, within the education and training sector.

198 Q 16 (Professor Phillip Brown), written evidence from OCR (DSC0014), OECD (DSC0016), British Sky Broadcasting (DSC0036), ALT (DSC0057), NMI (DSC0062), Frog Education (DSC0071), Tony Harper (DSC0075), Apps for Good (DSC0080), HM Government (DSC0084), Association for UK Interactive Entertainment (Ukie) (DSC0086), NIACE (DSC0088), Samsung Electronics UK (DSC0092), Science Council (DSC0096), UK Digital Skills Taskforce and TeenTech CIC (DSC0101) and Tablets for Schools (DSC0118)

199 BIS, 'Industrial Strategy: government and industry in partnership': https://www.gov.uk/government/collections/industrial-strategy-government-and-industry-in-partnership [accessed 18 December 2014]

200 Deloitte, *London Futures: Agiletown: the relentless march of technology and London's response* (November 2014): http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [accessed 20 January 2015]

Creativity

"We want young people to be not only consumers of technology, but also creators and makers."[201]—Apps for Good[202]

95. We received substantial evidence that one of the UK's competitive strengths exists in its creative industries.[203] Statistics from the Department for Culture, Media and Sport (DCMS) show the creative industries accounted for 1.68 million jobs in 2012, 5.6% of the total number of jobs in the UK; and employment in the sector increased by 8.6% between 2011 and 2012, a significantly higher increase than for the UK economy as a whole (which increased by 0.7%).[204] Research by the CBI identified the creative industries as one of the fastest growing sectors in the UK.[205]

96. We were told that more employers were looking for creativity alongside technical skills.[206] Innovate UK[207], for example, told us of "evidence that successful digital companies now 'fuse' the technical and creative skills of their staff".[208] A number of witnesses suggested expanding the 'STEM' package to include art ('STEAM'), or even art, entrepreneurship and design ('STEAMED') to meet this change.[209] This is in line with a recent study from Nesta[210], showing that creativity is important in a wide range of occupations, including for architects, broadcasting professionals, journalists and editors, librarians and public relations professionals.[211]

97. **Creativity is a strength of the UK's economy. Digital education that fosters creativity and innovation, providing students with the opportunity to test and experiment with technology, will help support this.**

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201 Written evidence from Apps for Good (DSC0080)

202 Apps for Good is an open-source technology education movement that partners with educators in schools and learning centres, and challenges the way computing is taught in schools. See: http://www.appsforgood.org [accessed 2 February 2015]

203 Q 4 (Jessica Bland), Q 205 (Dinah Caine), written evidence from Royal Society of Edinburgh (RSE) (DSC0030), Here East (DSC0048), Cornwall and Isles of Scilly LEP (DSC0054), Humber LEP (DSC0060), CBI (DSC0074), Ukie (DSC0086), Samsung Electronics UK (DSC0092), Creative Skillset (DSC0095), UK Music (DSC0097) and Nesta supplementary written evidence (DSC0003)

204 DCMS, *Creative Industries Economic Estimates* (January 2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/271008/Creative_Industries_Economic_Estimates_-_January_2014.pdf [accessed 18 December 2014]

205 CBI, 'Creative and digital Industries': http://www.cbi.org.uk/business-issues/creative-industries [accessed 11 December 2014]

206 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

207 Innovate UK (formerly known as the Technology Strategy Board) is a business-led organisation with a leadership role to stimulate technology development and innovation for the benefit of UK business in the areas which offer the greatest potential for boosting UK growth. The organisation operates across the Government and advises on polices which relate to technology, innovation and knowledge transfer. Innovate UK is the UK innovation agency and acts as the prime channel through which the Government incentivises business-led technology innovation. It has directly supported over 6,500 companies and works with nearly every university in the UK. See: https://www.gov.uk/government/organisations/innovate-uk [accessed 2 February 2015]

208 Written evidence from Innovate UK (DSC0070)

209 Written evidence from Apps for Good (DSC0080), Ukie (DSC0086) and supplementary written evidence from Creative Skillset (DSC0116)

210 Nesta is an independent charity that works to increase the innovation capacity of the UK. See: http://www.nesta.org.uk [accessed 2 February 2015]

211 Nesta, A Dynamic Mapping of the UK's Creative Industries (January 2013): http://www.nesta.org.uk/sites/default/files/a_dynamic_mapping_of_the_creative_industries.pdf [accessed 19 January 2015]

Primary and secondary schools

> "… there is enormous raw capability in young people … every business that wants an online presence would benefit from that capability if we could polish it up. If we could introduce that into our school system … that would transform productivity of businesses."[212]—Karen Price OBE, on behalf of the Tech Partnership

98. There was consensus that the long-term solution to the medium- and high-level skills shortage (digital 'workers' and 'makers') lies in the 'talent pipeline'—namely, primary, secondary, further and higher level education. Our evidence was clear that numeracy and literacy remain foundations of the UK's education system, and of the digital economy.[213] Evidence from the OECD indicated a correlation between digital skills and numeracy and literacy, particularly among the younger generation.[214] David Hughes from NIACE told us: "People with literacy and numeracy problems often have poor health understanding and poor financial skills, and they nearly always have poor digital skills as well."[215] Increasing literacy and numeracy levels could therefore have a positive effect on digital literacy.

99. The UK has a weak track record in skills.[216] For instance, Mr Hughes said: "… we have been talking about literacy and numeracy for 100 years but we still have not cracked it".[217] Now is the time to improve numeracy and literacy to enable the UK to make the most of the digital opportunity.

100. **Those who are not numerate and literate have limited access to and use of digital technologies. The UK has a long-standing systemic weakness in numeracy and literacy. It is imperative we continue to increase national levels of these core subjects to enable the UK to seize the opportunities that digital offers.**

101. Introduction of the new computing curriculum in England in September 2014 (whereby children throughout primary and secondary education will be taught how to code) was broadly welcomed.[218] Witnesses believed it would not only have a positive impact on STEM take-up at further and higher education, but would increase digital capability among the general population.

102. Computing and ICT education provision varies across England and the devolved administrations. Scotland includes computing in its curriculum, but computer science is not yet taught or perceived in schools on a par with other sciences (biology, chemistry and physics).[219] Wales and Northern Ireland do not currently include computer coding and programming as part

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212 Q 123
213 Q 4 (Martin Wolf), Q 89 (David Hughes), Q 164 (Mark Chambers), written evidence from RSE (DSC0030) and Philip Virgo (DSC0034)
214 Q 221 (Andreas Schleicher)
215 Q 100
216 Q 16 (Professor Brown), written evidence from OECD (DSC0016) and RSE (DSC0030)
217 Q 100
218 Q 3 (Oliver Quinlan), written evidence from The One Voice for Accessible ICT Coalition (DSC0033), BCS (DSC0051), QA Limited (DSC0069), NIACE (DSC0088), Samsung Electronics UK (DSC0092), UK Digital Skills Taskforce and TeenTech CIC (DSC0101) and TalkTalk (DSC0105)
219 Written evidence from RSE (DSC0030)

of their curriculums. The Welsh Government is currently carrying out a review of its own curriculum.[220]

103. The evidence showed a strong consensus on the need for digital literacy to be embedded within the curriculum not just as a separate subject, but as a third core subject underpinning all others.[221] UKForCE said: "A good computing education at school is in many ways akin to the 3 Rs. It is a deep skill which will be necessary to exploit fully the new digital environment as it continues to change at a remarkable speed."[222] The Minister of State for Culture and the Digital Economy, Ed Vaizey MP, agreed. He said: "It is part of the skillset that you really should be leaving school numerate as well as literate and digitally savvy."[223]

104. Some witnesses were concerned that not all school children had access to technologies due to inequalities in income.[224] NIACE told us: "There is enormous potential for schools to offer access to technology … They and their children need the digital skills to make a start on their digital journey".[225] It is unacceptable that children should be disadvantaged by not having access to educational internet and digital technologies.

105. **We agree with our evidence that digital and technology skills should be considered complementary to numeracy and literacy. Digital literacy is an essential tool that underpins other subjects and almost all jobs.**

Teaching the teachers

"… we have to just train our teachers".[226]—Clare Sutcliffe, Co-founder and CEO, Code Club

Box 10: Key Statistic: Teachers

- Only 44.9% of secondary school ICT teachers have a post A level qualification relevant to ICT, and the overwhelming majority of primary school teachers do not have a computing background.[227]

106. Delivery of the new computing curriculum is a major stumbling block for England. Chris Mairs from UKForCE summed up: "… there is not enough subject knowledge in this at the moment".[228] This may well be an issue for the devolved administrations in the future. The Royal Society of Edinburgh and Dr Bill Mitchell of BCS identified teacher expertise in ICT as an issue for all the constituent parts of the UK.[229]

220 Welsh Government, 'Review of Assessment and the National Curriculum for Wales': http://wales.gov.uk/topics/educationandskills/schoolshome/curriculuminwales/curriculum-for-wales/?lang=en [accessed 9 February 2015]
221 Q 97 (David Hughes), Q 103 (Helen Milner), written evidence from RSE (DSC0030), City & Guilds (DSC0044), UKForCE (DSC0078) and TalkTalk (DSC0105)
222 Written evidence from UKForCE (DSC0078)
223 Q 257
224 Q 23 (Professor Brown), Q 161 (Mark Chambers, Jack Evans), Q 248 (Chris Jones), written evidence from OECD (DSC0016) and Humber LEP (DSC0060)
225 Written evidence from NIACE (DSC0088)
226 Q 129
227 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
228 Q 148
229 Q 144 and written evidence from RSE (DSC0030)

107. Barclays Bank went further: "The UK's approach to education has not changed significantly since the first industrial revolution. Similar hours, similar holidays, similar environments."[230] This resonated with recent findings by Ofsted that "improvement in secondary schools has stalled" in 2013/14.[231] This seems to us to be particularly pertinent. We are in the midst of a technological revolution, where the world around us is constantly changing, and a new generation of tech savvy young people is constantly adapting to new technologies and new media. Evidence was clear that "[t]here needs to be recognition that we are introducing a new subject and that unlike other GCSE subjects we will need to train or re-train a new generation of teachers".[232] Although this message was echoed throughout our evidence, practice currently falls far short of this.

108. **We welcome the introduction of the new computing curriculum in England as a major step towards giving the UK a competitive edge, but there are serious challenges delivering its content. Many teachers are not confident or equipped to deliver the new curriculum.**

Initial Teacher Training and Continuing Professional Development

109. The evidence agreed that the biggest opportunities for addressing the knowledge gap in computing teaching was through Initial Teacher Training (ITT)[233] and Continuing Professional Development (CPD)[234].[235] The National College for Teaching and Leadership[236] (NCTL) told us they had announced increased ITT bursaries of up to £25,000 tax-free for computing trainees in 2015/16. They also funded a scholarship scheme in computing, delivered in partnership with BCS worth £25,000 tax-free.[237] The rationale behind this was described by the NCTL as: "We know that many STEM graduates are highly sought after which is why we are responding through the financial incentives on offer."[238] This is all laudable, but the numbers are tiny. For 2014/15, the number of scholarships awarded was just 121, out of only 400 applicants. In 2013/14, meanwhile, only 360 new computing teachers entered the profession.[239]

110. The Government has made some effort to support CPD, allocating £3.5 million funding for a training budget within schools.[240] We were told by the UK Digital Skills Taskforce and TeenTech CIC, however, that "The Government allocated training budget of £3.5 million so far only equates to £175 per school."[241] This is pitifully low and should be increased.

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230 Written evidence from Barclays Bank (DSC0047)
231 Ofsted, 'Ofsted Annual Report 2013/14 published': https://www.gov.uk/government/news/ofsted-annual-report-201314-published [accessed 10 December 2014]
232 Witten evidence from Ukie (DSC0086)
233 Initial Teacher Training (ITT) is the recruiting and training of skilled teachers.
234 Continuing Professional Development (CPD) refers to training for existing teachers.
235 Q 148 (Charlie Taylor, Sir Andrew Carter), Q 150 (Sir Andrew Carter), written evidence from ITTE (DSC0050), BCS (DSC0051), ALT (DSC0057), UKForCE (DSC0078) and Ukie (DSC0086)
236 The National College for Teaching and Leadership (NCTL) is an executive agency, sponsored by the Department for Education (DfE). It offers head teachers, school leaders, senior children's services leaders and teachers opportunities for professional development. See: https://www.gov.uk/government/organisations/national-college-for-teaching-and-leadership [accessed 2 February 2015]
237 Supplementary written evidence from NCTL (DSC0113)
238 *Ibid.*
239 Q 149 (Charlie Taylor)
240 Q 263 (Ed Vaizey MP (£3.6 million)) and written evidence from HM Government (DSC0084)
241 At date of evidence submission by UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

111. After taking scholarships and bursary efforts into account, UKForCE outlined the two main ITT challenges: "… convincing students with highly employable and well remunerated computing degrees that teaching is a desirable and worthwhile career"; and "… increasing the number of ITT trainers who are themselves computing specialists".[242] We are not convinced that these challenges can be met by current initiatives.

112. Evidence was consistent about the need for increased investment in CPD, as "new teachers develop the required skills, knowledge and understanding but quickly become out of date as technologies move quickly".[243] It is imperative that teachers keep up to speed with new technologies so that young people are similarly up to speed. This has to be done with industry. Sir Andrew Carter, the Head Teacher at South Farnham School, said: "… there are companies that could support schools enormously and could reach out. There ought even to be somebody from a technological firm on the governing body of every school".[244] This was supported by Marcus Mason from the British Chambers of Commerce, who believed this measure could "help to make schools more responsive to business needs".[245] This is an ambitious ask, but it is this kind of ambition the UK needs to claim its place as a global leader.

113. Witnesses identified school networks as the best way to deliver CPD. Several different examples were given, as are outlined in Appendix 5. We were encouraged to see varied examples of good initiatives, ranging from the Computing At School (CAS) network to teaching school alliances; but they were small scale and the disjoint between initiatives was alarming—none were connected to the others. The Chair of CAS, Professor Simon Peyton Jones, told us:

> "The DfE [Department for Education] and NCTL are consciously standing back from the process of training teachers and inviting the tech sector […] to come forward and lead the process of training and equipping teachers to deliver the new curriculum. That is innovative, diverse and creative; but it is also quite likely to be patchy. It is very difficult to guarantee the kind of uniformity of provision, regionally and across schools, that you might if you had big central provision."[246]

114. This lack of coordination and urgency were common themes throughout our inquiry. We were concerned that there was a level of complacency around delivery of the new computing curriculum. For example, Mr Vaizey told us: "There is some investment going into training teachers and that change will take time to come through, although one should not underestimate the ability of our children, as I am sure you are aware, to teach themselves how to do a lot of this stuff."[247]

115. **New and existing teaching staff need significant contact with industry to see the latest technologies in action and subsequently pass such knowledge on to young people.**

116. **The UK is taking significant steps to prepare school pupils for the future digital workforce, but we risk being let down by inconsistent**

242 Written evidence from UKForCE (DSC0078)
243 Written evidence from ITTE (DSC0050)
244 Q 150
245 Q 69
246 Q 144
247 Q 254

training for teachers. Leadership and coordination from the Government in teacher training is essential.

Further education

"The infrastructure and workforce skills in FE [further education] are in many instances woefully inadequate"[248]—UKForCE

117. We heard much evidence[249] about low skills levels threatening the digital future of the UK, both in terms of access and digital inclusion, and also the economic needs of firms and clusters (see paragraphs 242–261) in relation to predictions for the labour market and increased reliance on automation. For this reason, the evidence showed that the further education sector is crucial.[250]

118. Further education is the largest provider of apprenticeships, work-based training, lifelong learning and upgrading adult skills, as well as a significant route into higher education.[251] Whole industries are being wiped out due to changing technologies, with new ones emerging at the same time. Having a forward-looking and responsive further education sector is vital if the UK is to have a responsive workforce and remain competitive. Further education will play a key role in developing high-level digital skills, and we welcome the recent announcement of a National College for Digital Skills in London, supported by employers such as IBM, Deloitte and Bank of America.[252]

119. A focus of our inquiry has been how to join-up the local and national levels. Evidence showed that further education colleges were already well-placed to link local people with training and jobs.[253] Karen Price, on behalf of the Tech Partnership, summed up: "… our further education colleges could step into that space; they are well connected in the community".[254]

120. Our evidence suggested, however, that there are—as in schools and universities—pockets of excellence in the further education system; but provision is patchy, unresponsive and not meeting employer needs.[255] For instance, evidence from Siemens told us that there was only one college in the whole of London that could deliver the training needed by the company.[256] Further education has a very wide set of agendas and this risks a lack of focus on key sectors, such as digital.

121. The risk is that the further education sector will provide a piecemeal response across some areas and locations, but nowhere near the scale of support

248 Written evidence from UKForCE (DSC0078)
249 Written evidence from Tinder Foundation (DSC0077) and NIACE (DSC0088). See also footnote 193.
250 Written evidence from Digital Youth Academy and Pera Training (DSC0029), RSE (DSC0030), Elix-IRR (DSC0046), IET (DSC0049) and UKForCE (DSC0078)
251 Skills Funding Agency (SFA), *Statistical First Release: Further Education & Skills: Learner Participation, Outcomes and Level of Highest Qualification Held* (November 2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/382819/learner-participation-outcomes-and-level-of-highest-qualification-release-nov14.pdf [accessed 7 January 2015]
252 Prime Minister's Office, 'Maths and science must be the top priority in our schools, says Prime Minister': https://www.gov.uk/government/news/maths-and-science-must-be-the-top-priority-in-our-schools-says-prime-minister [accessed 7 January 2014]
253 Written evidence from ALT (DSC0057)
254 Q 117
255 Q 238 (Martin Hottass, Chris Jones), written evidence from Elix-IRR (DSC0046), UKForCE (DSC0078), Samsung Electronics UK (DSC0092) and TalkTalk (DSC0105)
256 Q 238 (Martin Hottass)

necessary either for specific communities, the population as a whole, or for those firms that must thrive and grow if the UK is to lead the world.

122. These are not problems that further education can or should solve alone. The Government already has a significant role in the system; it provides funding and regulates both qualifications and the system itself. It also ensures standards of teaching and learning through Ofsted.

123. The Government told us it had implemented significant reform to the further education system, removing central targets and commissioning so that further education providers were free to respond to local skills needs.[257] It highlighted the Further Education Learning Technology Action Group (FELTAG), and the subsequent measures announced in the Ministerial Response to FELTAG, "aimed to ensure that the FE [further education] workforce and FE delivery mechanisms become much more digitally agile".[258]

124. These are a step in the right direction, but a recent three-year study of further education colleges by the New Engineering Foundation[259] found that STEM provision was inadequate in every college: "In the worst examples, 80% of a curriculum was 'misaligned' (it did not match industry trends)".[260] This serves only to emphasise that the role of the further education sector needs to be stepped up. The evidence was clear that industry must input into further education to enable the sector to respond usefully.[261] There were also calls for a culture-shift towards lifelong learning. We say more about this in paragraphs 181–189.

125. **There is an urgent requirement for comprehensive industry input into the further education system. The Government should encourage strong partnerships between industry and colleges. Training delivery must be revamped. Further education colleges need to move up a gear and provide industry-designed and endorsed short courses that are going to lead to a job.**

126. **General digital skills could be improved by including a digital element in all further education courses, as well as more specific courses for digital and technology occupations. We welcome the introduction of the National College for Digital Skills in London. More provision like this would be positive—perhaps one linked to each major cluster in the UK.**

257 Written evidence from HM Government (DSC0084)

258 Written evidence from HM Government (DSC0084)

259 The New Engineering Foundation is an independent educational charity and professional body that supports improvements and innovations in science, engineering and technology education. See: http://www.thenef.org.uk/foundation [accessed 2 February 2015]

260 The New Engineering Foundation carried out a three-year study of further education colleges. See: New Engineering Foundation, *Inventing the Future: Transforming STEM Economies* (July 2014): http://www.thenef.org.uk/report/inventingthefuture/Inventing-the-future-final.pdf [accessed 20 January 2015]

261 Q 98 (David Hughes), Q 117 (Karen Price), Q 200 (Angela Harrington), Q 260 (Nick Boles MP), written evidence from McAfee (DSC0022), Dr Lisa Payne (DSC0031), Management Consultancies Association (MCA) (DSC0040), IET (DSC0049), KTN (DSC0056), Humber LEP (DSC0060), NMI (DSC0062), Prospect (DSC0064), Open University (DSC0065), QA Limited (DSC0069), iRights (DSC0108), National Library of Wales (DSC0117), Northern Ireland Government (DSC0125) and supplementary written evidence from Microsoft (DSC0006)

Accreditation and qualifications

127. There was evidence that as the economy moved to a requirement for a more nimble training system to allow employers to respond to new innovations, the accreditation and qualification framework remained slow, fragmented, inconsistent and unreliable.[262] Martin Hottass of Siemens summed up:

> "You could have an applicant with a diploma in engineering who could be from a UTC [University Technical College], and it could be the old engineering diploma that was 14 to 16 or 16 to 18, but now we have also renamed our national certificates and higher national certificates into diplomas and advanced diplomas, so you could have two completely different kettles of fish with the same name."[263]

128. It is no surprise therefore, that industry prefers accreditation by professional bodies, since this is a guarantee of high standards which are transferable beyond the immediate work-based context in which they are delivered.[264]

129. Ms Price went further: "… you need industry-designed and endorsed courses that are relevant so people will have the confidence that if they study and get a certificate in it, at the end of the day it is going to lead to a job".[265] In the same way that the education system needs reform to meet the changing world, so too does the qualification and accreditation system.

130. **The qualification and accreditation framework requires greater consistency and longevity. Employer trust in the system will be strengthened by industry-designed and endorsed certificates, delivering the necessary high standards.**

Skills funding

> "The Skills Funding Agency's role is to make sure that public funds are used in the most cost-effective way."[266]—Martin Hottass, Manager, Skills & Siemens Professional Education, Siemens

131. Sue Husband of the Skills Funding Agency stressed that the Government "support[s] over 1,000 colleges, private providers and training organisations, along with employers, with more than £4 billion of public funding each year".[267]

132. Despite Government efforts, we heard that the way funding is allocated is not conducive to gearing up provision in the way that employers need. The problem with the system is that "the offer of colleges is driven by where they can access the funding".[268] Ms Price told us: "… the amount of the adult skills budget that is being spent on it [further education] currently can be spent on relevant material that the community and the market need".[269]

133. Iain Wood from TalkTalk identified this as an inclusion issue:

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262 Q 172 (Paul Hynes), Q 244 (Chris Jones), written evidence from Philip Virgo (DSC0034), Virtual College (DSC0039) and Sanjeev Appicharla (DSC0042)
263 Q 244
264 For example, written evidence from Humber LEP (DSC0060) said: "Hull College has a Cisco Networking Academy, which delivers industry recognised certifications."
265 Q 117
266 Q 235
267 Q 231
268 Q 119 (Karen Price)
269 *Ibid.*

> "We also need to restructure skills training … around much shorter courses that are much more accessible and speak particularly to the harder to reach people who are never going to sign up for a three or four-year course. Within that, clearly there is budget restructuring that needs to happen."[270]

134. We do not believe skills funding is being used in the most cost effective way. Skills funding can be used to rebalance the further education offer to meet employer needs.[271]

135. **Skills funding is not presently targeted sufficiently to improve the capacity of the UK's workforce and grow its economy. Provision is cumbersome and slow to adapt. There is a clear opportunity for the Government here; to join-up industry, further education and funding. The Government's proposals to improve further education will not have the desired effects without an overhaul of the funding system.**

Apprenticeships

136. Our evidence agreed that apprenticeships were a good, agile solution for the future workforce,[272] as well as being able to meet immediate requirements.[273] We say more about filling the immediate skills gap in the next Part of this Chapter (see Part IV, paragraphs 181–218). For instance, Chris Jones from City & Guilds told us: "… apprenticeships [are] a very flexible tool, unlike much of education … Apprenticeships, and by their very nature the employer-driven agenda, should provide a far greater opportunity to be responsive to technology change".[274] In addition, according to the NAO, apprenticeships reap strong economic returns.[275]

137. Over recent years there has been a decline in the number of apprenticeships taken up across all subjects. In England apprenticeship starts across the board in 2013/14 had fallen by 13.7% from the previous year.[276] Apprenticeship starts in ICT fell from 19,520 in 2010/11 to 14,120 in 2012/13; and dropped again to 13,060 in 2013/14.[277] In addition, our evidence highlighted a traditionally low regard for vocational learning,[278] which has resulted in many students "studying, or at least starting, irrelevant or undemanding degrees, when a

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270 Q 142

271 Q 110 (Helen Milner), Q 119 (Karen Price), Q 134 (Iain Wood), Q 235 (Martin Hottass), written evidence from Citizens Online (DSC0005) and TalkTalk (DSC0105)

272 Q 41 (Mike Warriner, Chris Mairs), Q 232 (Sue Husband and Martin Hottass), written evidence from City & Guilds (DSC0044), Here East (DSC0048), KTN (DSC0056), UKForCE (DSC0078) and Ukie (DSC0086)

273 Written evidence from QA Limited (DSC0069)

274 Q 232

275 In 2012, the NAO recorded that each £1 in public funding for adult apprenticeships earned a return of £16 at the intermediate level and £21 for advanced level apprenticeships (£18 across all levels). See: NAO, *Adult Apprenticeships* (February 2012): http://www.nao.org.uk/wp-content/uploads/2012/02/10121787.pdf [accessed 18 December 2014]. See also: *UK Commission for Employment and Skills, International approaches to the development of intermediate level skills and apprenticeships: Case Study Report, Evidence Report 42—Volume 2, February 2012* (2012): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/305130/evidence-report-42-international-approaches-case-study-report.pdf [accessed 9 February 2015]

276 House of Commons Library, Apprenticeship statistics, Library Standard Note, SN06113, February 2014

277 SFA and BIS, 'FE data library: apprenticeships': https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships [accessed 6 February 2015]

278 Written evidence from IET (DSC0049), KTN (DSC0056), London Borough of Camden (DSC0058), learndirect (DSC0066) and UKForCE (DSC0078)

good quality apprenticeship or industry-provided vocational training would be more effective".[279]

138. For these reasons we welcome the Government's and the devolved administrations' efforts to increase the number of apprenticeships and higher apprenticeships.[280] These efforts are relatively new and so it is unclear how successful they will be.[281]

139. There is no evidence that apprenticeship numbers are yet anywhere near meeting the ambitions of the scheme. In fact, witnesses agreed that the number of apprenticeships, particularly high-level apprenticeships, was far below what the economy needed.[282] For instance, Mr Jones said that in the last year (2013/14) "less than 3% of the total number of apprenticeship starts were ICT apprenticeships".[283] This was alongside a gap in IT workers qualified to level three, as outlined by BCS which estimated currently the UK economy could easily absorb at least three times as many level three IT apprentices. According to BCS, in 2014 Microsoft reported that amongst its partners there were 100,000 unfilled vacancies in the UK; many of these were suitable for level three technicians.[284] There was also concern that non-digital provision "usually lacks any significant coding or other relevant computing skills acquisition, even though almost all trades and professions require these as standard practice".[285]

140. Evidence of the disjoint between apprenticeships offered and job vacancies appears in Government statistics, which show that the number of apprenticeship starts across the UK regions is not in alignment with the number of predicted regional employment opportunities. The majority of apprenticeships are in the North West of England, where 71,670 apprenticeships were started in 2013/14. This is almost 80% more starts than London, which had 40,050. This is despite the prediction for London to have a 15.9% share of UK employment by 2020, compared to the North West's 10.5% share. Yorkshire and the Humber (North East) had the 3rd most apprenticeship starts (at 53,120), but is predicted only a 7.9% share of employment (see Chart 2 below).

279 Written evidence from UKForCE (DSC0078)

280 The Government has committed £40 million to support an additional 20,000 higher apprenticeships and has agreed financial support for particular sector apprenticeships. The Welsh Government agreed an additional £20 million to provide an extra 5,650 apprenticeships in 2013/14 and 2014/15, of which 2,650 will be higher-level apprenticeships. In 2014 the Scottish Government announced that it would increase the number of places available year on year from 25,000 to 30,000 by 2020. The Northern Ireland Government has announced a commitment to higher level apprenticeships.

281 Provisional figures for 2014/15 are available for August to October only.

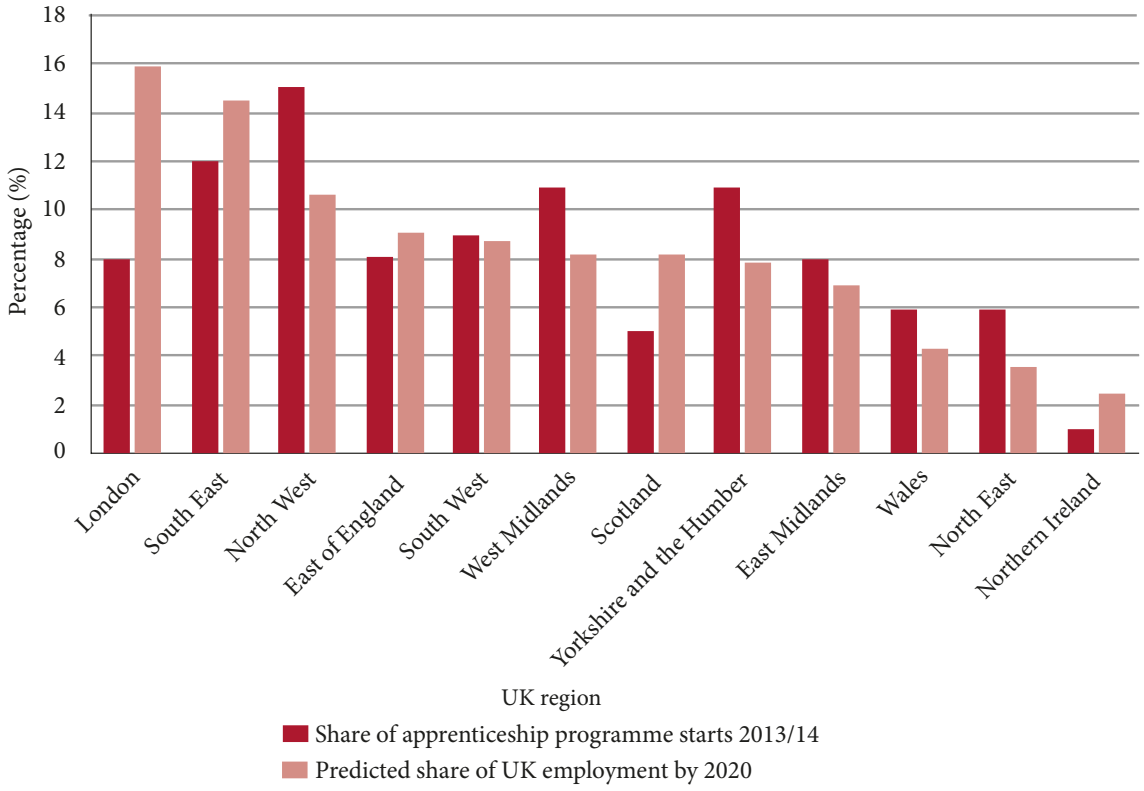
282 Q 206 (Dinah Caine), written evidence from Digital Youth Academy and Pera Training (DSC0029), IET (DSC0049), BCS (DSC0051), KTN (DSC0056), NMI (DSC0062), CBI (DSC0074) and Ukie (DSC0086)

283 Q 235. See also Q 232 and written evidence from City & Guilds (DSC0044)

284 IT technicians need to have completed at least the equivalent of a work-based level three apprenticeship that meets global standards. See written evidence from BCS (DSC0051)

285 Written evidence from London Borough of Camden (DSC0058)

Chart 2: Apprenticeship starts versus predicted UK employment by 2020[286]



141. To meet the skills shortfall, some witnesses called for later life apprenticeships.[287] These are already available. Conversely, our evidence, including Government statistics, showed that there was a shortage in the availability and take-up of apprenticeships for 16–19 year-olds.[288] The economic case for increasing the number of young apprentices was clear; the unemployment rate amongst 16–17 year-olds is 32.9%, whilst among 18–24 year-olds the rate is 14.2%.[289] In addition, for July to September 2014 there were still 954,000 young people in the UK who were not in education, employment or training.[290] Incentives are

286 Data taken from: UK Commission for Employment and Skills, *Working Futures 2012–2020: Annexes* (March 2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/298512/working-futures-2012-2022-annexes-bound.pdf [accessed 7 January 2015]; Apprenticeship starts: England: http://www.parliament.uk/business/publications/research/briefing-papers/SN06113/apprenticeship-statistics [accessed 18 December 2014]; Northern Ireland: http://www.delni.gov.uk/index/publications/r-and-s-stats/apprenticeshipsni-statistical-bulletins/appsni-sept07-july14.htm [accessed 18 December 2014]; Scotland: http://www.skillsdevelopmentscotland.co.uk/statistics/modern-apprenticeships/modern-apprenticeship-statistics-quarters-1-to-4-2013–14 [accessed 18 December 2014]; and Wales: http://wales.gov.uk/docs/statistics/2014/141126-further-education-work-based-learning-community-learning-provisional-2013–14-en.pdf [accessed 18 December 2014]

287 Q 41 (Chris Mairs, Mike Warriner) and written evidence from Bath Spa University (DSC0004)

288 Most apprentices in England are in the 19–24 age group (36.1%) followed by the 25–34 age group (16.9%). After 60+ (0.6%) the smallest proportion is age 16 (5.8%), then age 17 (8.8%). See: SFA and BIS, 'FE data library: apprenticeships': https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships [accessed 29 January 2015]

289 ONS, 'Labour Market Statistics, July–September 2014' (Table A05, Labour market status by age group): http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/november-2014/table-a05.xls [accessed 5 February 2015]

290 ONS, 'Young People Not in Education, Employment or Training (NEET), November 2014': http://www.ons.gov.uk/ons/rel/lms/young-people-not-in-education--employment-or-training--neets-/november-2014/stb---young-people-not-in-education--employment--training--neet----november-2014.html [accessed 29 January 2015]

available for companies who take on younger apprentices;[291] but the funding appears to us to be inadequate to seriously encourage take-up.

142. **Apprenticeships can help plug the short- and medium-term skills gap. We believe 16–19 year-olds must be targeted by employers, teachers, and careers guidance professionals to enable them to choose and take up good apprenticeships. There is also a need to tackle negative perceptions of vocational education among schools, teachers, head teachers and parents.**

143. **Including a digital element in all apprenticeship schemes, as well as offering more digital apprenticeships for specific technology occupations and sectors (taking into account the predicted changes to the labour market), could improve general digital skills.**

Apprentice employers

144. For apprenticeships to be fit for purpose—to meet industry requirements and to equip participants with the tools to be successful in the future economy—witnesses emphasised the necessity of industry input:[292] "… the employer needs to own the content".[293] During our inquiry we heard evidence of several apprenticeship schemes developed by big organisations, for instance Siemens, as a means of meeting an unfulfilled workforce requirement. We were impressed by the apparent quality of those schemes.

145. Witnesses agreed that there were inadequacies in the information, advice and guidance designed to encourage people to take up apprenticeships.[294] We deal with this more fully in paragraphs 160–180. As well as the demand-side problem, there is also a supply issue. This warning from BCS resonated with us: "… the capacity for providing [level three and higher] apprenticeships will only improve if some way is found for many more employers to provide them".[295] Although SMEs were identified as an important part of the supply side, big companies are not off the hook. Mr Jones told us: "SMEs make up about 54% of all apprenticeships, so they are doing a pretty good job. The real heavy lifting needs to come from the big companies."[296] There are simply not enough apprenticeships on offer. Our evidence identified a lack of funding support for businesses and a lack of clarity in the system, especially for SMEs, as some of the reasons for this shortfall.[297] Gary Warke from Humber Local Enterprise Partnership (LEP), for example, told us: "… to a certain extent [SMEs] feel disconnected around advice about things like funding for apprenticeships and how they might get support".[298]

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291 The Apprenticeship Grant for Employers (age 16 to 24) scheme provides £1,500 to employers with up to 1,000 employees to encourage businesses to take on new apprentices aged 16 to 24. See: SFA, 'Apprenticeship grant for employers of 16 to 24 year-olds': http://www.apprenticeships.org.uk/employers/steps-to-make-it-happen/incentive.aspx [accessed 30 December 2014]

292 Q 232 (Sue Husband), Q 254 (Ed Vaizey MP), Q 258 (Nick Boles MP), written evidence from MCA (DSC0040), City & Guilds (DSC0044), London Borough of Camden (DSC0058), CBI (DSC0074), UKForCE (DSC0078), HM Government (DSC0084), UK Digital Skills Taskforce and TeenTech CIC (DSC0101) and Northern Ireland Government (DSC0125)

293 Q 232 (Martin Hottass)

294 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101) and Tata Consultancy Services (DSC0106)

295 Written evidence from BCS (DSC0051)

296 Q 246

297 Written evidence from KTN (DSC0056) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

298 Q 199. See also written evidence from Humber LEP (DSC0060)

146. On this point, Mr Mason blamed a lack of industry involvement in the design of the apprenticeships programme: "… with regard to the Employer Ownership of Skills programme that is being run by BIS [Department for Business, Innovation & Skills], there are some questions as to how many SMEs are involved in designing those apprenticeships. It is really important to retain that involvement".[299] We say more about industry input into the education and training system in paragraphs 201–204.

147. In order to increase employer input, the Government told us:

> "CAVTL [Commission on Adult Vocational Teaching and Learning] recommended the adoption of the 'two way street' between providers and employers … Through its 'Teach Too' programme, more people from business will become directly involved in the delivery of vocational education, which will directly influence learners".[300]

148. This is a welcome move, but it is clear to us that much more needs to be done. As Antony Walker of techUK said: "I think industry is trying to do a lot, but there is a lot more to do."[301]

149. **Industry needs to be encouraged to offer more apprenticeships. Industry and the Government need to work together to set ambitions for apprenticeship numbers over the next five years, working to match apprenticeships with predicted workforce shortages.**

Higher education

> "University research is often at the cutting edge in developing the technological advances which drive the creation of new industries and new types of jobs."[302]—HM Government

Research and development

150. RCUK told us: "Postgraduate level study is extremely important for equipping the UK with the high level skills needed in an information economy."[303] More than that, research and development (R&D) enables the UK to be at the forefront of innovation, keeping abreast of the changing technological landscape and driving growth:

> "The strength of UK universities and the wider knowledge base is a national asset. Our knowledge base is the most productive in the G8, with a depth and breadth of expertise across over 400 areas of distinctive research strength. The UK produces 14% of the most highly cited papers and our Higher Education Institutions generate over £3 billion in external income each year."[304]

151. With this strength, the UK is, in theory, well positioned to predict, influence and respond to the changing economy and labour market—if universities are linked with their local economies (we say more about this in paragraphs 256–269). Recent figures, however, show R&D expenditure in the UK

299 Q 69
300 Written evidence from HM Government (DSC0084)
301 Q 61
302 Written evidence from HM Government (DSC0084)
303 Written evidence from RCUK (DSC0055)
304 BIS, *Innovation and Research Strategy for Growth* (December 2011): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229028/8239.pdf [accessed 20 January 2015]

decreased by 3% between 2011 and 2012.[305] Data from the WEF shows that the UK ranked 14th in 2014 for company spending on R&D, after leading economies Switzerland, Japan, Finland, the USA, Germany, Sweden, Israel, Qatar, Malaysia, Singapore, Belgium, Austria and Denmark.[306] This is down two places from the previous year.

152. During the Committee's visit to Imperial College London in November 2014 (see Appendix 8), a concern was expressed that a lack of funded research opportunities—along with restrictive visa rules—meant that researchers who had been funded by the university for up to 10 years left the UK to work elsewhere. The concern is that as the UK's talent pool—and investment in that talent pool—decreases, so too does our competitive advantage. Every graduate or postgraduate with high-level digital capabilities that we lose is an advantage ceded to another country or another firm in another place.

153. **Spending on overall research and development has fallen, meaning that the UK's position as a global leader in this field is threatened. This has a negative knock-on effect on the high-level talent pipeline.**

Computer science degree courses

154. A high number and quality of computer science graduates is important to UK competitiveness, both in terms of high-level talent, and to work in the talent pipeline as teachers. There was evidence that the higher education offer around computer science provision was not consistent between institutions. Recent press coverage reported a high unemployment rate among computer science graduates.[307] On this point, the Government told us: "NCUB [National Centre for Universities and Businesses] noted the poor employment rates of computing graduates, despite an industry skills shortage".[308]

155. Evidence from Professor Dame Wendy Hall contradicted this perception: "Our students [at Southampton University] are snapped up before they have finished their degrees. Many of our students start their own businesses, and that does not get reported properly in the statistics."[309] Our own research supported this. The ONS reported that in April to June 2013, graduates in mathematics/computer science were 89% likely to be employed (joint 9th out of 17 subjects).[310] For computer science alone, Which? reported that graduate employment rates across the Russell Group of Universities lay

305 ONS, 'UK Gross Domestic Expenditure on Research and Development, 2012': http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html [accessed 29 January 2014]. "In 2012, the UK's gross domestic expenditure on research and development (GERD), in current prices, decreased by 2% to £27.0 billion compared with 2011. Adjusted for inflation, in constant prices, research and development (R&D) expenditure decreased by 3%."

306 WEF, *The Global Competitiveness Report 2014–2015* (2014): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013–14.pdf [accessed 7 January 2015]

307 This was based on statistics published by the Higher Education Statistics Agency. See: Higher Education Statistics Agency, 'Performance Indicators: Employment of Graduates': https://www.hesa.ac.uk/index.php/content/view/1800/161 [accessed 18 December 2014]

308 Written evidence from HM Government (DSC0084)

309 Q 212

310 ONS, *Full Report: Graduates in the UK Labour Market 2013* (November 2013): http://www.ons.gov.uk/ons/dcp171776_337841.pdf [accessed 18 December 2014]

between 83% and 96%, with average salaries ranging between £21,700 and £34,300.[311]

156. One reason for this, Dame Wendy explained, was that: "When you dig under, you find that a lot of different types of courses are classed under computer science … You will get IT lumped in with all sorts of different things under computer science … We need to make people employable".[312]

157. Evidence showed that some higher education establishments work closely with industry to align course content with industrial need (see Box 11). This does not happen across the board.

Box 11: Case Study: The Open University and digital industries in Manchester and the North West

"Digital industries typically comprise SME[s] and microenterprises which individually may find it difficult to sustain collaboration with universities. For the past five years, the OU [Open University] has worked successfully with Manchester Digital (MD), a trade association for the sector in Manchester and the North West.

"OU students tend to be part-time and already have experience in work, potentially making them attractive to employers. Our relationship with MD has made the sector aware of OU students as potential employees and our students aware of, and prepared for, opportunities afforded by the sector.

"The long-term engagement with MD and its members has deepened the University's understanding of the sector's skills requirements, enabling us to develop these in our students and maximise employability. It has also brought opportunities for collaboration with other HEIs [Higher Education Institutions] and other institutions in supporting the sector. Interpretation of 'skills' and 'employability' is necessarily broad, with support including joint industry/academic talks (professional development), improved preparation of students for work in the sector, improved relevance of curriculum to industrial needs and collaborative R&D which contributes to the development of employers' high-level and strategic skills."[313]

158. **Universities need to be encouraged to work in partnership with industry, to make sure relevant courses are aligned with employer needs.**

159. **We believe that greater transparency and availability of destination data would enable prospective students to make a more informed choice about future study at higher education level.**

311 Which? University: http://university.which.co.uk [accessed 5 February 2015]. There was no data available for the London School of Economics, as it does not offer Computer Science as a subject.

312 Q 212

313 Written evidence from Open University (DSC0065)

A new approach to careers guidance

"Careers advice is patchy, uninformed and often unimaginative."[314]—UKForCE

Box 12: Key Statistic: Careers guidance

- In the UK, only 4% of 15 year-olds want careers in engineering and computing.[315]

160. We had evidence which said that careers guidance within education is especially important; not least in challenging perceptions of digital and STEM careers[316]—but evidence agreed the current offer is inadequate.[317]

161. The Government's written evidence provided little detail on careers guidance. Its only substantive comment was that the Department for Education had "new statutory guidance for schools, effective from September 2014 and will shortly publish equivalent guidance for colleges".[318]

162. Ms Husband provided us with a summary of the role of the Government's National Careers Service[319]:

> "We are there to provide impartial information and guidance to young people and adults, and that includes … provision of up-to-date labour market information that young people and parents can readily access through our website. We get that through a variety of sources: through the sectors and, importantly nowadays, through local enterprise partnerships and the Office for National Statistics. We liaise very closely with partner organisations and connect young people to other websites … The National Careers Service also has a professionally trained workforce, and I think that is key in giving young people the right advice about where to look for more detailed information on the careers that they should be pursuing".[320]

163. Careers guidance is not uniform across the UK; the National Careers Service is responsible for careers and skills advice in England. The devolved administrations have their own respective services: 'Careers Service Northern Ireland',[321] 'Skills Development Scotland'[322] and 'Careers Wales'.[323]

164. Despite the positive picture put forward by the Government and Ms Husband, the majority of the evidence said that current careers guidance was poor

314 Written evidence from UKForCE (DSC0078)
315 Not including architecture. OECD, 'Education at a Glance 2012' (Table A4.2): http://www.oecd-ilibrary.org/education/education-at-a-glance-2012/percentage-of-15-year-old-boys-and-girls-planning-a-science-related-career-or-a-career-in-engineering-and-computing-at-age-30-by-gender_eag-2012-table37-en [accessed 20 January 2015]
316 Written evidence from The UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
317 See paragraph 164.
318 Written evidence from HM Government (DSC0084)
319 The National Careers Service is run by the SFA. It was established in April 2012 and is responsible for advice about careers and skills in England. Northern Ireland, Scotland and Wales have their own individual services. See: https://nationalcareersservice.direct.gov.uk/Pages/Home.aspx [accessed 2 February 2015]
320 Q 232
321 Careers Service Northern Ireland: http://www.nidirect.gov.uk/index/information-and-services/education-and-learning/careers.htm [accessed 15 December 2014]
322 Skills Development Scotland: http://www.myworldofwork.co.uk [accessed 15 December 2014]
323 Careers Wales: http://www.careerswales.com [accessed 15 December 2014]

and outdated.[324] Ms Price described current careers guidance as "absolutely shocking" and as not working "for any sector or for any company".[325] This is particularly problematic given the predicted changes to the labour market; without the appropriate careers guidance and advice in place, young people (and the population in general), will not be able to make an informed decision about potential career choices.

165. Baroness Shields, the Government's Digital Adviser and Chair of Tech City UK, highlighted how the rise and pace of technological change had completely altered employment; whereas previously people would have most likely had one career for their lifetime, it was now likely that individuals would have a number of jobs: "… the 18 year-old of last year would have 11 jobs by the time they were 37 … The days are gone when you relied on a career counsellor … who said, 'You might be this', and then you became that for the rest of your life".[326] The role of the career advisor was more appropriate when people tended to have only one job for their entire working lives.

166. It was also questioned whether existing careers guidance encouraged people, regardless of gender, to consider all the opportunities and routes available to them. That is, whether advice extended beyond suggesting the higher education route.[327] The UK Digital Skills Taskforce and TeenTech CIC said that "one of the most obvious weaknesses" seemed to be alerting students to the choices they had post 16 and 18. For example, many students were given little—or no—information about apprenticeships, let alone digital apprenticeships.[328]

167. Other suggested reforms to careers advice centred on the age groups that should be targeted. On one end of the scale, the CBI told us that it was increasingly important that people received careers advice "from an earlier age".[329] Future career prospects are affected by subjects chosen at the age of 14.[330] At the other end of the scale, Mr Hughes said careers services focused "too closely on people aged between 18 and 24".[331] Straddling both of these views, the UK Digital Skills Taskforce and TeenTech CIC said that careers advice should be an ongoing process "from primary school right through to those already in work who may be seeking alternative career paths".[332]

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324 Q 236 (Martin Hottass, Chris Jones), written evidence from City & Guilds (DSC0044), IET (DSC0049), KTN (DSC0056), CBI (DSC0074), UKForCE (DSC0078), Science Council (DSC0096) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

325 Q 123

326 Q 217

327 Written evidence from City & Guilds (DSC0044)

328 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101). A survey of 5,500 teenagers (aged 12–13) was conducted at a series of TeenTech events during 2012/13, which revealed that 74% said they intended to go to university, 9% were thinking about apprenticeships, 9% wanted to go straight into a job, and the remainder did not know.

329 Written evidence from CBI (DSC0074)

330 Q 236 (Chris Jones). See also: Institute for Fiscal Studies, Research Report DFE-RR160, Subject and course choices at ages 14 and 16 amongst young people in England: insights from behavioural economics (October 2011): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/182677/DFE-RR160.pdf [accessed 22 January 2015]

331 Q 92

332 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

168. Much of our evidence proposed that industry play a greater and more active role in providing careers information, guidance and advice.[333] The CBI, for example, stressed: "Employer engagement … is key to ensuring the information young people receive is relevant, up to date and grounded in the realities of the labour market."[334]

169. Although we received evidence of innovative schemes attempting to improve careers advice (see Appendix 5), these were not consistent or connected.[335] This was a point reflected by the Minister of State for Skills and Equalities, Nick Boles MP, who said that there was "very little light-touch co-ordination", with little sense that there was "one place to go where you can find out exactly who is best".[336] Mr Boles acknowledged that this was a problem, particularly for schools.[337]

170. Some witnesses took this further. The IET said that professionals in industry should be "supported and encouraged to provide mentoring and advice to young people".[338] Lady Shields, meanwhile, said that she felt this was a grassroots/local issue: "You [businesses] cannot complain that you do not have the right skills if you are not extending your hand to the schools in your area".[339]

171. Compelling evidence from Ms Price said that careers guidance needed to be turned "on its head" and that we should "do something transformational".[340] Dame Wendy and Lady Shields said that careers guidance needed to head for the "social network route".[341] The benefit of this approach was that it would allow you to "scale the advice and allow people, either as themselves or anonymously, to interact and have conversations about their future potential".[342]

172. The UK Digital Skills Taskforce and TeenTech CIC suggested something similar. It advocated regional groups collaborating to establish websites dedicated to "connecting education and tech businesses in order [to] help improve careers guidance and facilitate work experience", which LEPs, local authorities or self-organising collaborations could lead.[343]

173. **The current careers guidance structure is outdated and does not support the needs of the future digitally-skilled workforce. It would be more appropriate to talk about 'employment' guidance. Industry has a vested interest in this; if employers want to close the skills gap and recruit the best individuals, they must have greater involvement.**

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333 Q 218 (Baroness Shields), Q 236–237 (Martin Hottass), written evidence from MCA (DSC0040), NMI (DSC0062), UKForCE (DSC0078), Ukie (DSC0086), BT (DSC0091), Chartered Institute of Public Relations Social Media Panel (DSC0094), Science Council (DSC0096) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
334 Written evidence from CBI (DSC0074)
335 Q 236 (Chris Jones) and written evidence from KTN (DSC0056)
336 Q 252
337 *Ibid.*
338 Written evidence from IET (DSC0049)
339 Q 218
340 Q 123
341 Q 217
342 Q 218 (Professor Dame Wendy Hall)
343 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

174. **We believe that a radical rethink is required to inject imagination into employment guidance. An employment guidance service needs strong central leadership which coordinates local schemes.**

The role of parents and teachers

175. The evidence also stressed the influence that parents and teachers had over young people when they were considering a future career.[344] Ms Philbin told us: "It is critical that we help teachers and parents in this space because it is shown that they are massively influential."[345] She highlighted that parents and teachers "are the ones who the teenagers will turn to, so all the inspiration in the world goes to one side if a parent goes, 'No, you ought to be a lawyer'".[346]

Parents

176. Parents (especially mothers) were shown to be extremely influential.[347] A survey of over 5,000 school pupils in 2012[348] found 43% of respondents[349] turned to parents as "their most significant source of advice on possible careers".[350] The influence of parents also has an impact on the number of women taking up digital careers. Dame Wendy, for example, noted that research on the failure to attract women to computer science courses found "it is so much about what the parents think".[351]

177. It was said that many parents had a negative perception of work in digital and STEM areas, and did not perceive them as a 'proper' career. A survey by O2 in June 2014 questioned over 2,000 parents, and discovered that a significant proportion (38%) would prefer their children to pursue 'traditional' career routes rather than so-called modern 'digital' careers. As many as one in 10 (10%) admitted they would actively discourage their child from pursuing a digitally focused career. O2's survey also highlighted a disconnect between the skills in demand from UK employers[352] and those skills valued by many parents, with many "seemingly oblivious of the growing importance of digital skills in all walks of life";[353] almost a quarter (23%) believed digital skills were irrelevant to their children's future career success. The lack of knowledge amongst parents was perhaps the most important outtake from the consultation, with one in three parents (38%) admitting they did not know enough about the digital economy to help their children make informed career choices.[354]

178. Given the importance of digital and the important role parents have to play in influencing career choices, respondents stressed that there needed to be increased awareness amongst parents; that is, increased awareness

344 Q 113 (Maggie Philbin), written evidence from Samsung Electronics UK (DSC0092) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
345 Q 123
346 Q 123
347 Q 232 (Chris Jones)
348 UK Digital Skills Taskforce, *Digital Skills for Tomorrow's World: Interim Report* (July 2014): http://www.ukdigitalskills.com/wp-content/uploads/2014/07/Binder-9-reduced.pdf [accessed 8 December 2014]
349 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
350 Written evidence from UKForCE (DSC0078)
351 Q 217
352 Analysis carried out in May 2014 by jobs website Monster.co.uk provided evidence of the growing demand for digital jobs. Of the tens of thousands of roles posted on their site, vacancies within the ICT category represented more than one fifth (22%) of the total.
353 O2, 'Parents' analogue ambition could damage UK competitiveness': http://news.o2.co.uk/2014/06/11/parents-analogue-ambition-could-damage-uk-competitiveness [accessed 8 December 2014]
354 *Ibid.*

of the opportunities digital could provide and the potential career paths.[355] Ms Philbin said that "… they need to understand that it does not matter whether you work for Network Rail, Ocado, Google, a charity or a tiny SME, you need a level of digital skills".[356] As part of this, we heard that the media had a role to play. UKForCE told us: "This is an area where the BBC and national newspapers can and should play a significant role."[357] Samsung similarly said that highlighting role models and "the many successful new market entrants" would be another way to raise awareness.[358]

Teachers

179. A number of respondents touched on the importance of teachers in relation to careers guidance. Ms Philbin and the UK Digital Skills Taskforce and TeenTech CIC said that teachers sometimes seemed more focused on achieving good exam results than on giving good advice.[359] UKForCE suggested that as part of an improved and more inspirational careers guidance model, teachers should have more exposure to the roles of digital skills in various sectors "through short work placements and shadowing".[360] A similar view was expressed by Mr Jones, who said that it should be an "absolute requirement for them [teachers] to go back into industry for the most possible time that they can afford".[361]

180. **Parents and teachers play a critical role in influencing future employment options and choices; both, however, suffer from a lack of awareness that must be addressed. For teachers, part of tackling this awareness could be achieved through increased industry exposure.**

Part IV: Filling the immediate skills gap

Continuing Professional Development

181. The conclusions we have drawn in the earlier Parts of this Chapter are aimed at preparing the UK for the changes in the labour market. Perhaps of more immediacy, our evidence showed that the existing workforce must be future-proofed for the UK to reach its economic potential.[362] The world is changing now and the UK's workforce must adapt to compete. Traditional 'safe' industries have recently announced redundancies and closures. Lloyds Banking Group announced 9,000 job losses and the net closure of 150 branches;[363] and large supermarkets such as Sainsbury's, Asda and Morrisons are cutting back jobs and costs in response to changing shopping habits.[364]

355 Written evidence from Digital Youth Academy and Pera Training (DSC0029)
356 Q 113
357 Written evidence from UKForCE (DSC0078)
358 Written evidence from Samsung Electronics UK (DSC0092)
359 Q 123 and written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
360 Written evidence from UKForCE (DSC0078)
361 Q 236
362 Written evidence from Elix-IRR (DSC0046), IET (DSC0049), Humber LEP (DSC0060), Tony Harper (DSC0075), Chartered Institute of Marketing (DSC0076), Creative Skillset (DSC0095) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
363 'Lloyds Bank confirms 9,000 job losses and branch closures', *BBC News* (28 October 2014): http://www.bbc.co.uk/news/business-29798532 [accessed 20 January 2015]
364 'Sainsbury's snatches No 2 spot from Asda', *The Guardian* (13 January 2015): http://www.theguardian.com/business/2015/jan/13/sainsburys-asda-supermarket-sales [accessed 6 February 2015]

182. There was consensus that the workforce needs to be agile and workers learn throughout their lives to keep up with changing technologies.[365] To do so is to drive growth. Mr Hughes told us the job gap[366]: "… need[s] to be filled by people working longer, people working more hours and people who are not active getting back into the labour market".[367] Lifelong learning will support this.

183. As discussed in paragraphs 117–126, the training system does not currently meet employer requirements for flexibility. Andreas Schleicher from the OECD told us: "[Successful countries] modularise education a lot more than in the UK. You can accumulate qualifications over your life cycle, you can alternate education and work, and employers are a lot more open to people continuing their education".[368] This means other countries are better placed than the UK to compete in the changing world.

184. In order to service this need for constant re-education, Michael Gleaves from the Hartree Centre[369] told us: "… it needs to be embedded within the culture of our nation that people need continually to re-educate themselves and build new skills".[370] A shift towards learning throughout life brings increased responsibility to all participants: the individual, the Government, and employers.

185. Increased responsibility for employers necessitates increased industry input into training provision. As Mr Hottass explained:

> "When we [Siemens] started this journey it was purely driven by economics. We were saying, 'We need to grow our business. We want to grow our business. Do we have the right skills?' Surprise, surprise, they were not in the marketplace, so the only way you can do that then is to engage wholesale."[371]

186. The level of industry input, however, is not currently meeting demand. Mr Schleicher explained that intensity of industry participation in the UK was lower than in countries such as Sweden: "Employers in the UK invest in filling short-term skill gaps but they do not invest in the kind of sustained development that upgrades human capital."[372]

187. A culture shift in how people interact with the training system, particularly in how it is funded, is necessary. Mr Schleicher advocated Sweden's system: "… people are willing to invest in their skills because they translate into

365 Q 41 (Chris Mairs), Q 51 (Mike Warriner), Q 87 (David Hughes, Professor Martin Weller), Q 116 (Maggie Philbin), QQ 200–201 (Gerard Grech, Gary Warke), Q 207 (Dinah Caine), written evidence from Barclays Bank (DSC0047), IET (DSC0049), Tony Harper (DSC0075) and Go ON UK (DSC0079)

366 Q 31: "… about 13.5 million jobs need filling in [the] next 10 years and yet there are only 7 million young people entering the labour market in that period. There is a 6.5 million gap".

367 Q 87

368 Q 227

369 The Hartree Centre is a Science and Technology Facilities Council (STFC) high performance computing (HPC) facility based in the North West of England. The Centre looks at supercomputing, Big Data analytics and visualisation, which it tries to apply to industrially relevant problems. See: http://www.stfc.ac.uk/2512.aspx [accessed 2 February 2015]

370 Q 31

371 Q 232

372 Q 227

access to more jobs and ultimately better earnings".[373] He also told us: "the true costs are not in the tuition; the true costs lie in forgoing earnings".[374]

188. The Government's responsibility lies in facilitating industry input and individual take-up to happen. We explain this in more detail in paragraph 298. The Scottish Government told us it was responding to short- and medium-term skills gaps by means of its Skills Investment Plan for the digital/ICT sector,[375] which included: the development of an industry-led talent academy; support for CPD; supporting talent attraction strategies, including the recruitment of overseas talent and action to attract more women to enter and return to the profession; and the development of a targeted marketing campaign.[376]

189. **Continuing Professional Development and a move to short, sharp, relevant interventions later in life are imperative for the UK's workforce to remain competitive. The development of skilling throughout life needs a fundamental rethink. The Government must be at the forefront of this change.**

Online and self-learning

190. The evidence showed there is already an increased emphasis on self-learning and online learning,[377] such as through MOOCs, to support CPD. This re-emphasis needs to apply across the existing workforce, throughout the education system, and to those returning to work to enable the population to adapt to their changing work environments.[378] The first Government supported MOOC to educate cybersecurity professionals launched in September 2014;[379] and Codecademy—a free online programming website—had 24 million learners from around the world as of January 2015.[380]

191. Self-learning has no guarantee of success; risks include whether learners and educators know where to look for courses[381] and reliance on a learner's motivation.[382] Professor Martin Weller from the Open University told us: "The completion rates on these MOOCs, the big open courses, are very low at around 10%."[383] Evidence suggested that a solution lies in incorporating 'learning to learn' within the education system.[384] For instance, the Chartered Institute of Library and Information Professionals told us: "The only way you

373 Q 228
374 *Ibid.*
375 Skills Development Scotland, *Skills Investment Plan: For Scotland's ICT & Digital Technologies sector* (March 2014): http://www.skillsdevelopmentscotland.co.uk/media/987939/ict___digital_technologies_sector_skills_investment_plan.pdf
376 Written evidence from Scottish Government (DSC0128)
377 Q 32 (Kevin Baughan), Q 46 (Mike Warriner, Chris Mairs), Q 55 (Antony Walker), Q 114 (Karen Price), Q 215 (Professor Hall), written evidence from British Sky Broadcasting (DSC0036) and Cornwall and Isles of Scilly LEP (DSC0054)
378 Q 214 (Baroness Shields, Professor Hall)
379 BIS, 'Government supports UK's next generation of cyber security professionals': https://www.gov.uk/government/news/government-supports-uks-next-generation-of-cyber-security-professionals [accessed 26 January 2015]
380 Codecademy is an online learning website where users can learn how to code interactively for free. See: http://www.codecademy.com [accessed 29 January 2015]
381 Q 46 (Mike Warriner)
382 QQ 93–95 (Professor Weller, David Hughes), Q 131 (Lucy Hastings), written evidence from KTN (DSC0056) and UK Digital Skills Taskforce and TeenTech CIC (DSC0101)
383 Q 93
384 Written evidence from Chartered Institute of Library and Information Professionals (DSC0045)

can prepare students for a future workplace of such volatility is by inspiring them to become confident independent learners."[385] We agree.

192. **The role of business, industry and the Government needs to be examined to deliver a cultural shift towards preparing learners to learn for themselves.**

Short courses: training providers

193. Short, sharp training interventions which allow employers to be responsive to change are a vital part of the future. Mr Jones told us: "That sense of continuous learning, bite-sized learning or learning what you need when you need it is one that employers readily recognise".[386]

194. We have seen a few examples of private and third sector organisations which have begun to move into the gap left by the education and training system, but their offer is limited (see Appendix 5). Of the private sector, Guy Levin of the Coalition for a Digital Economy (Coadec) told us: "… you can do a three-month immersive course with them and they [the training provider] will teach you all the skills you need to be a junior web developer at a start-up or at a larger tech company. The only problem is that it costs you £8,000".[387]

195. We agree with Mr Levin that the £8,000 cost makes this option inaccessible to most people.

196. The third sector is active in training delivery; for instance Age UK Training delivers computer courses for all age groups,[388] whilst Code Club plans to increase in size. We were impressed with the community engagement of some of these organisations,[389] but they are barely resourced enough to deliver their core business. Provision is inconsistent across the UK; they do not have the resources to increase the range of courses they can offer.

197. **The third sector should be supported to use its existing networks and increase the provision of relevant digital courses.**

Further and higher education

198. As discussed in paragraphs 117–130, the further education sector is best placed to respond to the urgent need of employers, by delivering short, sharp training provision; what is required for the sector is a change of focus.

199. Evidence showed the higher education sector also has not responded to the urgent need for reskilling. Mr Boles told us: "I am surprised by how slowly the university sector has changed. I would have expected, and do expect in the next 10 years, a much more rapid embrace of sandwich courses, shorter courses, longer courses, more part-time courses."[390] Other witnesses spoke of the importance of conversion courses,[391] where degrees can be 'converted' to a more vocational employment pathway.[392]

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385 Written evidence from Chartered Institute of Library and Information Professionals (DSC0045)
386 Q 242
387 Q 62
388 Age UK, 'Training': http://www.ageuk.org.uk/work-and-learning/further-education-and-training/age-uk-training [accessed 7 January 2015]
389 For instance, Tinder Foundation, Code Club and Age UK.
390 Q 260
391 Q 21 (Professor Wajcman), Q 22 (Professor Brown) and written evidence from KTN (DSC0056)
392 For instance the Law conversion course (otherwise known as the Graduate Diploma in Law) allows graduates of any degree to 'convert' their degree into a recognised law qualification in one year.

200. **Universities could better serve prospective students by adding the option of shorter, more flexible provision to its existing course. This could be done via targeted skills funding. Universities should ensure that all graduates are digitally competent.**

Active employer engagement

201. There was consensus that there is an urgent requirement for industry input across the education system. The workforce will only be adaptable and employers competitive if training is targeted. We have heard that active employer engagement in primary and secondary schools, further education, apprenticeships, careers guidance, and accreditation and qualifications makes the difference between good provision and bad provision.

202. Government efforts need to be scaled-up. There is a key role for the Government in facilitating industry buy-in. We say more about this in Chapter 5 (see paragraph 298).

203. The Government told us of "£18.4m of co-funding for a new employer-led industrial partnership, the 'Tech Partnership'",[393] which aims to develop a certification brand, deliver CPD, supply employer-developed higher education programmes, supply an industry-backed MOOC, and gain employer-led support for careers education, information, advice and guidance, and run three tech skills hubs on Big Data cybersecurity.[394] This is a welcome initiative, but it is small-scale. Only 2,750 young people will undertake industry-accredited apprenticeships. In addition, according to the Government, reforms to careers guidance will encourage only 14,000 new female entrants to the sector.[395]

204. **Immediate industry involvement to enhance the education and training agenda is vital to make sure the UK's workforce can adapt to the requirements of the new world. We recognise the Government's efforts to engage business and industry in education, but these efforts do not go far enough and are geographically inconsistent. Over the next five years the new Government has a responsibility to ensure industry-education partnerships flourish.**

Immigration

> "Digital business is global business … so we absolutely need to be attractive to talent and be able to bring the talent in".[396]—Paul Willmott, Director, McKinsey & Company

205. The role of immigration in filling the immediate skills gap was raised throughout our inquiry.

206. The evidence highlighted that the rising demand for individuals with high-level skills was "difficult to meet from national sources".[397] For example, we heard that in the UK demand for engineers was 87,000 per annum for the next decade, whilst the current number of engineering graduates per annum was just 46,000.[398] The Government noted "it is impossible to estimate how

393 Written evidence from HM Government (DSC0084)
394 *Ibid.*
395 *Ibid.*
396 Q 70
397 Written evidence from RCUK (DSC0055)
398 Written evidence from IET (DSC0049)

quickly the gap could be closed by home grown talent alone" and so "British Tech companies will … need access to the global skills market to obtain the talent required to grow in the short-term".[399] There is another issue here, namely the small minority of the engineering workforce made up of women. This was covered more extensively in paragraph 54.

207. Innovate UK noted that in a globalised world, it would be imperative for the UK to have access to—and remain an attractive location for—the global talent pool in order to build a highly-skilled technical workforce.[400] As Paul Willmott from McKinsey & Company said: "It is very important that we are globally competitive in our ability to attract talent."[401]

208. To do this, a different approach was called for. For example, the Recruitment & Employment Confederation[402] said: "… in the short term, the UK must adopt a flexible approach to immigration to ensure that candidates with skills in short supply or lacking in the domestic market are able to come to work in the UK".[403] This was supported by other evidence.[404]

209. There was broad consensus that visa and immigration policy—at least in relation to high-skilled immigration in the short- to medium-term—was not working and needed to be reformed.[405]

210. We were warned that the changes to the visa process since 2010 had a negative impact on securing those with the necessary talent and digital skills. Specifically, we were told that the UK was educating its competitors. Mr Levin explained:

> "The visa reforms since 2010 have been quite detrimental … Scrapping post-study visas means that some of our best [international] STEM graduates and computer science graduates … are forced to leave when they could be delivering massive contributions not just for start-ups but in any section of the economy".[406]

211. Imperial College London has experienced this problem. When we visited the College in November 2014 (see Appendix 8), we were told that over half of its students were from outside the UK. With the College recognised as the 2nd best university in the UK for engineering and technology (and 6th in the world),[407] it seems economically counter-productive that visa restrictions would prevent its graduates from remaining in the UK to contribute to the economy. This had a negative effect of training graduates who would then be sent back to work for the UK's competitors.

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399 Written evidence from HM Government (DSC0084)
400 Written evidence from Innovate UK (DSC0070)
401 Q 70
402 The Recruitment & Employment Confederation is the professional body for the UK recruitment industry, representing over 3,500 corporate members, who together account for around 80% of the recruitment industry by turnover. See: https://www.rec.uk.com [accessed 2 February 2015]
403 Written evidence from REC (DSC0035)
404 For instance, see written evidence from McAfee (DSC0022), Here East (DSC0048) and Sunderland Software City (DSC0063)
405 For instance, Q 63 (Guy Levin), Q 70 (Marcus Mason), Q 80 (Dominic Field), written evidence from REC (DSC0035), Tony Harper (DSC0075), Ukie (DSC0086), Makers Academy (DSC0119) and Imperial College London (DSC0122)
406 Q 63
407 The Times Higher Education World University Rankings 2014–15, 'Engineering and Technology': http://www.timeshighereducation.co.uk/world-university-rankings/2014–15/subject-ranking/subject/engineering-and-IT [accessed 10 December 2014]

212. Makers Academy pointed out that because of visa reform, many of its graduates had ended up securing employment in other countries (such as Singapore, Australia and South Africa), despite more UK companies looking to hire Makers Academy graduates than there were graduates seeking employment.[408]

213. Witnesses highlighted that post-study visas played an important role for allowing international students to remain in the UK and contribute to the economy using the skills they had been taught. For instance, Mr Walker said: "When those researchers have completed their studies, when they have developed their ideas, we need to be encouraging them to stay in the UK and build businesses and wealth here."[409] In their report, 'International Science, Technology, Engineering and Mathematics (STEM) students', the House of Lords Science and Technology Committee recommended that the Government "immediately reinstate the previous post-study work route".[410]

214. It was generally accepted that longer-term immigration was necessary for competitiveness. For example, Mr Mason said that we should not regard high-skilled immigration as "just about plugging a skills gap".[411]

215. As well as this, evidence stressed that home-grown talent was of greater importance (as was discussed in Part II of this Chapter, see paragraphs 88–92). Tata Consultancy Services[412], for example, said: "In order for it to win the 'skills race' and succeed … the UK needs to be able to develop its skills base and home-grown talent".[413]

216. There was some evidence which did not agree that the visa and immigration agenda needed reforming. Professor Alan Manning from the LSE said that the skills shortage was due to a failing within the training system. Professor Manning argued that individual companies "do not want to pay for the training themselves" and "cannot get their act together well enough to agree on a system [for training]".[414] Digital Youth Academy and Pera Training[415] said that the UK was one of the world's digital front runners, and thus did not view encouraging high-skilled immigration as necessary.[416] Despite these strongly worded views, the overwhelming body of evidence favoured a need for a reformed visa process.

217. **Current immigration and visa rules do not support the urgent short-term need for talent. We agree with the House of Lords Science and Technology Committee who, in their report 'International Science, Technology, Engineering and Mathematics (STEM) students',**

408 Written evidence from Makers Academy (DSC0119)
409 Q 63
410 Science and Technology Committee, *International Science, Technology, Engineering and Mathematics (STEM) students* (4th Report, Session 2013–14, HL Paper 162), paragraph 110
411 Q 70
412 Tata Consultancy Services is one of the top 10 technology firms in the world. It is the 7th largest IT services supplier in the UK and has over 150 customers, including British Airways, Marks & Spencer, Boots and Aviva. Tata Consultancy Services employs over 11,000 people across the UK, from Edinburgh to London and beyond. See: http://www.tcs.com/Pages/default.aspx [accessed 2 February 2015]
413 Written evidence from Tata Consultancy Services (DSC0106)
414 Q 22
415 The Digital Youth Academy is a training provider which specialises in supporting the digital sector. Pera Training is a national independent training provider, and is a delivery partner of the Digital Youth Academy. See: http://www.digitalyouthacademy.com and http://www.peratraining.com [accessed 2 February 2015]
416 Written evidence from Digital Youth Academy & Pera Training (DSC0029). See also written evidence from BT (DSC0091)

recommended that the Government "immediately reinstate the previous post-study work route".

218. **Even if the previous post-study visa work route was reintroduced, an incoming Government could not rely solely on high-skilled immigration as the main mechanism to reduce the skills shortage in the short term. Greater emphasis is needed on cultivating home-grown talent, with a longer-term immigration policy that would still allow the UK access to the best global talent, especially to graduates.**

CHAPTER 4: THE BUSINESS ENVIRONMENT

Part I: Connecting and supporting business

219. The UK already has a competitive advantage in some areas. For instance, the UK is renowned for its creative skills (see paragraphs 95–97). Paul Willmott from McKinsey & Company told us: "… the video games sector hardly existed 20 years ago but is now a substantial sector of the economy; it is actually larger globally than the movie industry. We in the UK have been a leading player."[417] For example, Framestore[418], the world's leading visual effects company, is based in London.

220. But this advantage is fragile, and threats include challenges within the talent pipeline, as well as low levels of spending on research.

221. Evidence showed that the UK is not sure where its next competitive advantage will lie. What we do know, however, is that entrepreneurship is booming, our most successful local areas include tech clusters (see paragraphs 242–261), and our research institutes are world-leading (such as Imperial College London's high performance computing (HPC) facilities). For example, Antony Walker from techUK told us: "There are 340,000 new start-ups already this year [2014], according to StartUp Britain. All that change is enabled by digital technologies, so I think that is a huge tick for the growth and jobs agenda for the UK driven by technology."[419]

Business support for small and medium-sized enterprises

"If we can digitise the other 50% of SMEs, we can drive the productivity of the UK economy … It is a massive prize".[420]—Antony Walker, Deputy Chief Executive Officer, techUK

Box 13: Key Statistic: Small and medium-sized enterprises

- Approximately 30% of SMEs do not have a website.[421]

222. We heard that SMEs drive innovation and growth, and that digitally empowering the UK SME sector could unlock £18.8 billion of annual revenue[422] and stimulate the creation of 58,000 new jobs.[423] There are, however, a number of challenges facing SMEs, which are holding this potential back. These fall under three broad categories: awareness, skills and finance.

223. As with individuals, SMEs require a certain core level of digital skills if they are to remain competitive and take advantage of the digital economy. The skills required by both organisations and individuals have been summarised by Go ON UK and can be found in Appendix 7. We were told that it was vitally

417 Q 66
418 Framestore is a British visual effects company based in Soho near Oxford Street in London. In 2014, Framestore won an Oscar Academy Award for Achievement in Visual Effects for the film Gravity. See: http://www.framestore.com [accessed 2 February 2015]
419 Q 55
420 *Ibid.*
421 Cabinet Office, 'Government Digital Inclusion Strategy' (April 2014, updated November 2014): https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy [accessed 3 December 2014]
422 Written evidence from Elix-IRR (DSC0046), Go ON UK (DSC0079) and Virgin Media (DSC0100)
423 Centre for Economics and Business Research, *Data equity: Unlocking the value of Big Data* (April 2012): http://www.sas.com/offices/europe/uk/downloads/data-equity-cebr.pdf [accessed 10 December 2014]

important for SMEs to use digital technology, otherwise they would miss out economically. SMEs who made full use of the internet, and associated activities such as ecommerce, enjoyed particular benefits. According to research by McKinsey & Company, such SMEs grow faster, export more and create more jobs.[424] Virgin Media said that digitally mature small businesses were three times more likely to grow than immature ones.[425]

Awareness

224. One of the core issues specific to SMEs is a lack of awareness of the potential value and use of digital technology.[426] Mr Walker said that awareness was a "major area of concern", as there were huge opportunities to "digitise and therefore drive the productivity of those small companies".[427] When we visited Google Campus[428] in September 2014 (see Appendix 8), it was stressed that one of the benefits of this initiative was that it helped provide SMEs with information on where to go for assistance, as well as making them aware and appreciate the opportunities of digital technology. The Google Juice Bar has travelled across the UK offering free advice to local business owners.[429]

225. Both Go ON UK and Virgin Media said that 92% of SMEs had access to the internet.[430] We therefore find it astonishing that a third of SMEs do not have a website.[431]

226. Increasing the awareness of the value of digital technology could have a dramatic impact on SMEs. As an example, Mr Walker described how a small company worked with a local web developer to improve their online presence. The company spent £10,000 on upgrading their website and implementing 'search engine optimisation', which resulted in doubling their revenues in a year.[432] Mr Walker said that "The first steps of getting on the ladder of being digital are not particularly difficult".[433] The UK Digital Skills Taskforce and TeenTech CIC suggested that the Government should therefore mount an awareness campaign about the need to improve digital skills among SMEs.[434]

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424 Q 68 (Paul Willmott) and written evidence from Go ON UK (DSC0079). See also: McKinsey & Company, Internet matters: The Net's sweeping impact on growth, jobs and prosperity (May 2011): http://www.mckinsey.com/insights/high_tech_telecoms_internet/internet_matters [accessed 10 December 2014]

425 Written evidence from Virgin Media (DSC0100)

426 For instance, see written evidence from RSE (DSC0030) and Elix-IRR (DSC0046)

427 Q 54

428 In 2012 Google established its 'Campus' to equip entrepreneurs and start-ups with the resources they need to develop and grow. Their mission is: "… to create an environment that encourages innovation through collaboration, mentorship, and networking". The Campus is equipped with high-speed WiFi, a cafe, frequent networking and speaking events, and co-working space. The Campus is funded, facilitated and managed by Google, in collaboration with partners. See: https://www.campuslondon.com [accessed 2 February 2015]

429 Google Juice Bar is a series of free seminars and workshops aimed to empower small business owners and aspiring entrepreneurs gain the necessary skills to get the most out of their digital marketing and boost their online presence. For instance, see: Newcastle City Council, 'The Google Juice Bar is coming to Newcastle': https://www.newcastle.gov.uk/news-story/google-juice-bar-coming-newcastle [accessed 5 February 2015]

430 Written evidence from Go ON UK (DSC0079) and Virgin Media (DSC0100)

431 Cabinet Office, 'Government Digital Inclusion Strategy' (April 2014, updated November 2014): https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy [accessed 3 December 2014]

432 Q 55

433 *Ibid.*

434 Written evidence from UK Digital Skills Taskforce and TeenTech CIC (DSC0101)

Skills

227. Linked to the lack of awareness, the Government's evidence said that 28% of SME employers reported that a general shortage of skills was an obstacle to their business success.[435] Elix-IRR, for example, said: "In today's knowledge economy talent is one of the main sources of competitive advantage but retaining the most skilled employees often remains a challenge for SMEs".[436] If SMEs are not made up of individuals with the right talent, knowledge and basic competencies, there would be a large proportion who would "not be able to participate in the digital economy".[437]

228. RCUK used the Science and Technology Facilities Council's (STFC) Sci-Tech Daresbury and Harwell Oxford as examples of high-tech campuses for SMEs to grow their ideas into profitable businesses (see Box 14).[438] We visited the Hartree Centre in October 2014—one of the facilities at Sci-Tech Daresbury—where we saw first-hand the benefits of synergies between SMEs and research (see Appendix 8).

Box 14: Sci-Tech Daresbury and Harwell Oxford

At the Sci-Tech Daresbury and Harwell Oxford campuses, high-tech businesses of all sizes—from entrepreneurs with an idea, to established transnational companies such as Unilever looking for inspiration or to reduce costs and their time to market with new products—can harness the STFC's facilities, expertise and resources, and those of its partners and other research-based or commercial organisations.

The campuses, both run as joint ventures between the public sector and private sector property development partners, currently host over 230 enterprises and support more than 5,000 jobs.

Early stage businesses are able to gain easy access to a range of angel networks and venture capital organisations looking to invest in the earliest, and riskiest, stages of technology companies.

Companies also get regular opportunities to attend valuable networking events through a programme of business breakfasts, knowledge sharing and professional development events. Being active members of the campus communities enables SMEs to make and leverage new connections. Many companies are actively collaborating with the STFC, universities or other companies. At Sci-Tech Daresbury, for example, around 57% of companies are working together on projects, generating a value in terms of new sales or cost savings of £1.2 million.[439]

229. Virgin Media explained how the barrier to accessing talent was stunting potential growth: "The Centre for Economics and Business Research listed the prohibitive costs for SMEs in gaining technically trained staff capable of undertaking large scale data analysis as the primary barrier to the UK

435 Written evidence from HM Government (DSC0084)
436 Written evidence from Elix-IRR (DSC0046)
437 Q 55 (David Pollard)
438 Written evidence from RCUK (DSC0055)
439 STFC, 'Campuses: the ideal environment for high-tech innovation': http://www.stfc.ac.uk/2943.aspx [accessed 15 December 2014]

realising the £42 billion opportunity associated with SME adoption of data optimisation."[440]

Finance

230. SMEs by their very nature will have less financial capital than larger organisations. Marcus Mason from the British Chambers of Commerce told us: "… an issue we hear about all the time is access to finance and having the right finance in place to allow SMEs to grow and get the investment they need to become world-leading firms".[441] We were told that this was holding back businesses from expanding "where growth is a viable option", thereby hindering potential economic growth for the UK. Given that "micro-firms" account for "most businesses across the country", this is particularly concerning.[442] It was suggested that the British Business Bank[443] could receive increased funding and be given a remit to work directly with SMEs to support the financing of smaller firms.[444]

Awareness raising and industry partnerships

231. Analysis of our evidence showed that awareness-raising and industry partnerships were the best approaches to tackle the majority of SMEs' issues, particularly at the local level. Appendix 5 provides some examples of initiatives aimed at supporting SMEs in this regard.

232. Mr Mason highlighted the role of Chambers of Commerce in sharing knowledge between businesses.[445] As thousands of businesses are members of Chambers across the country, collectively employing millions of people, it was argued that these were the most appropriate places to bring businesses together and develop the infrastructure and skills of local businesses. We heard the example of Norfolk Chamber of Commerce, which ran a series of events on digital skills bringing in some of its local businesses to deliver workshops and talks on the latest technological and digital advances. This provided the rest of the local business community the opportunity to exploit those advances and grow.[446] Networking was also supported by Barclays Bank, which suggested that the Government could work with business to identify best practice for SMEs to draw upon.[447]

233. Another proposal was for the establishment of specialist SME coaching in UK online centres. TalkTalk argued that online centres should receive increased funding from the Government, which could then be used to "address the skills needs of start-ups and SMEs".[448] Examples of how online centres could achieve this included short courses and drop-in sessions focused on coding, online marketing and promoting businesses through social media.[449]

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440 Written evidence from Virgin Media (DSC0100). See also: Centre for Economics and Business Research, *Data equity: Unlocking the value of Big Data* (April 2012): http://www.sas.com/offices/europe/uk/downloads/data-equity-cebr.pdf [accessed 10 December 2014]
441 Q 66
442 Q 67
443 British Business Bank: http://british-business-bank.co.uk [accessed 5 February 2015]
444 Q 67 (Marcus Mason), written evidence from IET (DSC0049) and HM Government (DSC0084)
445 Q 66
446 *Ibid.*
447 Written evidence from Barclays Bank (DSC0047)
448 Written evidence from TalkTalk (DSC105)
449 *Ibid.*

234. The Government also suggested accessing external advice could help SMEs overcome many barriers, stressing it would be important to articulate the benefits of being digital and fully exploiting the internet "more clearly".[450]

235. David Pollard from the Federation of Small Businesses noted that the Government was not doing enough to support SMEs. He said that Government programmes "always go for the sexy, high-profile ones like finding the companies that are going to grow by 20% or 30% per annum", but that there were no local programmes looking at "local problems".[451] Mr Pollard pointed out that it was LEPs that were beginning to get more involved in skills and business support, and that they were "the natural people … to put together programmes of this nature that can help businesses".[452]

236. There was consensus that LEPs were a good mechanism for increasing awareness amongst SMEs and helping them to overcome the various barriers.[453] The Government, for example, highlighted that evidence from existing SME digital skills programmes delivered by LEPs and their partners showed that a portfolio of activity—including face-to-face advice, seminars, group workshops, exhibition events, portals, case studies and action planning events—was effective in engaging SMEs and improving their digital skills.[454] The Government cited Manchester Growth Hub estimates, which suggested that by June 2015 the total number of companies engaged through their Digital Growth Service would be 395, with an increased expected GVA of £8,559,300.[455] Part II on regional ecosystems and clustering provides more detail on the role of LEPs (see paragraphs 240–277).

Scale-up

237. Our evidence agreed it was important for SMEs to be able to scale-up, but few were able to suggest how this could be successfully achieved. This problem was best summarised by Mr Walker: "… while we have focused on start-ups and SMEs, we have not really focused on what it takes to get more scale-up companies to scale but also to get them to stay in the UK and not move to the US or other markets".[456]

238. The Digital Youth Academy and Pera Training made the compelling suggestion that more needed to be done to promote the development of "bespoke vehicles" such as Apprenticeship Training Agencies[457] to enable micro-businesses and SMEs to upscale quickly "through alternative recruitment models".[458] The Digital Youth Academy and Pera Training explained that if employers were able to take on resource quickly and at a reduced risk, this would help support effective growth.[459] It is our view that

450 Written evidence from HM Government (DSC0084)
451 Q 55
452 *Ibid.*
453 Written evidence from NIACE (DSC0088)
454 Written evidence from HM Government (DSC0084)
455 *Ibid.*
456 Q 55
457 Apprenticeship Training Agencies (ATAs) are specifically designed to support employers who wish to take on an apprentice but are unable to in the current economic climate. The distinctive feature of this model is that it is the ATA who acts as the apprentice employer and who places them with a host employer. The host employer pays the ATA a fee for the apprentices' services; this fee being based on the wage agreed with the host and the ATA management fee. See: http://www.apprenticeshipsolutions.org.uk/apprenticeship-solutions/what-is-apprenticeship-training-agency-ata [accessed 2 February 2015]
458 Written evidence from Digital Youth Academy and Pera Training (DSC0029)
459 *Ibid.*

apprenticeships are a fundamental building block of the future labour market (see paragraphs 136–149), enabling companies to recruit and train workers in the skills they need to be competitive in the changing world. It is vital that all businesses, particularly SMEs, are supported to offer apprenticeships.

239. **Barriers holding back SMEs from reaching their full potential include their low awareness of the opportunities presented by digital technology, limited access to the necessary talent pool and skills, and challenges in accessing adequate finance. The Government has a responsibility to coordinate and facilitate the right conditions for business; but the development of knowledge and support needs to be driven by local and other networks, for example through Chambers of Commerce, UK online centres and Local Enterprise Partnerships.**

Part II: Regional ecosystems and clustering

"Where are the next tech cities coming from?"[460]—Dominic Field, Partner & Managing Director, Boston Consulting Group

Regional differences

240. Regional and sub-regional economic disparities are well documented,[461] as are differing levels of expertise and investment within and between areas at all levels, including local, regional and pan-regional. Access factors such as broadband coverage and digital literacy levels interplay with the complex dynamics of local business and labour markets. Some regional economies are well in advance of others; for instance in the value of the local economy, the number of apprenticeship starts and the predicted share of employment (see Chart 2), and in identifying and growing regional specialisms (see Appendix 5). This means different areas have unequal starting positions when competing in the new digital world. See, for instance, Appendix 12, showing the proportion of non-users of the internet across all UK regions.

241. In addition, evidence from the Northern Ireland Government[462] cited the 'Knowledge Economy Index Report 2014', which compared the growth of the UK's respective regional knowledge economies between 2009 and 2014 (see Chart 3 below).[463] The report also found a correlation between the relative size of each region's share of the knowledge economy, and GVA per capita.

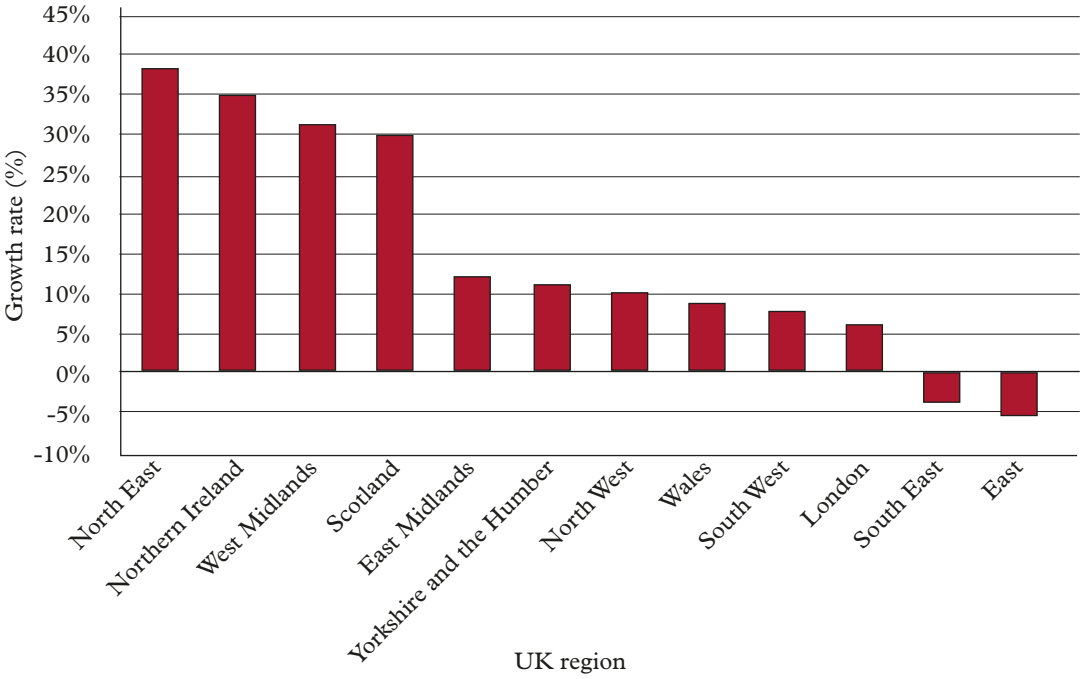
460 Q 82

461 Written evidence from David Chan (DSC0007), OECD (DSC0016), ALT (DSC0057), Go ON UK (DSC0079) and supplementary written evidence from BBC (DSC0112)

462 Written evidence from Northern Ireland Government (DSC0125)

463 NISP CONNECT, *Knowledge Economy Index Report 2014* (October 2014): http://www.nisp.co.uk/wp-content/uploads/2013/11/NI-KEI-Full-Report-2014.pdf [accessed 21 January 2015]. The report defines 'knowledge economies' as follows: "Knowledge economies are comprised of individuals, companies and sectors that create, develop, hone and commercialise new and emerging ideas, technologies, processes and products and export them around the world. In order to maintain their competitive advantage, these companies constantly strive to remain at the forefront of their industry by recruiting highly skilled individuals, investing in R&D, innovation, encouraging creativity, marketing and seeking out new markets." (page 7)

Chart 3: UK regional growth in the Knowledge Economy Index, 2009–2014[464]



Clusters

> "… every city has its own DNA, every city has its own history, every city has its own legacy".[465]—Chris Mairs CBE, Chair, UKForCE and Chief Scientist, Metaswitch Networks

242. We heard much evidence on the importance of clusters—groups of companies grouped around a particular industry in a specific location or area. Clusters have always formed around particular sectors and industries.[466] 'Tech' clusters are increasingly in the news, but the line between traditional and tech clusters is becoming blurred as digital affects more industries.

243. We were told that tech clusters are linked with innovation.[467] For instance, Professor Tony Venables told us: "… this [clustering] seems to be a particular feature of innovation including that in the digital sector".[468] It is widely accepted that innovation effects competitiveness and inequality; a report

464 Source: NISP CONNECT, *Knowledge Economy Index Report 2014* (October 2014): http://www.nisp.co.uk/wp-content/uploads/2013/11/NI-KEI-Full-Report-2014.pdf [accessed 21 January 2015]. "The Knowledge Economy Index is a composite index in that [it] includes all twenty one of the indicators listed in table one of the report. It is calculated using the weighted average growth rate of each of the indicators from 2009. Weights are detailed in Annex C of the report." (page 14, footnote 5); "The index is an indicator of the overall performance of the Knowledge Economy and has been adopted by DETI [Northern Ireland Department of Enterprise, Trade and Investment] as one of the independent measures of progress in the recently published Innovation Strategy." (page 14)

465 Q 197

466 Q 121 (Karen Price) and written evidence from Professor Tony Venables (DSC0114)

467 For instance, Q 30 (Professor Nick Bostrom)

468 Written evidence from Professor Tony Venables (DSC0114)

by the WEF found that innovation influenced the "competitiveness divide" across Europe.[469]

244. Companies in all industries have always formed clusters. Professor Venables told us that activity tends to cluster for the following reasons:

- "Proximity to supplier and customer firms economises on shipment costs/delays …
- "Proximity to supplier and customer firms facilitates communication about product specifications [and] design.
- "To benefit from knowledge spillovers—a 'buzz' of sector specific interaction.
- "To locate close to a pool of labour with sector specific skills (and for new entrants, the possibility of poaching workers from existing firms)".[470]

245. Furthermore:

> "It is sometimes suggested that ICT will lead to the 'death of distance' … This seems not to be the case: face-to-face communication remains important, partly to build trust in relationships, and also in activities (such as innovation) where ideas are complex and fast moving and it is important to be 'in the loop'".[471]

246. The importance of location was supported by other evidence, which showed specific regions such as London, Manchester, the South East and the M4 corridor, as having a strong concentration of digital industries.[472] Research by the National Institute of Economic and Social Research showed that digital industries were spread unequally around the UK (see Figure 1), and Professor Nick Bostrom from Oxford University told us: "… in the UK there might be one or two clusters that will be hotbeds of innovation but other parts of the country are left behind".[473]

469 WEF, *Enhancing Europe's Competitiveness: Fostering Innovation-driven Entrepreneurship in Europe* (January 2014): http://www3.weforum.org/docs/WEF_EuropeCompetitiveness_InnovationDrivenEntrepreneurship_Report_2014.pdf [accessed 2 February 2015]. "The Global Competitiveness Report 2013–2014 analysis … shows that Europe's competitiveness is far from even, with a sharp competitiveness divide between a highly competitive Northern Europe outperforming Southern and Central-Eastern Europe. This divide is particularly strong in innovation performance, one of the key drivers of competitiveness for Europe, given its advanced stage of economic development and the imperative to focus its production on high value-added, innovation-rich products and services." (page 7)

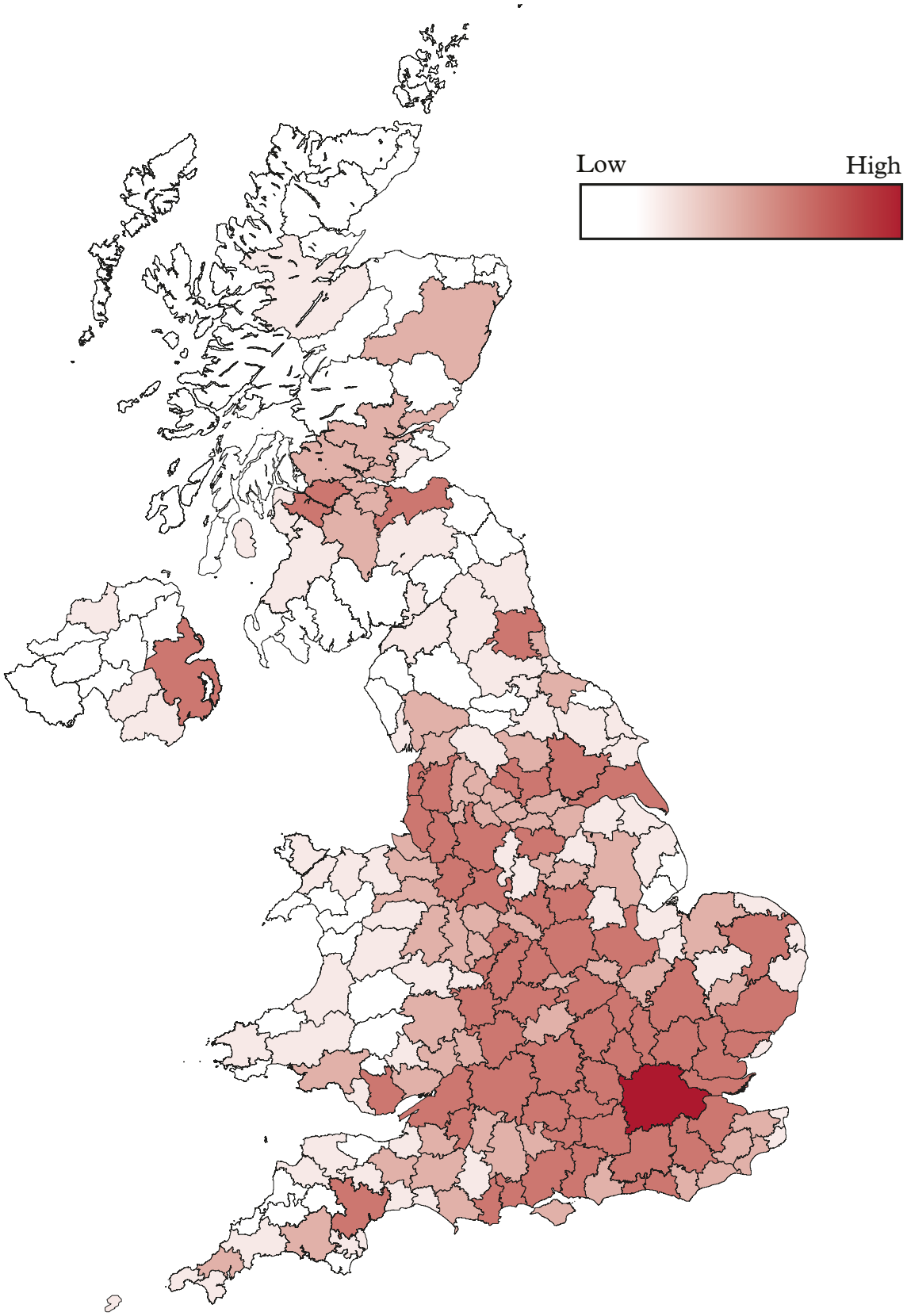
470 Written evidence from Professor Tony Venables (DSC0114)

471 *Ibid.*

472 Written evidence from City & Guilds (DSC0044)

473 Q 30

Figure 1: Concentration of digital companies across the UK[474]



474 By travel to work area. Compiled using digital economy standard industrialisation classification codes. The top 10 travel to work areas: London (51,491 companies); Manchester (4,737); Guildford and Aldershot (4,489); Luton and Watford (3,908); Reading and Bracknell (3,823); Wycombe and Slough (3,648); Bristol (3,233); Birmingham (3,116); Brighton (2,992); and Crawley (2,751). Source: NIESR, *Measuring the UK's Digital Economy with Big Data* (2014): http://niesr.ac.uk/sites/default/files/publications/SI024_GI_NIESR_Google_Report12.pdf [accessed 18 December 2014]

247. This causes labour market relocation. The Association for Learning Technology said: "Successful UK regions and counties import a considerable proportion of their specialist technology workforce. Less successful ones export."[475] Evidence from Humber LEP agreed: "… many students are recruited directly on graduation into major employers from outside the region, and internationally in some cases. In some cases, over 50% of graduates on a given course leave the region".[476]

248. While there is evidence of clusters emerging around large companies when they relocate (for example Microsoft's move to Seattle), there is also evidence of new industries emerging to take advantage of local talent (for example the Silicon Roundabout tech cluster in East London, supported by Tech City UK). Research has also demonstrated evidence of a link between local human capital levels (as well as the proximity to universities) and the emergence of digital industries.[477]

249. Much of our evidence focused on the possibility of developing more technology clusters, in part to drive the UK's economic competitiveness and also to combat inequality between regions and to take advantage of regional strengths. This is in the context of potential huge labour market shifts across the UK.

250. Evidence from Gerard Grech of Tech City UK, which supports the UK's most successful cluster, outlined some of the pre-conditions present in the formation of tech clusters: "… there are four crucial components in building a successful tech cluster. They are: local leadership committed to digital growth and an existing digital community; local infrastructure, including transport, broadband and property; access to finance, both seed capital and growth capital; and finally, a talent pool".[478] Other evidence was in agreement.[479] These core pre-conditions can be summarised as: human capital (skills); infrastructure; money; and leadership. We heard evidence on clusters which began (a) following a significant employer—such as the BBC's move to the North West (MediaCityUK), (b) around a core industry—such as Sci-Tech Daresbury or (c) in the midst of concentrated skills—such as Tech City in East London (see Box 15). The existence of an 'anchor'—that is an institution or industry around which a cluster can form—seems important.

475 Written evidence from ALT (DSC0057)
476 Written evidence from Humber LEP (DSC0060)
477 See Deloitte, *London Futures: Agiletown: the relentless march of technology and London's response* (November 2014): http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [accessed 30 December 2014]
478 Q 192
479 Q 30 (Professor Bostrom)

Box 15: Successful clusters

MediaCityUK, Salford[480]

MediaCityUK was formed following the BBC's 2004 announcement of its intention to move to the site in 2006.

Now home to major BBC and ITV departments, the University of Salford and over 80 businesses across the creative and digital sectors, MediaCityUK is recognised as one of the most innovative developments in the UK.

The research work at MediaCityUK draws on the expertise of over 40 research centres across 10 academic schools. Its research actively seeks to include businesses from large companies, such as Adobe, Avid, BT, Cisco and the BBC, to smaller companies, particularly those in the digital and creative industries who want to co-create new ideas, products and services in a neutral open innovation environment.

A University Technical College (UTC) dedicated to providing 14–19 year-olds with education in the core curriculum combined with the right skills to access careers in the digital, media and creative industries will open in September 2015. All UTC graduates will be guaranteed a place on a university course so long as they meet the minimum entry requirements.

Tech City, East London

Tech City or 'Silicon Roundabout' "… is named after the distinct Old Street roundabout that sits at the heart of the hub and has been leveraged by the UK Government through its Tech City UK initiative. Tech City UK launched in 2010, to support the growth of the technology cluster in East London and has since expanded to become one of Europe's largest digital initiatives that collaborates with the digital community, government, educational establishments and business to support the growth of digital businesses across the country.

"The area's success has enticed global giants such as Google and Microsoft to set up shop in the tech hub. Other companies include Facebook, Intel and a wealth of new startups such as design consultancy BERG, currency transfers service Transferwise and business card service MOO, [which] clearly feel that being a part of such an innovative and thriving community will only enhance their chances of success. There are a host of UK universities including UCL [University College London] and Imperial College London who are also getting involved by becoming academic partners within projects based in the cluster".[481]

251. Tech City UK outlined the Government's role in identifying tech clusters. We welcome this action; so far 21 clusters have been identified across the UK.[482] Witnesses were, however, unable to tell us what happens after a cluster has been identified. We say more about this in paragraphs 272–274.

252. **The role for the Government and local leaders lies in early identification of emerging clusters and in providing targeted support.**

480 University of Salford, 'What is MediaCityUK?': http://www.salford.ac.uk/mediacityuk [accessed 19 January 2015]

481 Red Brick Research, 'The Buzz of the Silicon Roundabout': https://www.redbrickresearch.co.uk/the-buzz-of-the-silicon-roundabout [accessed 2 February 2015]

482 Tech City UK, Tech Nation (February 2015): http://www.techcityuk.com/wp-content/uploads/2015/02/Tech%20Nation%202015.pdf [accessed 6 February 2015]

253. As digital is pervasive across most industries, most companies will rely on digital technologies to operate and grow, alongside their core business. Martin Wolf of the Financial Times told us: "I regard it as almost a joke that if you think of the two industries that are most changed by this they are the IT sector itself and the finance sector."[483]

254. A number of our witnesses highlighted places across the UK where the historical strengths of the area had been married up with digital technologies, thereby driving growth. For instance, we heard of the medical technology cluster and the innovation hub in Leeds (as well as growing digital industries). See Box 16 below and Appendix 5 for further examples.

Box 16: Case Study: Leeds key industry clusters

Leeds Innovation Health Hub

The city has developed a Leeds Innovation Health Hub (LIHH), which uses some of the city's unique assets to develop work and attract inward investment in health, innovation and associated digital technologies. The aims of LIHH are:

- to achieve improved health and social care outcomes for the population of Leeds;
- to maintain and further enhance the international reputation of Leeds as a centre of excellence for innovation in health and medical technology; and
- to attract inward investment and encourage local enterprise and business opportunities through innovation in health and medical technology.

The core assets in the city include: national health organisations; three universities; thriving private businesses from the health sector; patients, families and communities; and coordinated partnerships working across health and social care in a large UK city.

The core areas of focus for delivery from the hub are: medical technologies; health informatics; and engaging communities.

Digital electronics

The Airedale Digital Corridor has a combined turnover equal to that of Cambridge. It is home to a significant cluster of market-leading digital and electronic firms, including Pace, Filtronic, Echostar Europe, Radio Design, Teledyne Defence and Bradford Technology.

The Advanced Digital Institute supports innovation in this sector by providing expertise in digital TV, smartphone technology, telehealth and telecommunications infrastructure.

Gaming

Leeds City Region is home to a significant gaming industry and global players, including Team 17, Rockstar, Dubit and Four Door Lemon. Well-known games developed in Leeds City Region include Max Payne and several instalments of the best-selling Grand Theft Auto franchise. The sector is supported by industry-led games network, Game Republic.[484]

483 Q 6
484 Written evidence from Solace and Leeds City Council (DSC0124)

255. **The strength of the UK is an aggregation of the power of its regional economies. To be competitive we must nurture regional specialisms. We do not know where our next big industry will come from. In this digital age the UK must be agile enough to give timely support to business opportunities.**

The importance of universities in clusters

256. We previously analysed the importance of university research in influencing the changing technological landscape, driving competitiveness, and in responding to labour market need. The UK is a world leader in innovation (see paragraphs 150–153); the UK must harvest that leadership and translate it into practice, or risk losing its competitive edge.

257. Chris Mairs from UKForCE told us: "Establishing new clusters is entirely possible with the right infrastructure, the key things being good transportation links, very good communication links and one or two key players in there to start, which is either a strong university or a very strong tech company".[485] Government initiatives such as Catapult Centres[486] and the Big Innovation Centre[487] bring together some of the conditions described by Mr Mairs at national level by joining up ideas with on-the-ground practice in a single space. Innovate UK describes Catapult Centres as "a physical centre where the very best of the UK's businesses, scientists and engineers work side by side on late-stage research and development—transforming 'high potential' ideas into new products and services to generate economic growth".[488] The Government has made efforts to tie some of these centres to regions: "… the Digital Catapult that we have just launched [in Kings Cross, London] has also launched with three regional centres. One of them is in Bradford, because it has a cluster of health technology companies. Brighton is another good example".[489]

258. We welcome the existence of those Government initiatives. We believe, however, that more needs to be done. We heard compelling evidence about the role of the higher education sector in leading regional ecosystems and supporting the development of new clusters[490]—a form of local catapult. A university has access to people, infrastructure, money and leadership (as outlined in paragraph 250 above), as well as ideas. Mr Wolf gave some examples of clusters with strong university links: "… you have the Boston cluster and you have the San Francisco cluster and that is because of the universities. I have long believed that in the long term we are going to find

485 Q 49

486 Catapult centres were launched in 2010 as a means of joining up research and outputs; their intent is to capitalise on the UK's leading position in research, specifically to boost the UK's innovation sector. See: https://www.catapult.org.uk [accessed 2 February 2015]

487 The Big Innovation Centre, launched in September 2011, exists to make the UK a global open innovation hub, to build a world-class innovation ecosystem, and to re-balance and grow the UK economy. It brings together some of the world's leading companies with key institutions from across the policy landscape, all united by a commitment to innovation. It will carry out business-oriented research, taking emerging ideas and backing them with evidence. With support from all political parties, the Big Innovation Centre will make recommendations on how the UK can become a global innovation hub and transform the UK economy. See: http://www.biginnovationcentre.com [accessed 2 February 2015]

488 Catapult: https://www.catapult.org.uk [accessed 30 December 2014]

489 Q 254 (Ed Vaizey MP)

490 Q 6 (Martin Wolf), Q 213 (Baroness Shields), written evidence from RCUK (DSC0055) and Humber LEP (DSC0060)

that our universities are the most important regional development institutions in our country".[491]

259. Both of the above examples are in the USA. Guy Levin of Coadec agreed that the American model worked better than the UK's: "… in the US there are far better links between universities such as Stanford and MIT [The Massachusetts Institute of Technology] with local digital clusters. You have that in the UK too with UCL [University College London] and Cambridge with their local tech cluster, but that could be massively improved upon".[492]

260. We note that Mr Levin indicated only two UK universities. Several witnesses gave examples of other good university links. For instance, Paul Hynes, the Vice Principal at George Spencer Academy in Nottingham, told us: "… we are very tightly linked to a very good university, Nottingham Trent University that leads our local region".[493] See Box 17 below for an example from the city of Bristol.

Box 17: Bristol City Council and the University of Bristol

Bristol is a leading Smart City, and has a considerable track record in digital industries. The Council has strong links with a number of sectors, including with the University of Bristol.

Two university-led projects include:

- SETsquared Centre: an incubator for high-tech, high-growth start-ups; and
- Engine Shed,: a container for multiple assets of the innovation ecosystem.

SETsquared has "… accelerated about 160 companies in the high-tech, creative and digital sector—more in the high-tech end of creative and digital but, nonetheless, supported the high-tech ecosystem and encouraged … promoted the concept of entrepreneurialism which itself has had an impact on innovation—and also raised the profile of the city".

Engine Shed has "… a broader focus than high-tech; so we're also interested in creative and digital and we are working with other organisations to help focus activity. So we're doing work with the high-tech sector group of the LEP, the creative sector group of the LEP and working with schools to help encourage young people into the creative and digital sectors".[494]

261. The value of these university links is evident, but these strong examples only serve to highlight the lack of partnerships in other UK areas. Again, it seems that local partnerships are piecemeal and regional success in this area is based somewhat on luck and individual efforts. The UK is missing a coordinator.

The role of Research Councils and Innovate UK

262. As outlined by the WEF in Box 18 below, well-funded scientific research institutions enable academia to reach out to business networks. Research Council funding is key to this.

491 Q 6
492 Q 62
493 Q 165. See also written evidence from Solace and Leeds City Council (DSC0124) and Bristol City Council (DSC0126)
494 Written evidence from Bristol City Council (DSC0126)

Box 18: Innovation in Switzerland: the World Economic Forum

"This year [2013] marks Switzerland's fifth year at the top of the Global Competitiveness Index (GCI) rankings. The Global Competitiveness Report has long singled out Switzerland for its extraordinary competitiveness levels. What is the formula that makes this small European country so successful? …

"Innovation is not just about coming up with new products—it is also about doing things differently. For this to happen, the entire innovation ecosystem, which consists of a set of closely intertwined and reinforcing factors, is critical. In the case of Switzerland, an excellent innovation ecosystem has been a significant part of making the country an attractive place to work for highly qualified people. Its well-functioning labor market and excellent educational system provide the fundamentals for innovation to prosper, instigating the close relationships among enterprises, universities, and research institutes that have made the country a top innovator. Its scientific research institutions are among the world's best, and the strong collaboration between its academic and business sectors, combined with high company spending on research and development, ensures that much of this research is translated into marketable products and processes reinforced by strong intellectual property protection. This robust innovative capacity is captured by its high rate of patenting per capita, for which Switzerland ranks 2nd".[495]

263. Evidence from Imperial College London showed one of its barriers to developing regional links to be "Efficiency measures placed on research funding from Research Councils".[496] The College went on to emphasise the risks of a lack of investment in universities: "… universities and research institutes need to work together to set up collaborations; clusters of peer institutions in close geographical proximity and covering a range of subjects are a good approach".[497]

264. This point seems particularly important. Imperial College London is ready and willing to set up subject-led, geographic-based clusters, but is being prevented from doing so by existing funding mechanisms. If these proposed clusters were set up in conjunction with local communities, they would be well-placed to drive regional economies. There is a clear opportunity here; universities, with their regional connections, are well-placed to identify local specialisms, turning academic ideas into on-the-ground initiatives.

265. We question whether the Research Councils and Innovate UK need to think about digital change in a more general sense. RCUK were confident they had "responded by establishing various initiatives, such as the cross disciplinary Digital Economy (DE) Theme".[498] Innovate UK told us although this theme supported inter-disciplinary research, a problem was: "… faculty boundaries don't lend themselves to crossing of disciplines; the business school has no history of talking to the computer science department or the history faculty, and academia seems to discourage the multidisciplinary academic that tries to progress a career with a foot in two camps".[499] This echoes the disjointed

495 WEF, *The Global Competitiveness Report 2013–2014* (2013): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013–14.pdf [accessed 18 December 2014]
496 Written evidence from Imperial College London (DSC0122)
497 *Ibid.*
498 Written evidence from RCUK (DSC0055)
499 Written evidence from Innovate UK (DSC0070)

approaches to digital we have witnessed throughout our inquiry, and does not support the promotion of cross-sector working.

266. Research Councils aim to:

> "… support excellent research, as judged by peer review, that has an impact on the growth, prosperity and wellbeing of the UK. To maintain the UK's global research position we offer a diverse range of funding opportunities, foster international collaborations and provide access to the best facilities and infrastructure around the world".[500]

267. They are therefore closely connected with the higher education system, and are well informed about ground-breaking innovations. The Government recently announced the Nurse Review of Research Councils, in part to examine: "How … the Research Councils [should] take account of wider national interests including regional balance and the local and national economic impact of applied research".[501] We would suggest that Sir Paul Nurse gives particular consideration to the digital economy in his review.

268. **In our view there is a gap in the structural support for university-regional partnerships. Innovate UK is well-placed to identify, fund and coordinate regional opportunities for academia-industry partnerships and could do more.**

269. **Research Councils are also well-placed to identify strengths in local universities and connect them with the regional area. Individual Research Councils should be given more power to do so.**

Joining-up in the regions

270. Regions themselves are of different sizes and organisational structures. RCUK therefore told us: "LEPs have the ability to take a regional view on the best opportunities for the development with the region based and existing assets and future needs of the communities. The STFC Hartree Centre is engaged with the Liverpool LEP …".[502]

271. We received evidence on the good work of Leeds LEP and Sheffield LEP.[503] Evidence from Humber LEP said it drove the area's digital agenda, in conjunction with the university and further education sector. The LEP offer, however, is not consistent across the UK; meaning that their role in identifying and supporting regional economies is variable.

272. For example, there seems to us to be a gap after a potential cluster is identified in a region. When pressed on this point, the Minister of State for Culture and the Digital Economy, Ed Vaizey MP, told us:

> "To take a hypothetical situation—it has not happened yet—where we say that a particular cluster really needs a boost because we have this

500 RCUK: http://www.rcuk.ac.uk [accessed 21 January 2015]

501 BIS, *Terms of Reference for the Nurse Review* (2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388069/Terms_of_Reference_for_the_Nurse_Review.pdf [accessed 30 January 2014]. Of relevance the review also asks: "Are the right arrangements in place to ensure optimal funding for research that crosses disciplinary boundaries?" and "What are the gaps or holes in the funded portfolios of the research councils?" (page 1)

502 Written evidence from RCUK (DSC0055)

503 Q 36 (Kevin Baughan), Q 196 (Gerard Grech), Q211 (Baroness Shields), written evidence from Humber LEP (DSC0060), HM Government (DSC0084), Samsung Electronics UK (DSC0092), Dynamo North East (DSC0107) and Solace and Leeds City Council (DSC0124)

> critical mass of companies and the LEP is just not engaging, you would probably see us as a ministerial team, if I can put it that way, looking at ways in which we could get the LEP to recruit more skilled people to help us, because we would need the LEP's help. What I am saying is that there is no prescriptive solution. It might involve working with the council or direct negotiations with the LEP. I think that would be how you would address an issue like that, but it is quite a tight group; all of us are effectively focused, with BIS and No. 10, on supporting those clusters."[504]

273. This concerns us; there could be a good opportunity for a region or sub-region. If the LEP is unable to respond to this opportunity, as far as we can make out, nothing happens.

274. There was a suggestion that funding from the EU could be used to support regional development.[505] The Government told us it had already made "£330m of skills capital funding available to LEPs as part of the Local Growth Fund, providing local areas with a powerful lever for increased influence over the FE [further education] and skills sector".[506] This is welcome, but it does not give protection to those LEP regions which are at risk of falling behind. As the Minister of State for Skills and Equalities, Nick Boles MP, told us: "… I do not want a hopeless or perhaps otherwise focused LEP to be a barrier to this happening".[507]

The role of the Government

275. Witnesses outlined the potential role for the Government in connecting regions and sharing opportunities throughout the UK. Baroness Shields, the Government's Digital Adviser and Chair of Tech City UK, outlined what the Government had done to grow the regions:

> "Everything from the R&D tax credit to the Patent Box[508], which is an absolutely brilliant concept, are things that allow more money to come in and give people the comfort that they should take the conviction of their ideas all the way forward and invest their time and energy in building businesses from the ground up."[509]

276. There are some good initiatives here, but all the Government's hopes seem to be pinned on attracting investment. Evidence showed that a wider, more strategic role for the Government would be necessary. For instance Mr Wolf said: "… if the British Government were to say, 'We are going to make a rather big effort to ensure that relevant scientific and technological research activities and their interface with business do not all end up in the Oxbridge-London triangle', that would be a perfectly reasonable thing for them to think about".[510]

277. **Growth within different areas of the UK cannot be Government-directed, nor should it be. Much expertise lies with local authorities**

504 Q 252
505 Q 102 (David Hughes) and written evidence from Sunderland Software City (DSC0063)
506 Written evidence from HM Government (DSC0084)
507 Q 252
508 The Patent Box enables companies to apply a lower rate of Corporation Tax to profits earned after 1 April 2013 from its patented inventions. See: https://www.gov.uk/corporation-tax-the-patent-box [accessed 2 February 2015]
509 Q 211
510 Q 7

and Local Enterprise Partnerships (LEPs). Light-touch coordination from the central Government would help facilitate reciprocal learning. It is the Government's role to intervene if local structures, including LEPs, are not working.

CHAPTER 5: MAKING IT HAPPEN

Part I: A leading Government

"There have been 61 Secretaries of State in the last 30 years responsible for skills."[511]—Chris Jones, Chief Executive Officer, City & Guilds

Digital opportunity

278. Our evidence showed that the changing technological landscape creates a massive opportunity for the UK.[512] The fast pace of change and emergence of new industries means the UK is well-placed to harness the economic growth new technologies bring. We agree with Elix-IRR: "The value of digital capability in economic terms for the UK is enormous."[513]

279. We must be ambitious; countries around the globe are pursuing the same goal. The UK ranks 9th in the WEF's Global Competitiveness Index for 2014–15,[514] placing it behind Switzerland, Singapore, the USA, Finland, Germany, Japan, Hong Kong and the Netherlands.[515] Of these Japan has climbed three places since the previous year.

280. The world's 'digital leaders' change on a month-by-month basis, although countries such as Finland, Singapore and Sweden consistently top the tables.[516] While we recognise that these economies are different from the UK in many respects, from size to demographics, they have developed digital agendas for the future and research implies that consequently their global position is improving. Other 'developing' economies are also moving quickly. For instance, Professor Phillip Brown from Cardiff University told us: "… new technologies have allowed China and India to leapfrog decades of development and come into key areas of competition with western economies".[517] There is a sense that the digital opportunity is here for the taking. The question is: who will take it?

Risk

281. Professor Manning cautioned "it is not inevitable that technology is a force for good".[518] As discussed in paragraphs 1–13, technological changes have serious consequences for the labour market, as well as offering significant opportunities.

282. Witnesses struggled to point to a sector of the economy that was unaffected by digital technologies. For instance, Kevin Baughan of Innovate UK said:

511 Q 249

512 Q 15 (Professor Alan Manning), QQ 27–28, 31 (Kevin Baughan, Michael Gleaves), Q 53 (Antony Walker), Q 66 (Paul Willmott), Q 74 (Marcus Mason), Q 134 (Iain Wood), written evidence from Andrew WS Ainger (DSC0015), City & Guilds (DSC0044), RCUK (DSC0055) and Humber LEP (DSC0060)

513 Written evidence from Elix-IRR (DSC0046)

514 WEF, 'The Global Competitiveness Index 2014–2015': http://www3.weforum.org/docs/img/WEF_GCR2014-15_Global_Image.png [accessed 6 January 2014]

515 This is up one position from 2013–14, but still down one place from its 8th place position in 2012–13.

516 See: WEF, 'Networked Readiness Index': http://www.weforum.org/issues/global-information-technology/the-great-transformation/network-readiness-index [accessed 30 January 2015]; Booz & Company, *"This Is for Everyone": The Case for Universal Digitisation* (November 2012): http://www.go-on.co.uk/wp-content/uploads/2013/12/The-Booz-Report-Nov2012.pdf [accessed 30 January 2015]; and World Wide Web Federation, 'The Web Index': http://thewebindex.org [accessed 3 February 2015]

517 Q 15

518 *Ibid.*

"… whether it is the creative industries that now have 80% of their films in a virtual world instead of a physical world, whether it is transportation and bringing together streams of information for more intelligent mobility, I struggle to find any one of them [that is not involved in this]."[519]

283. This has huge implications. Martin Wolf from the Financial Times told us that technological changes would, "along with other changes in the economy, reinforce the trends towards massive inequality in our society".[520] Barclays Bank said: "The societal shift that took place 150+ years ago led to some people feeling left behind and disenfranchised. This risk is even more acute in today's globalised world, and the desire not to leave anyone behind is perhaps one of society's greatest challenges."[521]

284. The Government's evidence on this issue recognised the potential labour market disruption, but was sparse on solutions. We agree with the Government that "the challenge is not really what specific digital skills future workers need, but rather what basic skills are required by everyone and how adaptable the educational, training and labour market systems are in responding to the needs and demands of the future before and as they arise";[522] but, as outlined throughout the report, we are not persuaded that Government is doing enough to prepare the UK for the future.

285. When we raised this issue with the Minister of State for Culture and the Digital Economy, Ed Vaizey MP, he mentioned three foci for the Government:

- clusters (for example, the Digital Catapult);
- putting computer coding into the curriculum; and
- a "massive emphasis" on apprenticeships.[523]

286. Whilst these are all good things in and of themselves, they do not go nearly far enough in preparing the UK for the future.

The Government's role

287. Elix-IRR offered a warning: "The government and big business each have a role to play in setting the UK up for digital success. Failing to act now will compromise our future business sustainability and leave UK PLC trailing behind other countries."[524] Other evidence agreed.[525] It is evident that there are three major players—the Government, industry, and the education system—who must act together.

288. Currently the major players are not in synergy; our inquiry has shown that the UK is structurally weak and has not yet created the right human capital, infrastructure and business environment to support a changing society. As Karen Price, on behalf of the Tech Partnership, summarised: "We lack a conductor, a co-ordinator. There is confusion in the marketplace; every school is bewildered, employers are bewildered, and we could get so much better

519 Q 28
520 Q 14
521 Written evidence from Barclays Bank (DSC0047)
522 Written evidence from HM Government (DSC0084)
523 Q 254
524 Written evidence from Elix-IRR (DSC0046)
525 Q 126 (Rachel Neaman), Q 192 (Gerard Grech), Q 195 (Angela Harrington), written evidence from IET (DSC0049), Innovate UK (DSC0070), HM Government (DSC0084) and iRights (DSC0108)

value if it could sit within a national framework."[526] Many other witnesses agreed it is the responsibility of the Government to provide that framework.[527]

289. Part of this role includes seeking out the UK's next competitive edge. Paul Willmott from McKinsey & Company told us: "… we need to find the next sectors like [the gaming sector] and invest in them so that we remain globally competitive and provide productive opportunities for our workforce".[528] Mr Wolf linked this need to the talent pipeline: "… we have to think about what our particular areas of comparative advantage are likely to be and what sort of skills we are going to need to support those".[529]

290. The evidence was mixed on where efforts should be focused. Some suggestions picked out specific sectors: Creative Skillset (Sector Skills Council for the Creative Industries) urged support for the creative sector;[530] Michael Gleaves from the Hartree Centre pressed for a combination of technology and design;[531] and BT pushed for effectively near-universal coverage of fibre broadband infrastructure across the UK.[532] For others, such as Ms Price, the UK's competitive edge lies in doing digital well: "Economic growth is going to flourish if the UK has the talent to be a global leader in data analytics, mobile, e-commerce, cloud, cyber … [and] the internet".[533] The Welsh Government agreed: "The pace of change through the daily development of new and emerging technologies is driving a greater need for Wales to remain competitive on a global stage … a strong ICT sector is critical to Wales".[534] The answer lies in building an environment which will support both the specific and the general approach.

Joining-up

291. It was clear from a range of witnesses that the Government was lacking the necessary comprehensive digital agenda which made the most of the digital opportunity.[535] The evidence from Professor Dame Wendy Hall of Southampton University was illustrative of the external perception of the Government's efforts:

> "My problem is that there are too many things going on. We have Joanna's [Baroness Shields's] efforts, we have [Baroness] Martha Lane Fox's efforts, we have the new Digital Skills Taskforce that is run out of DCMS [Department for Culture, Media & Sport] … Yes, and then there is Your Life and so on. I find it hard to understand what is going on".[536]

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526 Q 125
527 Q 59 (Antony Walker), Q 74 (Angela Morrison), Q 118 (Nick Coleman), Q 125 (Rachel Neaman), Q 128 (Karen Price) and Q 231 (Megan Richards)
528 Q 66
529 Q 4
530 Written evidence from Creative Skillset (DSC0095)
531 Q 28
532 Written evidence from BT (DSC0091)
533 Q 120
534 Written evidence from Welsh Government (DSC0123)
535 Q 59 (Antony Walker), Q 74 (Angela Morrison), Q 125 (Rachel Neaman), Q 128 (Karen Price), Q 142 (Iain Wood), Q 181 (Nick Coleman), Q 231 (Megan Richards) written evidence from Prospect (DSC0064) and Go ON UK (DSC0079)
536 Q 219. 'Your Life' is a campaign aimed at boosting participation in science, technology, engineering and maths (the 'STEM' subjects) at school and beyond. See: http://www.yourlife.org.uk [accessed 2 February 2014]

292. Evidence from the two Ministers did not reassure us that there was sufficient coordination. We were told that the current digital 'activity' the Government is responsible for includes four Government Ministers, a Taskforce, a Committee, a Unit and "various other random issues".[537] This does not demonstrate a cohesive digital approach to us. Indeed, our body of evidence demonstrated a great deal of Government activity, some of it very good; but it does did not come together in a cohesive way. The Government's organogram (see Appendix 9) highlighted the wide variety of initiatives, but this activity lacks a central vision. This contrasts with the Scottish Government's 2011 Digital Strategy (see Appendix 10), which "sets out what the Scottish Government will do to secure Scotland's digital future".[538] Indeed, the Scottish Government highlighted that "Reports on the progress made in implementing this strategy are published annually."[539]

293. The UK Government's Digital Strategy[540] sets out its 'digital by default' approach, outlining how all Government services have moved online. The GDS is responsible for rolling out the Digital Strategy. This demonstrates a degree of pulling together of initiatives, albeit internally. Indeed, the UK recently part-founded and hosted a new global network of leading digital governments: the 'D5'.[541] Yet there is still significant joining-up to be done externally.

294. Part of this is about recognising the scale of the digital opportunity, and challenge, within the structure of Government. As Lady Shields summarised: "Everyone is doing great things but in a very small, micro way, and we have to think about how we identify and scale these best practices. I think that is what a Cabinet level [Minister] or a Committee like this could do."[542] Bristol City Council emphasised the role of all departments within the Government: "… some parts of government have a really strong understanding of digital technology and how it can help to solve city or urban challenges, but that is yet to be completely recognised across all aspects of government".[543]

295. There is a huge opportunity for the new Government in May 2015. The incoming Government will need to join up better, be much more strategic as it coordinates and delivers policy, it will need to advocate and to champion

537 Q 250 (Ed Vaizey MP): "… I do think we are getting better, not just by me being a joint Minister but also by the establishment of the Digital Taskforce, which is chaired by Francis Maude, with Jo Swinson from BIS [Department for Business, Innovation & Skills] as a vice-chairman alongside me. It is now bringing together three or four different elements of the digital agenda. Infrastructure is one of them, and I do not know how much this Committee will concentrate on that but we have already brought together more than a dozen different digital infrastructure projects in which the Government have an interest. That is not only delivering savings but making sure that we have a much bigger impact for the money we invest. It is bringing together skills—I think Nick is a member of the committee or turns up to the committee when it is relevant—and issues such as investment in digital technology and various other random issues, if I can put it that way, that are very central to the digital agenda: the Internet of Things, investment in 5G and so on. That is point number two, and that is supported by the Digital Economy Unit that sits across BIS and DCMS [Department for Culture, Media & Sport]".

538 Scottish Government, *Scotland's Digital Future: A Strategy for Scotland* (2011): http://www.scotland.gov.uk/Resource/Doc/343733/0114331.pdf [accessed 5 February 2015]

539 Written evidence from Scottish Government (DSC0128)

540 Cabinet Office, 'Government Digital Strategy—December 2013': https://www.gov.uk/government/publications/government-digital-strategy/government-digital-strategy [accessed 17 December 2014]

541 HM Government, 'D5 London 2014: leading digital governments': https://www.gov.uk/government/topical-events/d5-london-2014-leading-digital-governments [accessed 30 January 2015]; and HM Government, 'D5 Charter': https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/386290/D5Charter_signed.pdf [accessed 30 January 2015]

542 Q 219

543 Written evidence from Bristol City Council (DSC0126)

change and sometimes it will need to reassure and safeguard. This does not mean bigger Government or necessarily more expenditure, but it does mean a smarter Government that uses technology better and tries to support all of its citizens to use technology and to benefit from its impact, as well as supporting the clusters of firms and organisations that can lead the digital economy.

296. We agree with Professor Judy Wajcman from the London School of Economics: "We need some targets and we need to have some kind of national force behind these things. We have now 30 years of reports about these problems. I think we understand them well but we need a bit of political will."[544]

297. **The Government should act as the 'conductor of the orchestra' and play an enabling role, focused on business and education. Although the Government is tackling many issues through a range of initiatives, their efforts would be more effective if they were better coordinated. The Government needs to take responsibility for leading the UK through the seismic changes brought about by changing technologies.**

298. The UK is looking towards an exciting new future; to rise up and meet the challenges ahead, all sections of society must be engaged. An important theme running throughout our inquiry was the urgent need for industry input across the board. A key question is how industry buy-in can be achieved. One way to achieve this is by communicating better; the Government needs to do more to communicate the benefits of investment in the future and current talent pipeline to industry. The Government could incentivise industry to take a leading role. This might mean financial incentives and/or tax breaks for industry. Whatever the methods, the Government must step up to the challenge and bring industry with it.

299. The Government's ambition must be to exploit technology with an aim to develop a digital economy second to none. The Government should work to identify and prioritise the UK's growth sectors. Consequently, **the Government should develop an ambitious 'Digital Agenda' for the UK: at its heart should be the Government's vision for the UK to keep up with the best leading digital economies across the board in five years' time.**

300. **This Digital Agenda should be the responsibility of a Cabinet Minister in the Cabinet Office, who would assume ultimate responsibility for driving the Digital Agenda across all Government departments.**

301. **The responsible Cabinet Minister should evaluate the UK's Digital Agenda on a regular basis, seeking to drive the UK's digital competitiveness. The Minister should report to Parliament annually against the measures within the Digital Agenda. We recommend an initial progress report to Parliament by summer 2016. We note that a similar practice is already undertaken by the Scottish Government.**

302. **Our Committee has completed its work with the production of this report, but it has highlighted an issue of critical importance that will need continuing oversight; we urge the Liaison Committee to consider how best to integrate such a commitment into the future work of select committees in the House of Lords.**

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544 See QQ 15–25 (Professor Wajcman's opening remarks)

Part II: A Digital Agenda for the UK

303. A Digital Agenda should articulate the Government's ambitions for the UK, including the broad objectives it wants to achieve (and by when). This Agenda should focus on the delivery of these objectives—that is, what will be done practically to achieve them. Countries such as Estonia[545] and Sweden[546] are excellent examples of how this can be achieved (see Appendix 11 for an excerpt from Sweden's digital agenda).

304. Our single major recommendation is that the incoming Government establishes a Digital Agenda for the UK to produce radical, rapid and continuing change. The illustrative Agenda below contains the objectives which we think such an Agenda should incorporate, including examples of how these objectives could be met. **In its response to this report we invite the incoming Government to comment on the focus of our illustrative Digital Agenda and to commit to designing its own, with specific detail on how it intends to meet its objectives.**

The UK's Digital Agenda

Access to digital technologies

305. Objective 1: The population as a whole has unimpeded access to digital technology.

306. This includes:

(a) facilitation of universal internet access: the internet is viewed as a utility; and

(b) removal of 'not-spots' in urban areas.

Skill levels

307. Objective 2: The population as a whole has the right skill levels to use relevant digital technologies.

308. This includes:

(a) a culture of learning for life, with responsibility shared between the Government, industry and the individual;

(b) a commitment to meet the target set in the Government's Digital Inclusion Strategy, that by 2020 everyone who can be digitally capable, will be;

(c) a commitment to increase significantly the number of girls studying STEM subjects at further and higher education, including vocational education;

(d) a target for 10% of the workforce to have high-level digital skills by 2020; and

(e) facilitation of a bigger role in skills development for industry.

545 Ministry of Economic Affairs and Communications, *Digital Agenda 2020 for Estonia*: https://mkm.ee/sites/default/files/digital_agenda_2020_estonia_eng.pdf [accessed 7 January 2015]

546 Ministry of Enterprise, Energy and Communications, *ICT for Everyone: A Digital Agenda for Sweden* (November 2011): http://www.government.se/content/1/c6/18/19/14/70f489cb.pdf [accessed 7 January 2015]

Risk management and cybersecurity

309. Objective 3: Recognition of the risk and benefits of cybersecurity; the UK has a sufficient talent pool with the knowledge and abilities to keep its hard and soft infrastructure secure.

310. As part of this:

(a) cybersecurity is placed higher on the public agenda;

(b) cyber-education starts at the school level (and is extended to broader society and those not in formal education); and

(c) both individuals and businesses—especially SMEs—are targeted.

Schools and teachers

311. Objective 4: No child leaves the education system without basic numeracy, literacy and digital literacy.

312. As part of this:

(a) digital literacy is taught as a core subject alongside numeracy and literacy, embedded across all subjects and throughout the curriculum;

(b) more focus is placed on building links with employers (including somebody from industry on the governing body of every school); and

(c) delivery of the new computing curriculum is seen as a priority. In particular more investment in training new teachers and speed and urgency to train existing teachers, involving the third sector and industry.

Further education and apprenticeships

313. Objective 5: A world-leading further education system for digital skills, brought about by a comprehensive employer-led review of the further education offer.

314. This review could be commissioned at the start of the new Parliament, to be completed within six months, and conducted by the Tech Partnership. The review could examine what is needed for the future of further education, including:

(a) a consistent and agile offer across providers;

(b) facilitation of strong partnerships between industry and further education;

(c) more apprenticeships across the board—and more digital apprenticeships. All apprenticeships should include a digital skills element;

(d) an accreditation and qualification system that is fit for purpose; and

(e) a revamped skills funding system to promote short, flexible courses and apprenticeships.

Higher education and research and development

315. Objective 6: A responsive higher education system and world-leading research and development.

316. This includes:

(a) a higher education system that works with industry to align courses to employer requirements; and

(b) a review of spending on research and development aimed to ensure the UK is comparable with other leading economies.

Employment guidance

317. Objective 7: A central, online employment guidance resource. Parents and teachers are more fully aware of the opportunities offered by digital technology.

318. As part of this:

(a) access to the employment guidance resource is through social media and other channels; and

(b) change is brought about by a wholesale review.

Business involvement and support

319. Objective 8: The right conditions for industry set by the Government.

320. This includes:

(a) facilitation of industry involvement across the board;

(b) an awareness campaign about the need to improve digital skills among SMEs; and

(c) information, advice and guidance for businesses readily available through local networks.

Regional ecosystems and clustering

321. Objective 9: Regional and sub-regional strengths are recognised and encouraged. Regions build on their local specialisms, facilitated by the Government.

322. This includes:

(a) a higher education system that is closely linked with industry and regional economies; and

(b) Government intervention when a Local Enterprise Partnership or locality is weak.

APPENDIX 1: LIST OF MEMBERS AND DECLARATIONS OF INTEREST

Members

Lord Aberdare
Earl of Courtown
Baroness Garden of Frognal (resigned 4 November 2014)
Lord Giddens
Lord Haskel
Lord Holmes of Richmond
Lord Janvrin
Lord Kirkwood of Kirkhope
Lord Lucas
Lord Macdonald of Tradeston
Baroness Morgan of Huyton (Chairman)
Baroness O'Cathain

Declared Interests

Lord Aberdare

Digital Industries Ambassador, e-skills UK (unpaid)

Earl of Courtown

None relevant to inquiry

Baroness Garden of Frognal (until 4 November 2014)

None relevant to inquiry

Lord Giddens

Patron, Keeping In Touch (IT for people in care homes; charity)

Lord Haskel

Board Member, Parliamentary Office for Science and Technology (POST)
Honorary President, Materials Knowledge Transfer Network

Lord Holmes of Richmond

None relevant to inquiry

Lord Janvrin

Deputy Chairman, HSBC Private Bank (UK) Ltd
Chair of Trustees, Entente-Cordiale Scholarship Scheme
Chair of Trustees, The Royal Foundation of The Duke and Duchess of Cambridge and Prince Harry
Prime Minister's Trade Envoy to Turkey
Trustee, National Portrait Gallery
Trustee, Gurkha Welfare Trust

Lord Kirkwood of Kirkhope

None relevant to inquiry

Lord Lucas

A founder of Behind the Screen (the e-skills UK programme that is now run in over 500 schools)
Closely involved with digital skills via The Good Careers Guide
Employer of Philip Virgo as a researcher (who is active in the digital skills space)

Lord Macdonald of Tradeston

Non-Executive Director, Scottish Power
Senior Adviser, Macquarie Infrastructure Real Assets

Baroness Morgan of Huyton

Adviser, Board, Absolute Return for Kids (ARK) (charity)

Board Member, Teaching Leaders (middle school leaders' training; charity)

Chair, Future Leaders (head teacher training; charity)

Chairman, Ofsted (until the end of August 2014)

Member, Advisory Committee, Board of Virgin Group Holdings Ltd (holding company)

Member of Council, King's College, University of London

Non-Executive Director, Carphone Warehouse

Non-Executive Director, Infinis Energy plc

Baroness O'Cathain

None relevant to inquiry

A full list of Members' interests can be found in the Register of Lords' Interests: http://www.parliament.uk/mps-lords-and-offices/standards-and-interests/register-of-lords-interests/

Dr Carl Frey, Specialist Adviser

None relevant to inquiry

Andy Westwood, Specialist Adviser

Board Member, Liverpool Institute of Performing Arts

Board Member, WonkHE (higher education news blog)

Chair, LLAKES Research Centre at Institute of Education (provider of teacher training and education research)

Chair, Organisation for Economic Co-operation and Development Forum on Social Innovation

Chief Executive, GuildHE (membership body including universities and colleges that provide a range of programmes and courses, including art & design, computer gaming and teacher training)

Former political adviser, Department for Innovation, Universities & Skills

PhD student and lecturer, Cardiff University

Professor, Winchester University (provider of teacher training and other courses)

Committee visit to the Hartree Centre, Wednesday 22 October 2014

The Hartree Centre provided the delegation with a buffet lunch and taxi transportation between the Centre and local railway station

APPENDIX 2: LIST OF WITNESSES

Evidence is published online at www.parliament.uk/digital-skills-committee and available for inspection at the Parliamentary Archives (020 7219 3074).

Evidence received by the Committee is listed below in chronological order of oral evidence session and in alphabetical order. Those witnesses marked with ** gave both oral evidence and written evidence. Those marked with * gave oral evidence and did not submit any written evidence. All other witnesses submitted written evidence only.

Oral evidence in chronological order

**	Jessica Bland, Senior Researcher in Technology Futures, Nesta	QQ 1–14
**	Oliver Quinlan, Programme Manager, Digital Education, Nesta	
*	Martin Wolf, Economics Journalist, Financial Times	
*	Professor Phillip Brown, School of Social Sciences, Cardiff University	QQ 15–25
*	Professor Alan Manning, Department of Economics, London School of Economics	
*	Professor Judy Wajcman, Department of Sociology, London School of Economics	
*	Professor Nick Bostrom, Director, Programme on the Impacts of Future Technology, University of Oxford	QQ 26–39
*	Michael Gleaves, Head of Business Development, The Hartree Centre, Science and Technology Facilities Council	
**	Kevin Baughan, Director, Technology and Innovation, Innovate UK (formerly known as the Technology Strategy Board)	
*	Mike Warriner, UK Director of Engineering, Google	QQ 40–52
**	Hugh Milward, Director of Corporate Affairs, Microsoft	
**	Chris Mairs CBE, Chair, UK Forum for Computing Education and Chief Scientist Metaswitch Networks	
*	Guy Levin, Executive Director, Coalition for a Digital Economy	QQ 53–65
**	David Pollard, Chairman for Education, Skills and Business Support, Federation of Small Businesses	
*	Antony Walker, Deputy Chief Executive Officer, techUK	
*	Marcus Mason, Policy Manager, Employment and Skills, British Chambers of Commerce	QQ 66–75
*	Angela Morrison, Chief Information Officer, Direct Line Group	
*	Paul Willmott, Director, McKinsey & Company	
*	Dominic Field, Partner and Managing Director, Boston Consulting Group	QQ 76–86
**	Sean Williams, Group Director Strategy, Policy and Portfolio, BT	
**	Daniel Butler, Head of Public Affairs, Virgin Media	

**	David Hughes, Chief Executive, National Institute of Adult Continuing Education	QQ 87–102
**	Professor Martin Weller, Professor of Educational Technology, Open University	
*	Professor Patrick Barwise, Chairman, Which? and Emeritus Professor of Management and Marketing, London Business School (speaking as an independent academic)	QQ 103–112
**	Phil Fearnley, Director, BBC Homepage and myBBC, BBC	
*	James Thickett, Director of Nations and Market Development, Ofcom	
**	Helen Milner, Chief Executive, Tinder Foundation	
**	Rachel Neaman, Chief Executive Officer, Go ON UK	QQ 113–128
*	Karen Price OBE, on behalf of the Tech Partnership (Chief Executive, e-skills UK)	
**	Maggie Philbin, Chair, UK Digital Skills Taskforce and CEO, TeenTech CIC	
*	Lucy Hastings, Programme Director for Strategy, Age UK	QQ 129–142
*	Clare Sutcliffe, Co-founder and CEO, Code Club	
**	Iain Wood, Public Affairs Manager, TalkTalk	
*	Mary Payne, Chief Executive Officer, UCanDoIT	
**	Dr Bill Mitchell, BCS Director, Academy of Computing, BCS, The Chartered Institute for IT	QQ 143–157
**	Professor Simon Peyton Jones, Chair, Computing At Schools	
**	Charlie Taylor, Chief Executive, National College for Teaching and Leadership	
*	Sir Andrew Carter, Head Teacher, South Farnham School	
*	Miles Berry, Principal Lecturer, Computing Education, University of Roehampton	QQ 158–172
**	Paul Hynes, Vice Principal, George Spencer Academy	
*	Jack Evans, Specialist Support Teacher (Computing and DT Co-ordinator), Kingsmead Primary School	
*	Mark Chambers, Chief Executive Officer, Naace	
*	Stephanie Daman, CEO, Cyber Security Challenge	QQ 173–191
*	Nick Coleman, Global Head of Security Intelligence, IBM Services	
**	Hugh Boyes, Cyber Security Lead, The Institution of Engineering and Technology	
*	Angela Harrington, Head of Regeneration, Manchester City Council	QQ 192–204
**	Gary Warke, Board Member and Business Development Board Member, Humber Local Enterprise Partnership	
**	Gerard Grech, Chief Executive Officer, Tech City UK	
**	Dinah Caine, Chief Executive Officer, Creative Skillset (Sector Skills Council for the Creative Industries)	QQ 205–209

**	Saint John Walker, Head of Development, Creative Skillset (Sector Skills Council for the Creative Industries)	
*	Professor Dame Wendy Hall, Director, Web Science Institute, University of Southampton	QQ 210–220
*	Baroness Shields	
*	Megan Richards, Principal Adviser, DG CONNECT, European Commission	QQ 221–231
**	Andreas Schleicher, Director for Education and Skills and Special Adviser on Education Policy to the Secretary General, Organisation for Economic Co-operation and Development (via video link)	
**	Chris Jones, Chief Executive Officer, City & Guilds	QQ 232–249
*	Martin Hottass, Manager, Skills & Siemens Professional Education, Siemens	
*	Sue Husband, Director, Apprenticeships and Delivery Service, Skills Funding Agency	
**	Nick Boles MP, Minister of State for Skills and Equalities, Department for Business, Innovation & Skills and Department for Education	QQ 250–264
**	Ed Vaizey MP, Minister of State for Culture and the Digital Economy, Department for Business, Innovation & Skills and Department for Culture, Media & Sport	

Alphabetical list of all witnesses

*	Age UK (QQ 129–142)	
	Andrew WS Ainger	DSC0015
	Sanjeev Appicharla	DSC0042 DSC0081
	Apps for Good	DSC0080
	Association for Learning Technology	DSC0057
	The Association for UK Interactive Entertainment	DSC0086
	Association of Information Technology in Teacher Education	DSC0050
	Barclays Bank	DSC0047
*	Professor Patrick Barwise (QQ 103–112)	
	Bath Spa University	DSC0004
**	BBC (QQ 103–112)	DSC0112
**	BCS, The Chartered Institute for IT (QQ 143–157)	DSC0051 DSC0110
*	Miles Berry (QQ 158–172)	
*	Boston Consulting Group (QQ 76–86)	
*	Professor Nick Bostrom (QQ 26–39)	
	Dr Jo Briggs	DSC0083
	Bristol City Council	DSC0126
	British and Irish Association of Law Librarians	DSC0020
*	British Chambers of Commerce (QQ 66–75)	
	British Sky Broadcasting	DSC0036

	Broadway Academy	DSC0059
*	Professor Phillip Brown (QQ 15–25)	
**	BT (QQ 76–86)	DSC0091 DSC0104
	David Chan	DSC0007
	Channel 4	DSC0099
	Chartered Institute of Library and Information Professionals	DSC0045
	The Chartered Institute of Marketing	DSC0076
	Chartered Institute of Public Relations Social Media Panel	DSC0094
	David Chassels	DSC0061
	Citizens Online	DSC0005
**	City & Guilds (QQ 232–249)	DSC0044
	City of London Corporation	DSC0090
*	Coalition for a Digital Economy (QQ 53–65)	
*	Code Club (QQ 129–142)	
	Communications Consumer Panel	DSC0068
	CompTIA	DSC0082
**	Computing At Schools (QQ 143–157)	DSC0110
	Confederation of British Industry	DSC0074
	Cornwall and Isles of Scilly Local Enterprise Partnership	DSC0054
**	Creative Skillset (Sector Skills Council for the Creative Industries) (QQ 205–209)	DSC0095 DSC0116
	Alan Crymble	DSC0021
*	Cyber Security Challenge (QQ 173–191)	
	Professor Leela Damadoran	DSC0093
	Digital Youth Academy	DSC0029
*	Direct Line Group (QQ 66–75)	
	Dynamo North East	DSC0107
	EE	DSC0026
	e-learning Foundation	DSC0001
	Elix-IRR	DSC0046
	The European Azerbaijan Society	DSC0038
*	European Commission (QQ 221–231)	
**	Federation of Small Businesses (QQ 53–65)	DSC0103
	Bernadette Fishpool	DSC0025
	Frog Education	DSC0071
**	George Spencer Academy (QQ 158–172)	DSC0127
	Martin Goodyear	DSC0089
*	Google (QQ 40–53)	
**	Go ON UK (QQ 113–128)	DSC0079
*	Professor Dame Wendy Hall (QQ 210–220)	
	Tony Harper	DSC0075

*	The Hartree Centre (QQ 26–39)	
	Heart of Worcestershire College	DSC0018
	Here East	DSC0048
**	HM Government (QQ 250–264)	DSC0084 DSC0121
	Professor Tim Hitchcock	DSC0021
**	Humber Local Enterprise Partnership (QQ 192–204)	DSC0060
*	IBM Services (QQ 173–191)	
	Imperial College London	DSC0122
**	Innovate UK (formerly known as the Technology Strategy Board) (QQ 26–39)	DSC0070
**	The Institution of Engineering and Technology (QQ 173–191)	DSC0049
	iRights	DSC0108
*	Kingsmead Primary School (QQ 158–173)	
	The Knowledge Transfer Network	DSC0056
	learndirect	DSC0066
	London Borough of Camden	DSC0058
	David Longman	DSC0053
	Makers Academy	DSC0119
	Management Consultancies Association	DSC0040
*	Manchester City Council (QQ 192–204)	
*	Professor Alan Manning (QQ 15–25)	
	McAfee	DSC0022
*	McKinsey & Company (QQ 66–75)	
**	Microsoft (QQ 40–52)	DSC0006
*	Naace (QQ 158–172)	
**	National College for Teaching and Leadership (QQ 143–157)	DSC0013
**	National Institute of Adult Continuing Education (QQ 87–102)	DSC0088
	National Library of Wales	DSC0117
**	Nesta (QQ 1–14)	DSC0003
	NMI Systems & Software Leaders Network	DSC0062
	Northern Ireland Government	DSC0125
*	Ofcom (QQ 103–112)	
	Wendy Olphert	DSC0093
	The One Voice for Accessible ICT Coalition	DSC0033
**	The Open University (QQ 87–102)	DSC0065
**	Organisation for Economic Co-operation and Development (QQ 221–231)	DSC0016 DSC0120
	Oxford Cambridge and RSA Examinations	DSC0014
	Pera Training	DSC0029
	Dr Lisa Payne	DSC0031
	Promontory Financial Group	DSC0087

	Prospect	DSC0064
	QA Limited	DSC0069
	Recruitment & Employment Confederation	DSC0035
	Research Councils UK	DSC0055
	The Royal Society of Edinburgh	DSC0030
	Samsung Electronics UK	DSC0092
	Jatinder Sandhu	DSC0093
	Science Council	DSC0096
	Fiona Scott Lazareff	DSC0028
	Scottish Government	DSC0128
*	Baroness Shields (QQ 210–220)	
*	Siemens (QQ 232–249)	
*	Skills Funding Agency (QQ 232–249)	
	Social Security Advisory Committee	DSC0043
	Solace and Leeds City Council	DSC0124
*	South Farnham School (QQ 143–157)	
	Sunderland Software City	DSC0063
	Tablets for Schools	DSC0118
**	TalkTalk (QQ 129–142)	DSC0105
	Tata Consultancy Services	DSC0106
**	Tech City UK (QQ 192–204)	DSC0115
*	Tech Partnership (QQ 113–128)	
*	techUK (QQ 53–65)	
**	Tinder Foundation (QQ 103–112)	DSC0077
	Trustworthy Software Initiative	DSC0024
	Professor John Vivian Tucker	DSC0023
*	UCanDoIT (QQ 129–142)	
	UK Computing Research Committee	DSC0011
	UK Council for e-Business	DSC0102
**	UK Digital Skills Taskforce and TeenTech CIC (QQ 113–128)	DSC0101 DSC0111
**	UK Forum for Computing Education (QQ 40–52)	DSC0078
	UK Music	DSC0097
	Professor Tony Venables	DSC0114
**	Virgin Media (QQ 76–86)	DSC0100
	Philip Virgo	DSC0034
	Virtual College	DSC0039
*	Professor Judy Wajcman (QQ 15–25)	
	Dr Victoria Wang	DSC0023
	Welsh Government	DSC0123
	Janet Anne West	DSC0109
	Wikimedia UK	DSC0027
	Dr Jane Winters	DSC0021
*	Martin Wolf (QQ 1–14)	

APPENDIX 3: CALL FOR EVIDENCE

The Digital Skills Committee of the House of Lords, chaired by Baroness Morgan of Huyton, is conducting an inquiry into digital skills in the UK. The Committee invites interested individuals and organisations to submit evidence to this inquiry.

Written evidence is sought by 5 September 2014. The submissions we receive will guide the Committee's deliberations in oral evidence sessions later this year, and also inform the Committee's final conclusions and recommendations. Public hearings began in early July and will continue until late November. The Committee aims to report to the House with recommendations in late January 2015. The report will receive a response from the Government, and will be debated in the House.

Background

The terms of reference for the inquiry are "to consider information and communications technology, competitiveness and skills in the United Kingdom" and to report by 5 March 2015.

The Committee has decided to set the inquiry within the policy framework of rapidly changing technology and to examine what this means for the labour market. Recent and future developments in technology are changing the world in a number of ways, both positive and negative. In one study of US occupations by the University of Oxford, for example, it was found that 47% of total employment is at risk of "computerisation".[547]

The inquiry will therefore focus on the changes to the system which are likely to occur as a consequence, and whether the UK's workforce has the necessary digital skills to deal with this change.

The Committee will examine how prepared the workforce is for these changes. The digital industries currently predict a significant skills shortage. High-tech education is important in many industries. The need for digital skills can be divided into two groups: the need for a general workforce able to work in an increasingly digital environment (skills for digital competitiveness); and the need for more specialists to build and maintain that environment (high-level digital skills). Conversely, the ONS estimated in 2012 that seven million people in the UK had never used the internet.[548] The CBI surveys show that since 2008 at least half of employers have expressed concerns about IT skills in their workforce.[549]

We are keen to examine where the changing digital landscape leaves the UK in terms of global economic competitiveness. Questions in this area include:

- Are schools, further and higher education, businesses and other sectors ready for the implications of the changing digital landscape?
- What will be the implications for the Government? Is the Government prepared for these changes?
- Does the UK have the infrastructure to remain competitive with these new technologies when compared to other countries?

547 University of Oxford, *The Future of Employment: How Susceptible are Jobs to Computerisation?* (September 2013): http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf [accessed 9 February 2015]

548 ONS, 'Summary of Internet Access': http://www.ons.gov.uk/ons/rel/rdit2/internet-access-quarterly-update/2012-q4/sty-internet-access.html [accessed 9 February 2015]

549 CBI, *Changing the pace: CBI/Pearson education and skills survey 2013* (June 2013): http://www.cbi.org.uk/media/2119176/education_and_skills_survey_2013.pdf [accessed 9 February 2015]

The Committee is keen to take evidence from a wide range of stakeholders working in a variety of sectors. This includes, but is not limited to: businesses, and their representative organisations (including small and medium-sized enterprises (SMEs)); academics; local government/authorities; consultancies; sector skills councils; technology membership bodies; technology companies; telecommunications companies; digital literacy groups; civil society and non-governmental organisations; European bodies; apprenticeship schemes; careers guidance bodies; education in schools; lifelong learning organisations; and organisations working with hard to reach groups.

The Committee does not intend to inquire into the content of the new computing curriculum, due to be delivered in schools from September 2014. Nor does the Committee intend to inquire into specific digital technologies.

Issues

The Committee seeks evidence on any aspect of this topic, and particularly on the following questions:

The changing technological landscape

(1) What is the pace and change of the future digital technology landscape over the next five, 10 and 15 years? What are the leading innovations?

(2) What are the main challenges for economic growth as the UK transitions to a knowledge-driven economy?

(3) What is the employment impact on the UK's labour market? What are the regional differences?

Future workforce

(4) What skills do future workers need in order for the UK to be globally competitive? How do the digital skills required for technical roles compare to those needed by the wider workforce to operate in a digitally competitive environment? Can the current supply chain deliver this?

(5) How are we teaching students in a way that inspires and prepares them for careers in the future workforce in occupations that may not yet exist, rather than the current one? How can this be improved?

(6) How are schools preparing to deliver the new computing curriculum in an innovative way?

(7) How can the education system develop creativity and social skills more effectively?

(8) How does the current post-16 system inspire and equip students to pursue careers in the future workforce in occupations that may not yet exist? How can this be improved?

Short- and medium-term support to the digital sector

(9) How can the digital sector be supported in the short- and medium-term? What is the role for higher and vocational education, national colleges, industry, and industrial policy?

(10) Is there a need for increased high skills immigration in the short-term? What are the implications of this?

(11) Is there an inclusion agenda in relation to digital skills in the workplace? How are groups with protected characteristics such as older people, those with disabilities, and women, being engaged? How can this be improved?

(12) What do the best local skills delivery models look like? What is the role for local Government, Local Enterprise Partnerships and the third sector?

Industry

(13) What are the barriers for businesses, particularly SMEs preparing to operate in a knowledge-driven economy? How are these best overcome?

(14) How can businesses help equip the workforce with new skills in a rapidly changing environment?

Infrastructure

(15) Does the UK have a competitive infrastructure to support a knowledge-driven economy? How does the UK compare to other countries?

You need not address all these questions in your response.

26 June 2014

APPENDIX 4: ACRONYMS AND GLOSSARY

4G	The 'G' in 1G, 2G, 3G and 4G stands for the 'generation' of the mobile network. The higher number before the 'G' means more power to send out and receive more information. O2 and Vodafone launched their 4G networks in the UK in August 2013. 4G has internet speeds up to five times faster than 3G.
ALT	Association for Learning Technology
App	A mobile 'app' (application) is a computer programme designed to run on smartphones, tablet computers and other mobile devices.
ATA	Apprenticeship Training Agencies. These are specifically designed to support employers who wish to take on an apprentice but are unable to in the current economic climate. The distinctive feature of this model is that it is the ATA who acts as the apprentice employer and who places them with a host employer. The host employer pays the ATA a fee for the apprentices' services; this fee being based on the wage agreed with the host and the ATA management fee.
BCS	BCS, The Chartered Institute for IT
Big Data	Extremely large data sets that may be analysed computationally to reveal patterns, trends and associations, especially relating to human behaviour and interactions.
BIS	Department for Business, Innovation & Skills
CAS	Computing At School
CBI	Confederation of British Industry
CCP	Communications Consumer Panel
CCS	Crown Commercial Service
Cloud computing	The practice of using a network of remote servers hosted on the internet to store, manage and process data, rather than a local server or a personal computer.
Clusters	Groups of companies grouped around a particular industry in a specific location or area.
CO	Cabinet Office
Coadec	Coalition for a Digital Economy
CPD	Continuing Professional Development
Cyber risk management	The protection of hard and soft infrastructure. This includes cybercrime, cybersecurity, online security and business and personal risk.
DCLG	Department for Communities & Local Government
DCMS	Department for Culture, Media & Sport
DfE	Department for Education

Digital citizen	Someone with the ability to use digital technology purposefully and confidently to communicate, find information and purchase goods/services. The second band of UKForCE's categorisation of digital skill levels.
Digital economy	The whole economy has become digitised. As digital is pervasive across most aspects of our lives, so the 'digital economy' is becoming synonymous with the national economy.
Digital inclusion	Digital inclusion (or rather, reducing digital exclusion) is about making sure that people have the capability to use the internet and wider technology, and do things that benefit them day to day.
Digital maker	Someone with sufficient skills to build digital technology (typically software development). The fourth band of UKForCE's categorisation of digital skill levels.
Digital muggle	Someone with no digital skills—digital technology may as well be magic. The first band of UKForCE's categorisation of digital skill levels.
Digital worker	At the higher end, someone with the ability to evaluate, configure and use complex digital systems. Elementary programming skills such as scripting are often required for these tasks. The third band of UKForCE's categorisation of digital skill levels.
DSI	Data Science Institute
EU	European Union
EU5	Collectively, France, Germany, Italy, Spain and the UK are sometimes referred to as the 'EU5'.
FELTAG	Further Education Learning Technology Action Group
Fibre broadband	Fibre broadband ('fibre') is seen as the future of broadband. Fibre broadband uses fibre optic cable and is capable of delivering very high-speed internet connections (significantly faster than conventional broadband services).
Gbps	gigabits per second
GDP	gross domestic product
GDS	Government Digital Service. The Government Digital Service is leading the digital transformation of Government, making public services 'digital by default', and simpler, clearer and faster to use.
GMG	Guardian Media Group
GVA	gross value added
Hackathon	A hackathon is an event, typically lasting several days, in which a large number of people meet to engage in collaborative computer programming.

Hard infrastructure	The physical equipment, pipes and cables necessary to run the digital economy. This includes broadband coverage, broadband speeds, mobile phone coverage and mobile phone functionality (4G/5G).
HMT	Her Majesty's Treasury
HO	Home Office
HPC	high performance computing
ICT	information and communications technology
IET	Institution of Engineering and Technology
iOS	An operating system used for devices manufactured by Apple—for example, iPhones and iPads.
IPO	Intellectual Property Office
IT	information technology
ITT	Initial Teacher Training
ITTE	Association of Information Technology in Teacher Education
KTN	Knowledge Transfer Network
LEP	Local Enterprise Partnership
LSE	London School of Economics
Malware	Software that is specifically designed to disrupt or damage a computer system.
Mbps	megabits per second
MCA	Management Consultancies Association
MOOC	Massive Open Online Course. A MOOC is an online course aimed at unlimited participation and open access via the internet. In addition to traditional course materials such as videos, readings and problem sets, MOOCs provide interactive user forums that help build a community for learners.
NAO	National Audit Office
NCTL	National College for Teaching and Leadership
NIACE	National Institute of Adult Continuing Education
NIESR	National Institute of Economic and Social Research
NMI	NMI Systems & Software Leaders Network
Not-spots	Not-spots (also known as 'white areas' or 'white spots') indicate regions where there is no broadband infrastructure and where no such infrastructure is likely to be developed in the near future (taken to mean three years).
OCR	Oxford Cambridge and RSA Examinations
OECD	Organisation for Economic Co-operation and Development
OGD	Open Government Data
ONS	Office for National Statistics
Patent Box	The Patent Box enables companies to apply a lower rate of Corporation Tax to profits earned after 1 April 2013 from its patented inventions.

R&D	research and development
RCUK	Research Councils UK
REC	Recruitment & Employment Confederation
RSE	Royal Society of Edinburgh
SMEs	small and medium-sized enterprises
SOC	Standard Occupation Code
Soft infrastructure	Developing a population and workforce with the abilities and skills to use the hard infrastructure. Other definitions of soft infrastructure include, for example, intellectual property rights, but these are not within the scope of our inquiry.
STEAM	science, technology, engineering, art and mathematics
STEAMED	science, technology, engineering, art, mathematics, entrepreneurship and design
STEM	science, technology, engineering and mathematics
STEMNET	The Science, Technology, Engineering and Mathematics Network
STFC	Science and Technology Facilities Council
Superfast broadband	Superfast (or 'next generation') broadband is generally taken to mean broadband products that provide a maximum download speed that is greater than 24Mbps. This threshold is commonly considered to be the maximum speed that can be supported on current generation (copper-based) networks.
UKForCE	UK Forum for Computing Education
Ukie	Association for UK Interactive Entertainment
UKTI	UK Trade & Investment
UTC	University Technical College
WEF	World Economic Forum

APPENDIX 5: EXAMPLES OF INITIATIVES AND ACTION

Government action on hard infrastructure (paragraph 28)

- £1 billion investment in broadband and mobile infrastructure—long-term, has a projected GVA uplift that will rise to £6.3 billion per annum by 2024 and create a net increase of 20,000 jobs by 2024.
- £780 million for Broadband Delivery UK's Superfast Broadband Roll-Out Programme—this aims to provide over 5 million homes and businesses across the UK with superfast broadband, bringing coverage up to 95% by 2017, and to provide virtually all homes with standard broadband speeds of at least 2Mbps.
- In June 2014 the Government announced the eight successful bids for its £10 million innovation fund to explore ways to take superfast broadband to the most remote and hardest to reach places in the UK.
- The £150 million Urban Broadband Fund supports 22 Super Connected Cities to develop the digital infrastructure they needed to remain internationally competitive places to invest, visit and do business. The fund already supports wireless projects in 10 cities and has issued over 1,500 broadband connection vouchers to SMEs.
- £11.6 million investment in a world-leading 5G Innovation Centre at the University of Surrey.
- £150 million investment in the Mobile Infrastructure Project—building infrastructure to provide mobile coverage to the remaining 0.3%–0.4% of the population who had no coverage at all. All new sites would also be capable of providing 4G services.
- Working with infrastructure providers and developers to ensure all new buildings are equipped with the infrastructure for fixed high speed broadband access.[550]

Government cybersecurity initiatives (paragraph 76)

Cyber Streetwise

Cyber Streetwise is a cross-Government campaign, funded by the National Cyber Security Programme, and delivered in partnership with the private and voluntary sectors. The campaign is led by the Home Office, working closely with BIS and the Cabinet Office. The campaign aims to measurably and significantly improve the online safety behaviour and confidence of consumers and SMEs.

Links to various resources produced by the campaign's partners, helping individuals and organisations find the information they need to protect themselves, their families and their businesses, are available on its website.[551]

Get Safe Online

Get Safe Online is a public and private sector partnership supported by the Government and leading organisations in banking, retail, internet security and other sectors. The website aims to act as a resource providing practical advice on how to protect individuals, computers and mobile devices and businesses against fraud, identity theft, viruses and many other problems encountered online. It also contains guidance on many other related subjects—including performing backups

550 Written evidence from HM Government (DSC0084)
551 Cyber Streetwise: https://www.cyberstreetwise.com [accessed 15 December 2014]

and how to avoid theft or loss of a computer, smartphone or tablet. A wide variety of topics are included on the site—including safe online shopping, gaming and dating. The site also provides up-to-date news, tips and stories from around the world.

Get Safe Online also organises national events—such as Get Safe Online week—and works closely with law enforcement agencies and other bodies in support of their outreach activity, internal awareness and customer online safety.[552]

School networks delivering CPD (paragraph 113)

- The CAS network has over 14,000 members and runs over 110 free CAS Hubs across England.[553] There were 300 'master' teachers[554] by September 2014, with 400 predicted by 2015. There is a similar scheme in Scotland funded by the Scottish Government to develop lead practitioners.[555]
- Teaching school alliances: "… if you e-mail [something] to a teaching school today it will be in a school tomorrow and acted upon because there is a local need and local support there".[556]
- The Digital Schoolhouse initiative runs across 10 London secondary schools. It is "funded by the Mayor of London and delivered by video games trade body Ukie [Association for UK Interactive Entertainment] … with a target of over 100 schools participating in year one".[557]
- Code Club runs over 2,000 volunteer-led after-school coding clubs for 9–11 year-olds, as well as a new teacher training programme.[558]
- Local council-university partnership: "… early 2014, the Department of Computer Science at the University of Hull, responding to a significant demand from schools in the Humber region, created and delivered a small pilot programme to help address the skills gap in teachers moving from ICT to the new computing curriculum. The pilot involved 29 teachers from 17 local schools, and consisted of 2 hour weekly evening workshops in the autumn and spring terms, with the aim being to teach how to programme in Python".[559]

Industry-led initiatives on careers guidance (paragraph 169)

Sky Academy

Through its Academy, Sky is working with thousands of young people to "inspire and cultivate a passion for digital careers". For example, its Skills Studios experience allows students to use state-of-the-art technology to create their own TV reports. Sky is also developing a new careers initiative which will expose pupils to the breadth of career opportunities available at Sky.[560]

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552 Get Safe Online: https://www.getsafeonline.org [accessed 15 December 2014]
553 Findings by DfE, delivered through BCS. Written evidence from BCS (DSC0051)
554 DfE is funding a master teacher training programme. The idea of a master teacher is that a practising teacher who is outstanding (according to Ofsted) is paired with a local university and provides CPD for their local schools.
555 Q 144 (Dr Bill Mitchell)
556 Q 145 (Sir Andrew Carter)
557 Written evidence from UKForCE (DSC0078)
558 See QQ 129–142 (Clare Sutcliffe's opening remarks)
559 Written evidence from Humber LEP (DSC0060)
560 Written evidence from British Sky Broadcasting (DSC0036). See also: http://www.sky.com/academy/about [accessed 8 December 2014]

4Talent

4Talent is Channel 4's nationwide outreach scheme aimed at supporting people from a range of backgrounds looking to develop a career in the media. Channel 4 also engages young people from across the UK with its digital work, holding open days where careers advice and workshops are provided by Channel 4 staff and local television and digital companies.[561]

City & Guilds TechBac

The TechBac is a programme of study which "blends technical qualifications with practical, real world learning developed and delivered in partnerships between education and employers". The TechBac will provide an offer which makes digital skills integral to whatever vocational route chosen, as well as providing an option of specialising in digital industries.[562]

STEMNET (the Science, Technology, Engineering and Mathematics Network)

STEMNET runs the UK's only network of STEM Ambassadors, with over 27,000 volunteers. Across the UK, STEM Ambassadors volunteer to promote STEM subjects to young learners in a "vast range of original, creative, practical and engaging ways". They are a free resource for teachers, helping to deliver the STEM curriculum and raise awareness of STEM careers, achieved by revealing how essential STEM is throughout the world. STEM Ambassadors come from a wide range of careers and professions. STEMNET ensures that the population of STEM Ambassadors reflects the diversity of the population: 40% are women; 13% describe themselves as from BAME (black and minority ethnic) backgrounds; and they range from 18 to 70 years old, with almost 60% under 35 years old.[563]

Private sector skills training organisations (paragraph 194)

General Assembly

"At General Assembly, we are creating a global community of individuals empowered to pursue work they love, by offering full-time immersive programs, long-form courses, and classes and workshops on the most relevant skills of the 21st century—from web development and user experience design, to business fundamentals, to data science, to product management and digital marketing.

Established in early 2011 as an innovative community in New York City for entrepreneurs and startup companies, General Assembly is an educational institution that transforms thinkers into creators through education in technology, business and design at fourteen campuses across four continents."[564]

Makers Academy

Makers Academy was launched in February 2013 and is Europe's leading coding provider. The Academy helps complete beginners to learn the basics of software development and find their first job as junior programmers in world-class companies.

Since its launch, the Academy has graduated over 250 students who went to join leading software companies as junior developers earning an average starting salaries

561 Written evidence from Channel 4 (DSC0099). See also: http://4talent.channel4.com/4talent/about-us [accessed 8 December 2014]

562 Written evidence from City & Guilds (DSC0044). See also: http://www.cityandguilds.com/what-we-offer/centres/14-19-qualifications/techbac [accessed 8 December 2014]

563 Written evidence from UKForCE (DSC0078). See also: http://www.stemnet.org.uk/about-us [accessed 8 December 2014]

564 General Assembly, 'Our Story': https://generalassemb.ly/about [accessed 18 December 2014]

of £30,000 per annum. Companies hiring Academy graduates include: Marks and Spencer; the Ministry of Justice; British Sky Broadcasting; Compare The Market; Deloitte Digital; Just Giving; and many other leading tech companies.

The course is full-time, face-to-face and highly intensive. Students undertake a four-week, online, part-time pre-course on the basics of programming, followed by 12 weeks of project-based tuition at its teaching space in London's Silicon Roundabout. The Academy runs a new course every six weeks, taking an average of 25 students in each intake.[565]

Initiatives aimed at supporting small and medium-sized enterprises (paragraph 231)

Go ON UK's SME Digital Capability Programme

In partnership with BIS, Go ON UK launched its SME Digital Capability Programme. This Programme was designed to empower SMEs across the UK to capitalise on the time and cost savings associated with transacting online whilst maximising productivity and growth.

Go ON UK estimated that in the last year this initiative had inspired 300,000 SMEs to investigate online business opportunities, of which 5,500 had taken further action to transition towards transacting and marketing themselves online.

As the programme enters its second year, the Programme's focus will be on developing enhanced corporate partnerships and engineering a scalable digital incubation network for SMEs in collaboration with LEPs and Growth Hubs. This will include:

- Inspiring: General communications-led outreach to inspire businesses to take their first digital step, sharing of peer-to-peer and segmented content and explanation of business benefits, using targeted incentives where appropriate to encourage engagement.
- Educating: Explain the available options and provide choices for learning and sharing of best practice, and use online and offline activities to guide the digital development of SMEs.
- Supporting: Signpost and support training and skills development, create modules for the specific enhancement of transactional skills and enable user-defined journeys to acquire a range of advanced skills.
- Promoting: Promote case studies and tell peer-to-peer stories, encourage online community engagement to advocate, support and inspire action.[566]

Virgin Media and Free:Formers Training Programme

In July 2013, Virgin Media partnered with digital skills provider Free:Formers to conduct an intensive, three week training programme for 25 small businesses in Birmingham. They deliberately targeted businesses from a range of sectors who to date had not invested in digital services and were unconvinced by what broadband could offer them.

Virgin Media and Free:Formers devised a digital training module that started at a very basic level of technical understanding and built to providing advance training on how to code, build a website and populate it with content, embed video and develop a social media strategy. The fast-moving curriculum demanded a

565 Written evidence from Makers Academy (DSC0119)
566 Written evidence from Go ON UK (DSC0079) and HM Government (DSC0084)

classroom-based environment to ensure that the participants could ask questions and build as they learnt.

Virgin Media reportedly received very positive feedback from the group of businesses and at the end of the training programme, and observed a material improvement in the digital capability of all participants.[567]

Examples of regional specialisms (paragraph 240)

- Michael Gleaves: "The north-west of England is strong in chemistry and material science in effect. That cluster is there, so it makes sense to place the main specific application of graphene technologies or new lightweight material technologies in that area. Glasgow has a heavy industrial heritage and perhaps you would look at something in that area to try to build a cluster around that."[568]
- Kevin Baughan: "… information knowledge centres: we have one out in Belfast in Northern Ireland on security. That is flourishing. A whole lot of small industries have appeared [in] that domain or go to medical technology up in Leeds, and you have another set of industries appearing around that, so I think clusters will occur in every subject".[569]
- Chris Mairs: "… the car industry, for example around Birmingham and Oxford, you get massive, massive numbers of SMEs setting up around the big players".[570]
- Here East: "Here East is the unique cluster on the Queen Elizabeth Olympic Park, occupying the former International Press and Broadcast Centres."[571]
- Gerard Grech: "If you take Edinburgh, there are very good computer science courses producing great PhD students with extreme knowledge in artificial intelligence, which is one core capability of the digital economy … Manchester, obviously the arrival of the BBC is creating a huge cluster of knowledge and a critical mass of expertise around digital content development".[572]
- Stephanie Daman: "There is a very good example of that [cybersecurity] with the Malvern cluster".[573]
- RCUK: "… there is a concentration of expertise and businesses in London's financial sector, meaning that EPSRC's [Engineering and Physical Sciences Research Council] Centre for Doctoral Training in Financial Computing and Data Analytics (at London's UCL [University College London], Imperial College and LSE [London School of Economics]) can more easily collaborate with key Financial Sector players including the Bank of England, the Financial Regulators and the Treasury".[574]

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567 Written evidence from Virgin Media (DSC0100)
568 Q 39
569 Q 36
570 Q 49
571 Written evidence from Here East (DSC0048)
572 Q 196
573 Q 187
574 Written evidence from RCUK (DSC0055)

APPENDIX 6: LEAGUE TABLE OF EUROPEAN CAPITAL CITY AVERAGE DOWNLOAD BROADBAND SPEEDS

Rank	Capital City	Country	January 2015 speeds (Mbps)
1	Bucharest	Romania	80.14
2	Paris	France	78.6
3	Vilnius	Lithuania	59.99
4	Stockholm	Sweden	59.46
5	Reykjavik	Iceland	49.95
6	Bern	Switzerland	49.37
7	Copenhagen	Denmark	47.81
8	Bratislava	Slovakia	44.47
9	Riga	Latvia	42.9
10	Helsinki	Finland	42.79
11	Vienna	Austria	42.41
12	Oslo	Norway	40.25
13	Budapest	Hungary	40.1
14	Luxembourg	Luxembourg	40.03
15	Dublin	Ireland	39.43
16	Amsterdam	Netherlands	39.41
17	Tallinn	Estonia	39.34
18	Sofia	Bulgaria	38
19	Prague	Czech Republic	37.04
20	Lisbon	Portugal	34.73
21	Madrid	Spain	33.26
22	Kiev	Ukraine	32.76
23	Berlin	Germany	27.2
24	Brussels	Belgium	26.72
25	Warsaw	Poland	25.97
26	**London**	**United Kingdom**	**25.44**
27	Minsk	Belarus	17.79
28	Sarajevo	Bosnia & Herzegovina	13.41
29	Zagreb	Croatia	11.74
30	Rome	Italy	11.65
31	Belgrade	Serbia	10.91
32	Athens	Greece	9.76
33	Nicosia	Cyprus	9.11

Source: Ookla, 'Net Index Explorer': http://explorer.netindex.com/maps# *[accessed 16 January 2015]. Data correct as of 16 January 2015. Data not available for European cities not included.*

APPENDIX 7: GO ON UK'S DEFINITION OF BASIC DIGITAL SKILLS

	Managing information	Communicating	Transacting	Problem-solving	Creating
Description	Find, manage and store digital information and content.	Communicate, interact, collaborate, share and connect with others.	Purchase and sell goods and services, organise your finances and use digital Government services.	Increase independence and confidence by solving problems and finding solutions using digital tools.	Create basic digital content in order to engage with digital communities and organisations.
Safety	Assess the accuracy of sources of information; use security tools when browsing; regularly update and run virus-checking software; and manage parental controls.	Understand how to manage your identities; protect yourself from scams; use the right security settings (including parental controls); and protect your customer data.	Use secure websites for financial transactions; protect your personal data; and respect the privacy of others.	Use accurate sources of support; and avoid malicious websites, scams and pop-up windows.	Be aware of copyright law; protect your personal data; and respect the privacy of others.
Actions for Individuals	• Use a search engine to find the information you need. • Search for deals on comparison websites. • Bookmark useful websites and services. • Store data on a device or in the cloud.	• Keep in touch using email, instant messaging, video calls and social media. • Post on forums to connect with communities. • Communicate with organisations about their products and services.	• Understand and use marketplaces to buy and sell. • Order your shopping. • Book your travel. • Manage your bank account. • Set up and manage a Universal Credit account.	• Teach yourself simple tasks using tutorials. • Use feedback from other internet users to solve common problems. • Access support services.	• Create a social media post. • Create a text document such as a CV. • Create and share a photo album. • Create and share feedback about products and services.

	Managing information	Communicating	Transacting	Problem-solving	Creating
Actions for organisations	• Store digital information on suppliers and customers. • Search for new suppliers to find the best deals. • Understand who uses your website. • Discover potential growth opportunities for your business.	• Maintain customer and client relationships. • Use social media to promote your business and connect with new customers. • Improve your customer service by providing accessible product information and answers to frequently asked questions.	• Maximise your selling potential through a website. • Save time by applying for Government business permits and licences. • Manage invoices and accounts. • Receive payments or donations. • Protect yourself from fraud or scams.	• Save on business travel and be more efficient by using video conferencing. • Quickly understand which products and services work based on online feedback. • Interpret simple analytics to improve website performance. • Get solutions to problems from safe, accurate sources.	• Create an informational or e-commerce website. • Create content (pictures, logos, text) to promote your organisation and reach customers. • Use social media and create communities to engage with customers. • Create resources to improve employee skill levels.

Source: Go ON UK, 'Basic Digital Skills definition': http://www.go-on.co.uk/wp-content/uploads/2015/01/Basic-Digital-Skills-Table-CG.pdf *[accessed 29 January 2015]*

APPENDIX 8: SUMMARY OF COMMITTEE VISITS

Guardian Media Group and Google Campus, Tuesday 2 September 2014

This visit was intended to provide first-hand experience of certain technologies and allow Members from the Committee to talk with various stakeholders—such as start-up companies and individuals working within organisations—who make extensive use of digital technology. The Guardian Media Group (GMG)[575] offered the 'user' organisation view point, whereas Google Campus[576] provided the 'producer' organisation perspective. The delegation visited two sites, both of which were in London.

A delegation of Members from the Committee attended: Lord Aberdare, Earl of Courtown, Baroness Garden of Frognal, Lord Haskel, Lord Kirkwood of Kirkhope, Lord Lucas, Baroness Morgan of Huyton (Chairman) and Baroness O'Cathain. The delegation was accompanied by Aaron Speer (Clerk), Emily Greenwood (Policy Analyst), Thomas Cheminais (Committee Assistant) and Darell Carey (Press Officer).

Site visit #1: Guardian Media Group

The digital evolution of media: Andrew Miller (GMG Chief Executive Officer) and Tanya Cordrey (GMG Chief Digital Officer)

The delegation heard that The Guardian was the third largest English language newspaper website in the world online, with over 100 million unique browsers per month (and growing), versus around 200,000–300,000 per day in newspaper readership. We were told that The Guardian was gaining an international following online, for example, through the Guardian Australia edition, and the Guardian US edition (which was central to the reporting of the Snowdon story). Whilst readership of the paper newspaper was in decline, the consumer shift to digital was growing at pace.

This was an experience that echoed across the entire sector. For example, newspaper readership for The Guardian fell by 21% between 2007 and 2011, with The Independent and The Times suffering losses of 48% and 26% respectively over the same period. Andrew Miller (GMG's Chief Executive Officer) said that The Guardian was leaving behind traditional competition; new competitors were digital, such as the BBC, Facebook, Google and Twitter.

It was noted that the growing prevalence of mobile devices and tablets was driving strong growth. Mr Miller said that the future was mobile; and for 18–20 year olds the future was video.

The delegation was told that GMG faced three challenges: culture (internal); platforms (the way people are consuming); and obtaining a level playing field. A particularly important question The Guardian asked itself was whether it wanted to be more radical and jump to a wholly digital place. Although trends were pointing in this direction, such a move would result in lost readership.

Tanya Cordrey (GMG's Chief Digital Officer) went on to talk about the challenges of recruiting staff with the digital skills required by the business. Ms Cordrey highlighted that The Guardian's own digital team had doubled over the last two years. The organisation was recruiting the best individuals; the challenge was retaining them. It was noted that the UK was a major hub of expertise around

575 Guardian Media Group: http://www.gmgplc.co.uk [accessed 26 January 2015]
576 Campus London: https://www.campuslondon.com [accessed 26 January 2015]

news, with external pulls from outside the UK for top talent (such as from California).

A particular challenge was finding people with the right skills and mind-set. The Guardian had targeted young talent with no direct experience. For example, the Guardian's graduate programme had no computer science graduates. Under-represented groups also remained an issue; the percentage of women at The Guardian was approximately 15–20%. Overseas recruitment was often necessary—for example, the Chief Technology Officer was recruited from Google.

It was noted that business was about managing a mind-set which embraced technology and change. Cultural change could take 10–15 years, whereas technological change was happening every few months. To combat this, we were told that skills should be engrained in education, and immigration to fill those roles should be encouraged, not blocked.

The delegation heard that the UK's competitors were Silicon Valley and China; although the UK had a small advantage in the English language.

Graduate schemes and recruitment

The delegation spoke with the organisers and some participants of The Guardian's graduate scheme[577], including hearing about recruitment.

Attracting and retaining top talent had to be based around what people wanted. The Guardian had a defined 'employee value proposition'; people wanted to work with the top talent, work on top projects and be rewarded and recognised.

The graduate scheme project had been about The Guardian growing its own top talent. The team visited the West Coast of the USA and every company there (bar one) trained their own talent. Talent for the graduate scheme was identified through testing for insight (the 'hows' and 'whys'); and why applicants wanted to work for The Guardian.

Desirable recruits had the following skills:

- Skills required for soft and hard [technical] roles: aptitude and problem-solving skills.
- The ability to pick up a new (computing) language.
- Behavioural skills.

On the topic of staff retention, the delegation was hold how there was a shift to a 'tour of duty' (2–3 years) for more junior employees.

'Next Gen' launch

Since the visit, The Guardian's in-house team completed an 18-month programme to deliver the global roll-out of its new responsive website,[578] which was developed using an open approach, taking in more than 130,000 pieces of user feedback. The new website was engineered around the needs of readers, with industry-leading load times and enhanced interactivity, functionality and responsiveness, regardless of the device it was viewed on.

577 The Guardian, 'Guardian Graduate Scheme': http://www.theguardian.com/workforus/guardian-news-media-graduate-scheme-2014 [accessed 9 February 2015]

578 The Guardian: http://www.theguardian.com/uk [accessed 5 February 2015]

Site visit #2: Google Campus

After visiting GMG, the delegation visited Google Campus near the Silicon Roundabout in East London for an informal discussion with Sarah Drinkwater (Google's Head of Campus), Guy Levin (Executive Director of Coadec) and a number of start-up companies.[579]

Introduction to Google Campus

In 2012 Google established its 'Campus' to equip entrepreneurs and start-ups with the resources they needed to develop and grow. Their mission was: "… to create an environment that encourages innovation through collaboration, mentorship, and networking".[580] The Campus was equipped with high-speed WiFi, a cafe, frequent networking and speaking events, and co-working space. The Campus was funded, facilitated and managed by Google, in collaboration with partners.

Key stats:

- There were 38,000 registered members of Campus, from over 90 countries.
- In 2014, Campus hosted 850 community events, ranging from 'hackathons'[581] and demonstration days, to conferences and workshops (all free of charge).
- Campus delivered 1,100+ hours of mentoring in 2014, where Googlers (employees of Google) gave advice to start-up companies on anything from Google products to marketing or product development.
- Campus start-ups raised an average of £75,000 each in 2013 and together the start-ups employed over 2,000 staff—a number that was expected to exceed 4,000 by the end of 2015.

Informal discussion

Unfortunately the visit was cut short due to a power outage and evacuation of the building. Nonetheless, key points raised during the discussion included:

- Campus was a networking space where entrepreneurs could find talent, advice and support from their peer group and from Google experts. Like the Android operating system, Campus adopted an 'open source' approach, providing a platform on which others could build in an open and unrestricted way. The cafe's Device Lab, meanwhile, allowed software developers to test new apps on tablets and phones for free.
- The building provided facilities for those at various stages of development, from the cafe workspace (where many members were at very early stages), to the co-working floors run by TechHub[582]. Desk space was £275 per month and a flexible membership was £375 per year (which allowed one day per week of desk space). Seedcamp[583], the fourth floor fund, supported later stage companies, and, when companies were ready to find their own space (usually when they hired a third/fourth team member), they could join one of TechHub's larger London offices and remain part of the community.

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579 Note: Mike Warriner, UK Director of Engineering at Google, provided oral evidence to the Committee on Tuesday 22 July 2014 (see QQ 40–52). Guy Levin provided oral evidence to the Committee on Tuesday 29 July 2014 (see QQ 53–65).

580 Campus London: https://www.campuslondon.com [accessed 26 January 2015]

581 Hackathons are events, typically lasting several days, in which a large number of people meet to engage in collaborative computer programming.

582 TechHub: http://www.techhub.com [accessed 5 February 2015]

583 Seedcamp: http://seedcamp.com [accessed 5 February 2015]

- The delegation was joined by a start-up company currently based at Campus (Knodium); and a growing start-up company that had previously been based there (Proversity):

  (16) Knodium[584] was a collaborative tool connecting researchers and university students; it was a platform that allowed students and academic staff to learn and share information in a safe, online environment. At the time of the visit, Knodium had been used in 107 universities in the UK, six in EU and one in Singapore.

  (17) Proversity[585] was a UK platform where employers designed courses to up-skill potential employees. It had 12 employees (and subsequently outgrew Campus space).

- Tech companies were looking to drive innovation; with London becoming a hub for innovation. The London sector was unique in terms of established industries, from the creative and advertising fields to finance. Campus contributed to the environment, but in terms of enhancing what was already there. The main comparison point, from London to Silicon Valley, was the diversity of culture and the sheer small scale of London—it was very easy to meet and collaborate in a small area like Shoreditch.
- In addition to London, Google also operated a Campus in Tel Aviv.[586] Over the course of 2015, Google planned to open Campuses in Madrid, Warsaw, Sao Paolo and Seoul. It also worked with partners across the world who ran co-working spaces to support entrepreneurs. In Europe this included The Factory[587] in Berlin and NUMA[588] in Paris.
- In each situation there were certain requirements—an incubator would not work in all areas. There needed to be a density of need, in terms of companies and skills. There was anecdotal evidence that the visibility of start-up tech companies acted as an inspiration to others.
- Knodium and Proversity raised the issue of immigration, specifically the fact that post-study work visa reforms had been detrimental. They suggested that this could be changed to allow third party bodies (for example venture capitalists or incubators) to sponsor students.

Google programmes aimed at addressing the digital skills gap

Further to the visit, Google highlighted programmes it had run in the UK over the past few years, intended to help address some of the digital skills gaps—from equipping people with basic online skills (such as how to write an email), to filling the growing number of highly specialised and sophisticated data scientist roles. These included:

- Improving skills of businesses: Over the past three years, Google's 'Getting British Business Online' project[589] helped 250,000 SMEs get online and grow through the use of social media, advertising and analytics.
- Improving skills of charities: The 'Grow Your Charity Online' project[590] gave non-governmental organisations a free online health check, step-by-

584 Knodium: https://www.knodium.com [accessed 26 January 2015]
585 Proversity: http://www.proversity.org [accessed 26 January 2015]
586 Campus Tel Aviv: https://www.campustelaviv.com [accessed 5 February 2015]
587 Factory Berlin: http://www.factoryberlin.com [accessed 5 February 2015]
588 NUMA: http://en.numa.paris [accessed 5 February 2015]
589 Getting British Business Online: http://www.gbbo.co.uk [accessed 5 February 2015]
590 Grow Your Charity Online: http://www.growyourcharityonline.com

step videos (for example, on how to increase reach or fundraise online), and access to up to £10,000 free Google advertising per month.

- Training young people: Google partnered with Arch to bring digital marketing apprentices into Google for six month periods. The first intake was a success with two being offered full-time jobs at Google and others going onto roles at the likes of Coca Cola.[591]
- Supporting professionals: Google partnered with Home Learning College, the UK's biggest online-learning college, to develop Squared Online[592] (an online course to help marketing and advertising industries improve their digital skills). Over 1,000 people have now been through the course in the UK.

BBC Blue Room and BBC Research and Development, Thursday 16 October 2014

The Committee visited the BBC Blue Room—the BBC's media technology demonstration team who explored the new and exciting ways audiences found, consumed, created and interacted with content—and BBC Research and Development.[593]

A delegation of Members from the Committee attended: Lord Aberdare, Baroness Garden of Frognal, Lord Haskel, Lord Janvrin and Baroness Morgan of Huyton (Chairman). The delegation was accompanied by Aaron Speer (Clerk), Emily Greenwood (Policy Analyst) and Thomas Cheminais (Committee Assistant).

BBC Blue Room

"The Blue Room was set up … by Huw Williams (previously Head of BBC Research and Innovation) to investigate the impact of the rapidly changing consumer marketplace in the context of potential new platforms for BBC output and the changing nature of consumer behaviour".[594]

The delegation received demonstrations of technologies from Lindsey Suter and Garry Green, including:

- new platforms and devices the BBC was currently using and developing to ensure it was leading the way in content delivery (news and non-news) and maximise audience appreciation through, for example: set-top boxes; entertainment consoles; connected TVs; smartphones; video capture devices; digital radios; 3D technologies; consumer cameras; tablet computers; apps; and e-readers;
- the latest industry equipment to deliver high quality programming, including a curved TV which allowed two users (wearing glasses) to view two different channels on the full-sized screen simultaneously;
- a smartphone that recorded 360 degree video, demonstrating how user-generated content would further impact the future of journalism and content production; and
- 3D printing.

591 Arch, 'Google Apprenticeships': http://www.archapprentices.co.uk/job/google-apprenticeships-10-vacancies [accessed 5 February 2015]
592 Squared Online: http://www.wearesquared.com [accessed 5 February 2015]
593 Note: Phil Fearnley, Director of BBC Homepage and myBBC, provided oral evidence to the Committee on Tuesday 2 September 2014 (see QQ 103–112).
594 BBC Internet Blog, 'The Blue Room': http://www.bbc.co.uk/blogs/legacy/bbcinternet/2008/02/the_blue_room_1.html [accessed 26 January 2015]

BBC Research and Development

The delegation then heard from the BBC's Research and Development (R&D) department. BBC R&D led the world in broadcast technology innovation and acted as a catalyst for the UK broadcasting industry as a whole. By working with partners in academia and industry, it delivered research and engineering that set standards used around the globe.

It was said that without BBC R&D, the UK's broadcasting ecology would risk being defined by interests that were outside the UK, primarily the Far East and the USA, which was where the majority of broadcast research took place. BBC R&D helped maintain the UK's position as a centre of excellence in broadcast and related technologies, and in setting its standards.

Some of the most significant advances in broadcast technology seen in the UK began in BBC R&D, such as Ceefax, Red Button, Freeview and High Definition Television (HDTV).

The delegation was told that the BBC's research activity provided value to the UK's broadcast industry by:

- providing risk capital for technological development. At the 2014 Commonwealth Games in Glasgow, BBC R&D exhibited its new IP Studio system, in which consumer electronics were used to provide a completely IP-based production. The system excited the industry, as the use of consumer electronic devices for production would vastly reduce the expenditure of broadcasters on broadcast equipment;
- providing a strong voice for the broadcast industry. The industry looked to the BBC for leadership, acting as an honest broker for new developments. This provided confidence to companies in the private sector to come in behind and invest in new technology; and
- providing a training ground for broadcast technologists. Many of the broadcast engineering industry workforce began their careers at the BBC, before going out into industry and developing their careers in the private sector. The research department within the BBC helped ensure that the UK retained a strong broadcast engineering industry.

The Hartree Centre, Wednesday 22 October 2014

The Hartree Centre was a HPC facility based in the North West of England, located in the Sci-Tech Daresbury Campus in Warrington.[595] The Centre looked at supercomputing, Big Data analytics and visualisation, which it tried to apply to industrially relevant problems. The Committee received numerous submissions on the importance of Big Data and the future need for data technicians. This visit, therefore, was intended to put such evidence into context and allow Members to see cutting-edge technology in action.[596]

A small delegation of Members from the Committee attended: Lord Aberdare, Lord Haskel and Baroness Morgan of Huyton (Chairman). The delegation was accompanied by Aaron Speer (Clerk) and Emily Greenwood (Policy Analyst).

595 The Hartree Centre: http://www.stfc.ac.uk/2512.aspx [accessed 26 January 2015]

596 Note: Michael Gleaves, Head of Business Development at the Hartree Centre, provided oral evidence to the Committee on Tuesday 22 July 2014 (see QQ 40–52).

Introductory talk: Cliff Brereton (Director of the Hartree Centre)

The Centre was located in a campus which was described as a 'scientific cluster development zone'—a number of other buildings within the campus were full of SMEs which were there specifically for their interaction with the science community. The Centre was seen as an attractive place for SMEs, as it provided an opportunity for them to form partnerships. People working at the Centre included engineers, chemists, life scientists, software developers, data scientists and mathematicians.

The Centre had four service offerings (or 'products'): collaborative R&D; new software and algorithms; training and skills; and platform as a service (allowing users to purchase time on the machines at the Centre). The delegation heard that the Centre worked towards introducing computational modelling to the UK and industry by using the line: "better products, developed faster and cheaper". More organisations were beginning to approach the Centre as they learnt about the opportunities offered by HPC. It was noted that the language between science and business was not compatible, and so the Centre reduced what it did into much simpler business terminology; for example, by highlighting that pension schemes could be modelled using HPC.

One of the Centre's key clients was Unilever (which had an office on-site that examined digital R&D), which formulated household products (mainly liquids). The Centre demonstrated to Unilever that it could simulate the mixing of formulas in the time it took to make a cup of coffee. Unilever's staff, however, had no experience of the skills needed to do so. Other clients of the Centre included Dyson, Syngenta, Infineum, Barclays, GSK, BAE Systems, Bentley, JPMorgan and IBM.

The staff preferred to see the Centre as a hub space. In particular, the Centre wanted to create industrial opportunities for universities—in the 18 months prior to the Committee's visit, 42 universities had worked with the Centre (all at different levels). The delegation heard that the Centre had started an MSc at Liverpool University: the 1st Semester was a classroom-based course, where students were taught general principles; 2nd Semester students worked in groups to take part in projects the Centre had previously completed for clients; and 3rd Semester students were put into real life ongoing projects with the Centre's clients. This course was intended to help industry identify potential employees.

Looking forward at what the Centre planned to do in the future, Cliff Brereton (Director of the Hartree Centre) noted four forces of change: industrial engagement; power; Big Data; and democratisation. He also highlighted the US Solve Report, 'The Exascale Effect: the Benefits of Supercomputing Investment for U.S. Industry',[597] which highlighted the importance of HPC to economies. Algorithms would be able to be used for interesting new things—for example, planning where to locate emergency vehicles. Software architecture must, however, keep up with hardware infrastructure. In relation to Big Data, it was noted that it could be used for the prediction of risk-based correlations (of concern to the Centre, Big Data was not mentioned in Tildesley Report, which focused on the benefits of modelling

597 Council on Competitiveness, *"Solve". The Exascale Effect: the Benefits of Supercomputing Investment for U.S. Industry* (October 2014): http://www.compete.org/images/uploads/File/PDF%20Files/Solve_Report_Final.pdf [accessed 26 January 2015]

and simulation[598]). Consequently, the Centre wanted to the take the lead on Big Data and democratisation to give the UK a two and a half year lead over the rest of the world—but there was a skills issue to address first.

In discussing the 'skills agenda', the delegation was told that the UK needed more people with coding skills in general—profound changes in the computational science discipline would require new skills to develop codes. Additionally, the delegation heard that Big Data needed to be a discipline in its own right and not just an adjunct. Mr Brereton stressed that the UK needed 'T' shaped learning—that is, a broad level of basic understanding, complemented with a deeper, more specific and detailed understanding of a particular subject. For example, with disease control, an understanding of pharmaceuticals would be the deeper skillset.

Demonstrations

Following the introductory talk and a tour of the Centre's machine room, the delegation received two demonstrations of the practical application of HPC:

- A prototype tool using an Xbox Kinect system, which allowed the user to visualise air drag. By stepping in front of the camera, the tool demonstrated through computational fluid dynamics how drag formed around a person, showing how different positions allowed for reduced or increased drag. This had useful implications—for example, for cycling and other sports.
- A 'disease map'. Using a large visualisation screen (not possible on a typical desktop or laptop screen), diseases were grouped near their associated metabolic pathways. Links and shading then identified where there was literature or references in the various publications (or lack thereof). This had a number of potential uses—for example, developing new hypotheses or reorienting how medication was applied. It could also identify which areas/diseases warranted further targeting and research.

Future industrial requirements: Dr Massimo Noro (Manager, Physical & Chemical Insights Group, R&D, Unilever)

Dr Massimo Noro (Manager, Physical & Chemical Insights Group, R&D, Unilever) noted that the world was changing, particularly due to the 'Internet of Things' (everything will have an IP address and chip). This would be available to everyone, however, so what gave Unilever a competitive advantage? Dr Noro's answer was speed: "Today, to out compute is to out compete."

The delegation was told that Unilever was aiming for superior product claims alongside speed and innovation; all this at the same time as a sustainable strategy. This could only be done in a digital way. The 'innovation loop'—where scientists look for new ingredients—was quicker if an element of HPC was added in.

Unilever was looking for the transformation of R&D through information and data; there were six pillars to Unilever's R&D, including digitally enabled R&D.

Dr Noro believed that culture—the way people used data—needed to change; data should be shared and people should be rewarded for sharing data (as shared data leads to greater innovation). In particular, the delegation heard that complex data should be presented in the simplest way for non-experts to use.

598 Mr Brereton highlighted the report sponsored by David Willetts in 2011 (chaired by Dominic Tildesley), which reviewed the UK's position in terms of computational science capability. It found that the UK had fallen behind competitors in relation to super computational machines, skills, and so forth. It also found that for every £1 invested in supercomputing, there was a return of £2 after 2 years, which increased to £5 after 5 years.

Unilever and the Centre had created an app for scientists to conduct virtual experiments on an iPad—for example, virtually mixing different concentrations of liquids. They could then see a virtual outcome of their experiment. This took about five minutes of computing time, saving time and costs. Unilever had products on shop shelves developed with insight from this app. The scientists did not need to know about the computer, processors, logs, simulators, and so forth—they used their expertise in chemistry to determine whether the results were what they wanted. Dr Noro said that computer use skills (data handling and data mining) and knowledge science were both needed.

Regional R&D hubs were important to allow Unilever to develop initial products. Now it could roll out products across the world; all that was needed was an internet connection.

It was stressed that science and industry together was a balanced mix and increased entrepreneurship; new companies added in different expertise. SMEs chose to come for the facilities and scientists they would not otherwise have had access to.

Imperial College London, Wednesday 19 November 2014

The purpose of this visit was to understand more about the use of supercomputers and HPC from the academic perspective (whereas the Hartree Centre had focused on industry). In particular, Imperial College London was regarded as one of the leading universities in the UK in relation to its use of supercomputers and HPC for academic purposes.[599]

A delegation of Members from the Committee attended: Lord Giddens, Lord Haskel, Lord Janvrin, Lord Kirkwood of Kirkhope, Lord Lucas, Lord Macdonald of Tradeston, Baroness Morgan of Huyton (Chairman) and Baroness O'Cathain. The delegation was accompanied by Aaron Speer (Clerk), Emily Greenwood (Policy Analyst) and Thomas Cheminais (Committee Assistant).

Welcome: Professor James Stirling CBE (Provost of Imperial College London)

Professor James Stirling (the College's Provost) told the delegation that the leadership of the College was unique in the UK as the role was split between the President (Alice Gast) and the Provost. Part of the President's role was to work with the large number of the College's international alumni. The Provost was responsible for the management and oversight of the core academic mission: teaching, research and translation.

Professor Stirling gave a brief background to the College. He told us:

- The College was ranked as one of the world's best universities. QS World university rankings put the College joint second globally (with Cambridge), behind MIT (The Massachusetts Institute of Technology). The College had a reputation as a centre of excellence in innovation. This was achieved by recruiting the very best students and staff (more than half of the College's students came from abroad)—all of whom expected and deserved world class infrastructure, particularly digital infrastructure.
- The College had invested heavily in digital infrastructure recently to ensure it continued to attract the best people and keep pace with its competitors. Two recent developments were:

  (1) HPC now focussed on heavy duty numerical calculations to enable simulations of complex systems; and

599 Imperial College London: http://www3.imperial.ac.uk/ict/services/hpc [accessed 2 February 2015]

(2) the emergence of enormous data sets (including those generated from HPC).

- The College had established a new cross-faculty Data Science Institute (DSI) in recognition of this large area of work within the College. The College had always been at vanguard of HPC and had appointed a HPC champion—Peter Haynes. As such there was a need to continuously invest in HPC. Calculations were getting more challenging and competitors were investing heavily. The College had committed £10 million of investment over the next five years to remain competitive.
- 20–30 years ago HPC was supporting individual subjects—such as physics and mathematics—now it was used across the College from aeronautics to clinical science. There was a community of around 300 HPC users—this ranged from professors and lecturers, to PhD and Masters students.
- The College was in the process of developing its new campus (Imperial West). This would be developed over the next 15–20 years at a cost of approximately £3 billion.

Professor Stirling outlined engagement and funding at the College:

- The College engaged with various external stakeholders, such as schools. It was doing more with industry too. For example, inviting companies and SMEs to share space on the new campus. The new DSI had attracted a lot of interest from business and industry. For example, in 2014 the KPMG Centre for Advanced Business Analytics was established under the DSI umbrella. A large international communications infrastructure company was also interested—which could subsequently help with inward investment in the UK.
- Student entrepreneurship was encouraged. It encouraged undergraduates to think 'outside of the box' of their core studies. The College had incubation facilities for students and university spin-out companies. There had been a change in culture at universities; academics nowadays thought much more about applications of their research outside of their main area. This focus on impact was partly the result of the Research Excellence Framework system for assessing the quality of research in UK Higher Education Institutions, for which 'impact' was a key criterion.
- The College also received funding from the EU. Every time there was a new framework programme, effort was made to inform members of the College of opportunities in their area. The total volume of research income per annum was around £450 million, within a turnover of £850 million. The College welcomed the Government's introduction of 'full economic costing' methodology; but there was in practice an overhead recovery issue—like all universities, the College rarely recovered 100% of the full costs of carrying out research.
- The College was a member of the Athena SWAN Charter and held a Silver institutional award. The Athena SWAN Charter recognised commitment to advancing women's careers in science, technology, engineering, mathematics and medicine employment in academia. The College had excellent female academic role models, including the Head of Computing and President. Imperial College was on a journey, however, to improve this representation—for example, by aiming for more women in senior roles. The 'leaky pipeline' (whereby the percentage of women in academic posts decreased as you moved up the career ladder) remained an issue across all disciplines.

- Joining-up data science: the College was bidding to host the Turing Institute in partnership with other UK leading universities, including Oxford, Cambridge and University College London.

Demonstrations

Following a tour of the College's Data Centre, the delegation was provided with two presentations on the practical uses of HPC within the College.

Presentation 1: Dr Gerard Gorman

- From a research perspective Dr Gerard Gorman said that while the Research Councils were the main providers of research funding, industry also played an important role. Funding revenues from industrial collaborations included Intel, BG Group, Rio Tinto, Total and Rolls Royce. The College had a strong track record of collaborating with industry, both through academic connections with industry or through industry directly approaching the College with a project or problem that required a solution. This level of industrial engagement, however, was the exception rather than the rule. Despite this the UK was at the bottom of investment in R&D when compared to other countries, with South Korea and Japan leading the way.
- Researchers were very willing to adapt to new technologies to remain competitive; open to new ideas to remain a leading player in a highly competitive sector. Being able to simulate was key for new designs and using local plus national HPC facilities. For instance, HPC could produce simulations of airflow over various design modifications.
- Creating software was easy to get wrong, but when you got it right it you could build up an infrastructure you could keep reusing—for example coding for Formula 1 designs could also be reused for wind/water turbines.
- 94% of all small and medium manufacturers in the USA had not yet adopted high-performance digital manufacturing. By 2020 it was predicted that 98% of all products would be developed and manufactured digitally.[600]
- Users were required to have multidisciplinary skills. Traditional skills in physics, mathematics, geophysics and so forth needed to be combined with digital skills such as computer science, software engineering, HPC, programming languages, and so on. Undergraduates were some of the best nationally and internationally, but individuals with complete skillsets were rare. People tended to be good consumers, but poor producers. Student intake needed to be trained up in programming.
- There had been national and international cooperation to develop training materials for computer programming. After trial and error, the College had a successful programme and students were happy with how they were taught.
- There was rapid democratisation of digital skills; creating an entrepreneurial spirit through broad base training, hackathons and impact challenge competitions.
- Dr Gorman's wish list was:

  (a) Pair capital spending with investment in people and software development. Enhance private partnership; researchers required funding streams to support people and software development.

600 National Center for Manufacturing Sciences, 'Digital Manufacturing SIG': http://www.ncms.org/index.php/programs/digital-manufacturing-initiative/digital-manufacturing-sig [accessed 26 January 2015]

(b) Expand knowledge transfer/impact funding and make it more flexible. Eliminate barriers where possible. For example, innovation was a high-risk, high-gain enterprise. Requirement for 30%/50% contribution from SMEs was often viewed as unrealistic.

(c) Recognise computational science as a discipline in higher education. There were no established career paths. This was challenging for sustainable research dependent on science and engineering software.

(d) Government match funding: a new system was needed—but this was difficult to do.

(e) Although the College trained up lots of international students in these skills, visa restrictions meant they could not be kept in the UK. Visa rules for international students were very limiting.

Presentation 2: Dr Arash Mostofi

- Ages of human civilisation were marked by use of materials (for instance, Stone Age, Iron Age, and so on). Materials were ubiquitous—they were diverse with a range of uses; wider now than at any other period in history.
- It was about exploiting the properties of materials and getting them to do what we wanted. This was important given the big challenges the world faced: key challenges going forward would be in relation to the environment, energy and healthcare.
- Computer simulation was a third pillar of science alongside theory and experimentation. The theory and simulation of materials could help come up with solutions. For example, materials that could absorb and use solar energy more efficiently; or membranes that could desalinate water more efficiently and cost effectively.
- This narrative inspired potential students.
- Algorithms and software have had to keep pace with the increase in computational power. As computing power increased, you also had to improve the efficiency of algorithms. This highlighted the continued importance of people: "People are synonymous with software". If there was an increase in computing power, without the simultaneous advancement in algorithms and software, the benefit of this increased power would not be seen.
- If hard work was put into software, you could apply it to a diverse range of issues. It could be very general and used widely.
- Graduate students within the College were exposed to diverse career possibilities during their training, and not just academia. Alumni had moved on to a wide range of careers, including major international corporations and CEOs of their own digital start-ups.

Overview discussion

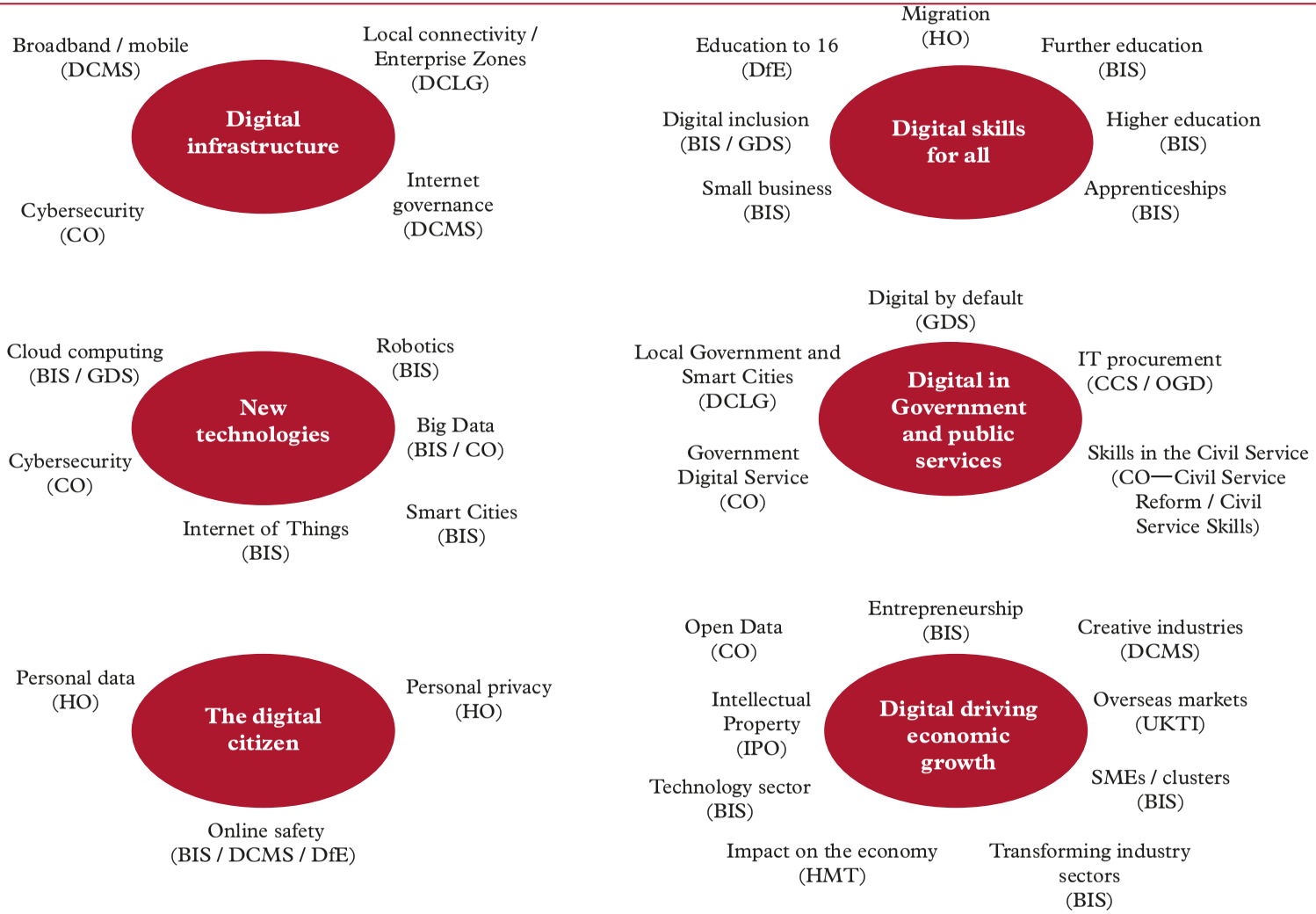
Following the presentations, the delegation engaged in a discussion with College staff. Some of the key points raised included:

- SMEs were concerned about the security of data (for competitiveness, industrial espionage, and so forth), and so they were uncomfortable with cloud computing. There was also an understood risk of the Government procurement of data. The difference at the university when interfacing with the customer was that there were the people at the university who wrote the code, knew the limitations and knew how to get the best out of them; they

could tailor for specific needs. Cloud was remote and did not have that; this was a university selling point.

- Recommendation: there was a role for universities in business. Costing would be done on an economic basis; either contract or ad hoc. A barrier was that core rent rules required 30–50% commitment from a small company. A lot of engagement showed that this was not going to happen; SMEs did not have flexibility and funding. In the USA there were specific Government pots of cash to support SMEs.

APPENDIX 9: GOVERNMENT INITIATIVES



Source: Written evidence from HM Government (DSC0084). See Appendix 4 for list of acronyms.

APPENDIX 10: SCOTLAND'S DIGITAL STRATEGY

The Scottish Government published a digital strategy in 2011,[601] which described a series of actions designed to ensure that Scotland was well positioned to take advantage of the opportunities of the digital age. It set out an integrated approach including "action to develop digital infrastructure, promote digital participation, stimulate the digital economy and promote the use of digital public services".[602] Reports on the progress made in implementing Scotland's digital strategy are published annually.[603]

Section three from Scotland's digital strategy, 'Growing a Digital Economy', is included below, to serve as an illustration for the UK.

"3 Growing a Digital Economy

"We want Scotland to be at the forefront of the digital economy

"Digital technologies are widely recognised as an enabler of productivity and a driver of innovation and international trade, helping to boost jobs and export income. They will underpin growth and help all of Scotland's industries to transform and prosper, while enabling greater engagement from remote communities.

"Our 'Low Carbon Economic Strategy' (published in November 2010)[604], sets out how Scotland can secure the transition to a low carbon economy. Digital technologies will be an integral part of that transition by, for example:

- replacing goods and services with virtual equivalents
- allowing more efficient use of energy
- offering virtual technologies that allow online shopping, teleworking and access to online public services

"Digital technologies will be an integral part of our transition to a low carbon economy

"The European Union recognises the importance of a flourishing digital future, and its commitment to supporting member states and local authorities with its roll-out is welcomed. The Digital Agenda[605] is one of the flagship initiatives of the EU 2020 Strategy. Its overall aim is, by 2020, to deliver sustainable economic and social benefits from a digital single market, based on next generation broadband networks and fully integrated ICT (information and communications technologies).

"The UK Government recently published its broadband strategy 'Britain's Superfast Broadband Future'[606] which outlines the positive impact of UK-wide next generation broadband on gross value added to employment and the overall economy. We are working closely with the UK Government to ensure that Scotland achieves the best outcomes from this strategy.

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601 Scottish Government, *Scotland's Digital Future: A Strategy for Scotland* (2011): http://www.scotland.gov.uk/Resource/Doc/343733/0114331.pdf [accessed 5 February 2015]

602 Written evidence from Scottish Government (DSC0128)

603 Scottish Government, 'Scotland's Digital Future': http://www.scotland.gov.uk/topics/economy/digital [accessed 5 February 2015]

604 Scottish Government, *A Low Carbon Economic Strategy for Scotland* (2010): http://www.scotland.gov.uk/Resource/Doc/331364/0107855.pdf [accessed 5 February 2015]

605 European Commission, 'Digital Agenda for Europe': http://ec.europa.eu/digital-agenda/digital-agenda-europe [accessed 5 February 2015]

606 BIS, *Britain's Superfast Broadband Future* (December 2010): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/78096/10-1320-britains-superfast-broadband-future.pdf [accessed 5 February 2015]

"Action 3.1: We will continue to ensure that action taken in Scotland builds on, and adds value, to that carried out at a UK and European level.

"Maximising future economic opportunities for Scotland

"Scotland's enterprise agencies, Scottish Enterprise (SE) and Highlands and Islands Enterprise (HIE) will play a critical role in helping us to deliver a world leading digital economy.

"Current and future digital opportunities for businesses in Scotland must be fully understood and realised. We are gathering views from a wide range of sources, for example, through the Industry Advisory Groups, consultation with key players and workshops with businesses. SE and HIE have recently undertaken a series of workshops with senior business leaders from across Scotland. These workshops are helping to identify strengths and opportunities, future job prospects and potential skills needs.

"In October 2010, the Technology Strategy Board (TSB) published a Digital Strategic Update[607]. This outlined how the TSB will help business unlock economic potential by addressing digital challenges and helping to bridge the gap between people, processes and technology. We are keen to see greater buy-in to TSB opportunities and encourage more Scottish partners to get involved. To achieve this, Scotland hosted a visit of the TSB's Digital team in November 2010 and a number of priority actions have been identified.

"Scotland's enterprise agencies will play a critical role in helping us to deliver a world leading digital economy

"Role of Scotland's Colleges and Universities

"Scotland's colleges and universities have a vital role in stimulating and supporting the digital economy. Through the Scottish Funding Council (SFC), we support colleges and universities by:

- ensuring Scotland has the right skills needed by industry, and by inputting courses to the curriculum. This includes programmes such as Digital Media and ICT Vendor Alliance (DIVA), and the E-Skills Placement Programme where we will place 750 students from universities and colleges across Scotland in IT companies
- the exchange of research, development and knowledge with business and industry through, for example, the Digital Design Studio at Glasgow School of Art. Joint ventures include the 'Scottish Ten' an ambitious 5 year project in partnership with Historic Scotland to create digital models of heritage sites.

"Action 3.2: Working through Scottish Enterprise, Highlands and Islands Enterprise, and other partners, we will undertake development work to map and understand future priorities for Scotland in relation to the digital economy and develop an aligned action plan on how to take this forward, including potential opportunities from the Technology Strategy Board during 2011.

607 Technology Strategy Board, *Digital Strategic Update* (October 2010): http://webarchive.nationalarchives.gov.uk/20130221185318/www.innovateuk.org/_assets/pdf/corporate-publications/tsb_digitalstrategicupdatev2final.pdf [accessed 5 February 2015]

"CASE STUDY: 3D Digital Design

"The Digital Design Studio (DDS) is a postgraduate research and commercial centre at Glasgow School of Art. It focuses on the interface between science, technology and the arts to explore imaginative and novel uses of advanced 3D digital visualisation and interaction technologies.

"In 2007, collaboration between Glasgow City Council and the DDS produced the Glasgow Urban Model, a unique 3D online tool mapping the city centre and River Clyde corridor down to a scale of just 20 cm. A world-first when launched, the model presents a wealth of practical applications for urban planners and emergency services as well as architects and developers. For tourists and students across the world, the model provides a showcase for the city's world-famous architecture and heritage and demonstrates the city's potential to business investors. The model also offers a way of generating income, with developers and architects able to obtain licenses from the City Council to use the data.

"Application of digital technologies are a significant driver of innovation in Scotland's creative industries and are also creating new markets. Scotland's creative industries have significant strengths and are one of the key sectors of the Scottish economy under the Scottish Government's Economic Strategy. They account for 3% of Scotland's employment (63,000 jobs in total) and 4% of its GDP.

"Application of digital technologies are a significant driver of innovation in Scotland's creative industries and are also creating new markets

"As well as being economically important in their own right, the creative industries have 'spillover' effects as catalysts for growth in other areas. For example, they prompt technological innovation and new thinking in areas such as design or computer games manufacture. A strong cultural and creative sector can also help to make regions more attractive places to live for highly skilled workers in other sectors of the economy.

"Virtually all sub-sectors of the creative industries are affected by technological change, and some, such as publishing, may be transformed by it. Individual companies will need to seize available opportunities. But it is equally important that the public sector offers an aligned and supportive approach to help them to do this, for example, through skills development or targeted investment.

"For this reason, the Scottish Creative Industries Partnership (SCIP) co-ordination group has been established. The group is chaired by Creative Scotland, and brings together COSLA, SE, HIE, Skills Development Scotland (SDS) and the SFC. SCIP has also established industry-led reference groups to inform its thinking on the challenges and opportunities facing different sub-sectors within the creative industries.

"Action 3.3: We will shortly publish our Creative Industries Strategy, which has been developed in collaboration with the SCIP co-ordination group. The Strategy will be consistent with the aims of this Digital Strategy, and will emphasise the importance of ensuring that the creative industries are equipped to prosper in a period of rapid technological change.

"The Digital Media Industry Advisory Group published its Digital Inspiration report in December 2009[608]. This outlines recommended actions for the public and private sectors to develop Scotland's digital media industries, for example digital content producers, distribution platforms or networks. The report focusses on encouraging innovation, promoting the development of interactive platforms, putting in place the right physical infrastructure, supporting internationalisation and seeking to boost investment for the sector.

"Since then, Scottish Enterprise has established Interactive Scotland, a new service to provide expert support for digital media companies to help turn their ideas into business opportunities. Interactive Scotland has managed or supported many events since it was founded, on themes such as music business innovation and social media.

"A recent Interactive Scotland[609] event explored how social networking such as Twitter, Facebook and LinkedIn could be used to help businesses give an edge over competitors and build a powerful online presence to communicate directly with clients, potential clients and end users.

"Business use of broadband

"The Scottish Government's new research[610] on the use of broadband by Scottish businesses is being published alongside this strategy. This work includes a survey of 1,000 SMEs (small to medium-sized enterprises) and micro-businesses (businesses with 0–9 employees).

"A striking statistic is that around 25% of those businesses surveyed do not use the internet at all, with most of this 25% showing no intention of doing so in the next three years, believing the internet to have little relevance to their business. One reason given by survey respondents for non-use relates to lack of adequate IT skills. Cost was not cited as the main barrier.

"Of the 75% who do use the internet, it tends to be mainly for email and web searching. And whilst the report indicates that more advanced use of the internet is taking place, these users are in the minority. Examples of more advanced use include social media, access to remote file systems and cloud computing.

"This apparent under-use of the internet could be seen as a missed opportunity in driving innovation, increasing productivity and, ultimately, contributing to sustainable economic growth in Scotland. We acknowledge that some businesses may not need to use the internet. However, we firmly believe that better use of the internet and the opportunities it presents can improve business productivity and profitability.

"Around 25% of SMEs do not use the internet at all, with many of these believing it to have little relevance to their business

"Under-use of the internet is a missed opportunity in driving innovation and, ultimately, contributing to sustainable economic growth

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608 The Scottish Digital Media Industry Advisory Group, *Digital Inspiration: Strategy for Scotland's Digital Media Industry* (December 2009): http://www.scottish-enterprise.com/~/media/se_2013/documents/scotland%20digital%20inspiration%20strategy%20pdf.pdf [accessed 5 February 2015]

609 Scottish Enterprise, 'Interactive Scotland': http://www.scottish-enterprise.com/services/develop-your-organisation/interactive-scotland/overview [accessed 5 February 2015]

610 Scottish Government, *Research on Broadband and Business in Scotland* (March 2011): http://www.scotland.gov.uk/Resource/Doc/342391/0113934.pdf [accessed 5 February 2015]

"The survey also highlights that businesses with stronger growth ambitions are more likely to view reliable high speed broadband as very important, indicating that digital technologies could help boost global exports through online marketing and trading.

"The Boston Consulting Group recently reported[611] that online sales for SMEs grew at a faster rate for larger companies over the period 2004–8 and those companies that are selling their goods and services online are seeing overall sales growth significantly higher than those that don't.

"In the retail sector, the Scottish Government is undertaking research (publication expected in March 2011) assessing the contribution of retailing to the Scottish economy. One specific area is the importance of e-commerce to the retail sector.

"SDS will publish a report in March 2011 looking at the supply and demand for e-commerce skills in Scotland. We will be examining the report's outcomes and exploring with SDS and other partners how any skills gaps identified could be addressed. More generally, as part of our work on action 3.4, we will ensure that the value of e-commerce is fully recognised by Scottish business.

"Action 3.4: We will work in partnership with Business Gateway, Scottish Enterprise and Highlands and Islands Enterprise to explore how we might best encourage the 25% of Scottish businesses currently not online, to get online, and to support the 75% already online to make better use of the broadband that is available to them.

"CASE STUDY: britishbusiness.co.uk

"The Getting British Business Online (GBBO) initiative is a collaboration between Enterprise UK, Google, BT, and e-skills UK, with support from the Department for Business, Innovation and Skills. GBBO's aim is to help SMEs create their first website and help them understand the opportunities offered by the Internet. GBBO estimates that there are at least 1.5 million businesses in the UK that don't yet have a website. Following a campaign during 2010, GBBO achieved its target of helping 100,000 UKSMEs get their first website by the end of 2010.

"Scottish Business Portal Programme

"The Scottish Business Portal Programme will deliver a primary portal for Scottish business, offering easier online access to relevant UK and Scottish business transactions, regulatory information and other guidance and services through the Business Gateway website. These improvements will start taking place during the course of 2011. We are developing this in partnership with our public sector partners, particularly local government, and in collaboration with business organisations to ensure that the website meets the needs of businesses of all sizes and in all sectors across Scotland. This work takes advantage of investment by the UK Government in the BusinessLink website, including the provision of online tax, VAT and Companies House transactions.

"The Business Portal Programme will deliver both cost savings and productivity

611 Boston Consulting Group, *The Connected Kingdom: How the Internet is Transforming the U.K. Economy* (2010): http://www.bcg.com/documents/file62983.pdf [accessed 5 February 2015]

benefits to business and public sector efficiency savings.

"Rural economic growth

"We recognise that good broadband connectivity is an enabler of economic growth in rural areas. However, we are aware that parts of rural Scotland are not able to exploit or benefit fully from digital opportunities.

"The combination of poor connectivity and limited ICT skills can lead to digital exclusion for many people. It can also increase the 'digital divide' and lower opportunities for learning, reduce access to public services and inhibit business growth. In turn, rural areas may lose their competitive advantage and be seen as less attractive places to do business. The recent 'Speak Up for Rural Scotland' consultation[612] highlighted broadband as the key issue, recognising broadband as a vital measure to support economic growth in rural areas. The Scottish Government's response to the consultation will be published in March 2011. Action to address rural connectivity is described in more detail in Chapter 5.

"During 2011, HIE is looking to provide additional support in the highlands and islands region to:

- Improve connectivity (including the Highlands and Islands next generation broadband project (described in more detail in Chapter 5)
- Provide ICT business and community support
- Develop ICT skills and digital participation
- Grow the ICT supply chain consistency

"Flexible working

"Broadband and ICT are crucial for flexible working practices such as home working or working remotely. These technologies can increase participation in the labour market and change various aspects of working life. These developments (coupled with changing attitudes amongst workers and employees, and requirements on employers to consider flexible working arrangements) continue to make working remotely more feasible and widespread.

> "A report on home businesses published by Enterprise Nation in 2007[613] showed that over 60% of all new businesses were started from home, and that out of the 4.5 million SMEs in the UK, 2.1 million were home-based. The fastest growing homeworking sectors were in the business/professional areas, online trading, personal services, food and domestic energy. The 2008 National Centre for Social Research Omnibus Survey and the National Travel Survey indicated that 3% of workers always worked from home and 7% did so at least once a week.

"The Scottish Government has a progressive scheme on flexible working which covers all its staff, not just those with children. Many large organisations actively promote flexible or home working and we would encourage all organisations to consider it. Both SE and HIE provide advice on the use of ICT for remote and home working, as part of a wider package of advice they offer to Scottish businesses."[614]

612 Scottish Government, 'Our Rural Future': http://www.scotland.gov.uk/Topics/farmingrural/Rural/speak [accessed 5 February 2015]

613 Enterprise Nation, *Home Business Report* (2007): http://www.scribd.com/doc/43354992/Home-Business-Report-2007?in_collection=2728400 [accessed 5 February 2015]

614 Scottish Government, *Scotland's Digital Future: A Strategy for Scotland* (2011): http://www.scotland.gov.uk/Resource/Doc/343733/0114331.pdf [accessed 5 February 2015]

APPENDIX 11: SWEDEN'S DIGITAL AGENDA

Sweden is a leading digital economy. Its digital agenda, entitled 'ICT for Everyone',[615] has at its core a set of policy objectives aimed at embedding the internet and digital technologies and skills across the population.

An extract from Sweden's digital agenda is included below, to serve as an illustration for the UK.

"ICT policy objectives

"In its budget bill for 2012 (Government Bill 2011/12:01), the Government has proposed that earlier ICT policy objectives and interim targets … on growth and quality should be cancelled and replaced by the following ICT policy objectives.

"Sweden will be the best in the world at exploiting the opportunities afforded by digitisation.

"Provided the Riksdag (Swedish Parliament) votes in favour of the Bill, the Government's work will be focused on this objective. Regarding the goals for accessibility, it is proposed that the goals stated in the bill Accessible Electronic Communications (Government Bill 2009/10:193) should continue to apply. The objective is that Sweden shall have world-class broadband. All households and businesses should have good opportunities to use electronic public services with broadband access.

"Sweden today is strongly placed in the field of ICT, which is also evident in international comparisons. According to the Network Readiness Index[616] compiled by the WEF, for example, Sweden has the best conditions and makes best use of ICT. This index measures national conditions for the development and spread of ICT, business climate, some regulatory aspects, human resources and access to hard infrastructure for ICT. In addition, readiness and interest is measured among three main groups of stakeholders: individuals, businesses and government. Finally, current use of ICT among the three main groups of stakeholders is also measured. Sweden is followed in the ranking by Singapore, Denmark, Switzerland and the United States. Sweden also comes out top in the Digital Economy Rankings for 2010[617], which compares the level of different countries in the information society, closely followed by Denmark, which had previously headed the rankings. In comparisons of the competiveness of different countries, Sweden is in the top group. In the Global Competitiveness Report[618] for 2010–2011, for example, Sweden is ranked second after Switzerland, which means that it has overtaken both Singapore and the United States since the previous reporting period.

"Sweden has a strong ICT and telecom sector and a solid tradition of research and innovation, which has resulted in new services and products and leading companies. It was, for example, in Sweden that modern mobile telephony was invented and developed. A large proportion of the Swedish workforce is employed in the ICT

615 Ministry of Enterprise, Energy and Communications, *ICT for Everyone: A Digital Agenda for Sweden* (November 2011): http://www.government.se/content/1/c6/18/19/14/70f489cb.pdf [accessed 7 January 2015]

616 WEF, *The Global Information Technology Report 2010–2011* (2011): http://www3.weforum.org/docs/WEF_GITR_Report_2011.pdf [accessed 2 February 2015]

617 Economist Intelligence Unit, *Digital economy rankings 2010: Beyond e-readiness* (June 2010): http://graphics.eiu.com/upload/EIU_Digital_economy_rankings_2010_FINAL_WEB.pdf [accessed 2 February 2015]

618 WEF, *The Global Competitiveness Report 2010–2011* (2010): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2010–11.pdf [accessed 2 February 2015]

sector or in ICT-related professions in other sectors. ICT also strengthens other key sectors in Sweden such as the defence industry, the pharmaceutical industry and the engineering industry. What has contributed to this is that Sweden has a high level of education, high use of ICT and interest in new technology, as well as good access to ICT infrastructure. In addition, Sweden introduced competition-promoting regulation of the telecom market at an early stage.

"Although Sweden has a top ranking in most international comparisons, there are areas where its position is weaker. These include conditions for companies and their use of ICT. Four indicators in the rankings referred to above in which Sweden is less well placed point in this direction. Companies' use of ICT is an important driver contributing to increased prosperity and economic growth. It is important that Sweden continues to strengthen its position in all areas.

"The objective of the Digital Agenda for Sweden can be related to the rankings referred to above, in that according to these or other similar ratings, Sweden is to be among the best nations in the world. However, it is also important that Sweden achieves a top ranking in other areas such as gender equality in the ICT sector, democracy and human rights, not covered by the studies mentioned above. This may, for example, relate to measuring the ability of schoolchildren to use computers. To create motivation and harness resources, there is a need for an overarching goal that marks out a desired direction where all stakeholders, individuals, businesses and organisations as well as municipalities, county councils, regional co-operation bodies and government agencies can contribute to Sweden's overall Digital Agenda.

"ICT policy aims in relation to other goals

"All government policy is covered to varying degrees by ICT policy, while the governing objectives for each area also encompass issues that lie outside ICT policy. This means that certain issues encompassed by ICT policy are also governed by objectives for other areas. An example is e-government, which is encompassed by ICT policy while the objective of administrative policy is what governs. Another example is the objectives for information security, where issues of everyday security come under ICT policy, while the whole area at the same time is governed by the objectives of information security for society.

"Strategic areas

"There is a need for action in several areas to attain the objective of the agenda and face up to the challenges that exist at both the global and national levels. Four strategic areas at an overarching level have been developed based on the perspective of the ICT user:

- easy and safe to use,
- services that create benefit,
- the need for infrastructure and
- the role of ICT in societal development.

"There are several sub-areas in each strategic area that represent the substantive issues the Government is actively working on.

"The introductions presented for each sub-area are not interim targets that have decided upon but express the Government's aspirations in ICT policy.

"Easy and safe to use

"At a time when more and more aspects of society are becoming digital, it is important that everyone can make use of the opportunities that are created. This entails, for instance, being able to use the Internet and other digital services in everyday life as a individual, entrepreneur or employee. The vast majority of Swedish people today use ICT and the Internet more or less regularly. But there are also those who are either unable or unwilling to make use of the opportunities offered by digitisation. These are mainly elderly people, but also include younger citizens, business owners and consumers, and the reasons include lack of trust in the Internet, lack of digital know-how or economic circumstances that prevent them from participating.

"Services that create benefit

"There is a need for attractive and easy-to use digital services for different aspects of life. To meet these varying needs, there is a need for a large and varied supply of services that are developed by both private and public actors. The development of new and better services encourages the use of digital channels and contributes to making established sectors and organisations more efficient while at the same time new creative ideas, innovations and business models are emerging.

"Need for infrastructure

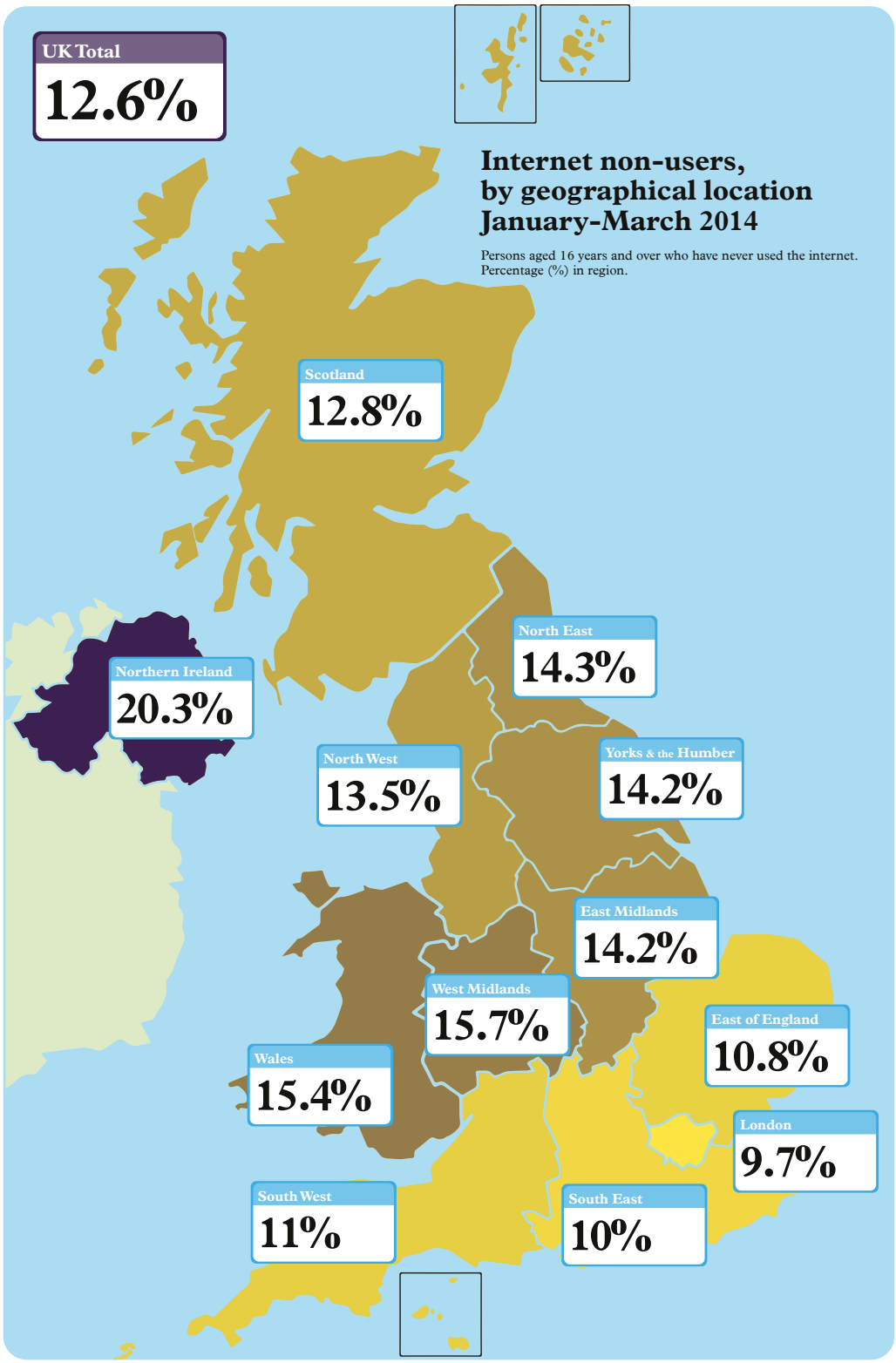
"To enable digital services to be used and offered, there is a need for a basic infrastructure with electronic communications that work well. The Internet as a carrier of services has to be accessible and robust, and the information transmitted online has to be processed in a secure manner. Successful work on the administration of the Internet and Internet standards, both nationally and internationally, is of crucial significance here. An important condition that needs to be met is good access to telephony and broadband in all parts of the country. The basic principle is that this should be provided by the market, and continued investments are needed in all parts of the country. The physical infrastructure therefore has to be built in such a way that data traffic works even if disruptions or outages occur. Geographical information of good quality is important for services that are dependent on location-bound information.

"The role of ICT in societal development

"Increased digitisation affects all societal processes and structures in Sweden and at the global level. ICT developments leads, for example, to the rules intended to protect personal privacy, secrecy, copyright etc. often needing to be adapted in order to respond to the changed circumstances to which technological development gives rise. Several of the most important factors for ongoing changes in society at the national and global levels come from the development and use of IT. Examples are the role of ICT for a more sustainable society, for global development, how research and innovation can be pursued, how people can exercise their freedom on the web, and modernised forms of democracy, participation and insight through increased transparency in the implementation of development assistance etc."[619]

619 Ministry of Enterprise, Energy and Communications, *ICT for Everyone: A Digital Agenda for Sweden* (November 2011): http://www.government.se/content/1/c6/18/19/14/70f489cb.pdf [accessed 7 January 2015]

APPENDIX 12: INTERNET NON-USERS BY GEOGRAPHICAL LOCATION



Source: ONS, 'Internet Access Quarterly Update, Q1 2014': http://www.ons.gov.uk/ons/rel/rdit2/internet-access-quarterly-update/q1-2014/stb-ia-q1-2014.html *[accessed 29 January 2015]*