The Institution of Engineering and Technology (IET) response to the House of Lords call for written evidence: “Digital Skills in the UK”

5th September 2014

1. The IET\(^1\) is Europe’s largest professional engineering and technology organisation. The members represent a wide range of expertise, from technical experts to business leaders, encompassing a wealth of professional experience and knowledge.

The changing technological landscape:

What is the pace and change of the future digital technology landscape over the next 5, 10 and 15 years? What are the leading innovations?

2. The technology landscape will see increasing society dependence upon mobile digital technology for information, entertainment, e-commerce, health and fiscal transactions, enabled by ubiquitous wireless services with seamless handover between them e.g. fourth generation (4G) and fifth generation (5G) mobile technology, through short range wireless technologies akin to Wi-Fi. To avoid very high infrastructure bandwidth requirements (and thus cost) multicasting technologies will be developed for popular entertainment. See the IET’s Demand Attentive Networks\(^2\) paper. These services will feature dynamic usage charging.

3. Current broadcast media services will slowly migrate towards on-demand services delivered in the manner similar to that of the Internet. Digital Terrestrial Television is likely to retain a central role over the next 10 years, with a full switch to alternative technologies such as Internet Protocol Television (IPTV) not appearing feasible until at least 2030\(^3\). Increasingly, society will become familiar with their choices being monitored and used to offer tailored content and services. Increasingly, digital technology will become a new enabling technology, or essential technology, in most work activity whether driving a vehicle, for example, or carrying out a surgical procedure. The presence of digital assist may be overt or covert. Society will become used to their health being monitored by personal digital devices with preventative healthcare measures being recommended sometimes before they are aware of any adverse health issues. Digital technology will increasingly support the elderly, to live safely, comfortably and well at home, and be less reliant on needing to visit and use health services. Digital technology will develop means for the elderly to remain socially engaged from their home.

4. As we see the number of devices connected to the Internet climb to an estimated 50 Billion by 2020\(^4\), the generation of an unprecedented volume of valuable data emerges. This data will be created, as we have already seen, within the current “Internet of People”, and increasingly by the predicted “Internet of Things”. The latter may take just 10 to 15 years to reach the current data size of the former, as “people” will be interacting with the “things”.

5. Storing, handling and processing this amount of data presents technical challenges, however there is an opportunity for society to address these issues.

6. Data science also known as “Big Data” will evolve to monitor and analyse in real time geographical surroundings, and the environment, to keep society in general, and the individual in particular, safe from harm. Data science will similarly be used to inform national and local services to improve transportation, energy efficiency, utility and infrastructure availability.

7. There are already examples of Big Data analytics providing revolutionary societal benefits, for example, human genome decoding is about to become economically viable for mainstream consumers. Predictive, proactive medical action is being taken across the community, with the potential to extend and enhance life expectancy. Data analytics is in its infancy. It is envisaged to have great potential as the science; comprehension; and know-how develop over the next 5 to 10 years. Regulatory oversight of many of these applications is envisaged to ensure compliance with various legal statutes e.g. Data Protection Act and the Common Law duty of Confidentiality.

8. The Big Data key digital skills are in software development, rapid algorithm data scanning using averaging and statistical techniques to pin point data seams and extract the value instantly. These are new skills, rare today but will form the basis of societal economic success in the future. These skills are not dependent upon a vast physical infrastructure and can be developed and utilised by a broad section of the population. In addition, their use does not have to be restricted by location. There is a big opportunity in the digital skills gap area and a need to recognise this within the education system before the UK is left behind, as this new industry(s) emerges.

\(^1\) [http://www.theiet.org/](http://www.theiet.org/)
\(^3\) [http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/summary/main.pdf](http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/summary/main.pdf)
9. Greater use of linked digital technology will necessitate increasingly sophisticated means of ensuring that technology, and society, is not impeded by mischievous or malevolent individuals or organisations i.e. “hackers”. This protection will in itself be a burgeoning sector.

10. It seems inconceivable that the current poor standard of software ‘engineering’ could be permitted to persist in its current form for another 15 years. We therefore predict that despite all the challenges entailed, by 2030, there will be a greater demand for digital systems development to have become a true engineering discipline, based on established computing science and mature methods for planning, change control, risk management and quality assurance. A larger quantity of software will be written in ways that can be shown to guarantee that it meets its specification and that it is free from the known classes of errors that lead to security vulnerabilities i.e. is “trustworthy”. “Test and fix” will have been replaced to a greater extent than today by “correct by construction”.

11. A greater demand for cyber-secure systems will create a larger market than today for software components to be supplied with well-founded warranties. This is an attractive market for UK companies, because UK universities taught mathematically formal software development methods for many years (the best departments still do so).

12. The IET is aware of and supports the evidence submitted by UKCRC, stating the generic five levels of digital skills that the UK requires. Noting that the “basic digital skills” are required by all the general public, from early school, throughout work-life and beyond. We further observe that senior management (across all disciplines e.g. general management, technical management, human resources, finance etc.) within large, medium and small commercial organisations, and government departments will need to understand how best to deploy their skilled digital workforce and know what ‘skills’ they need to recruit, otherwise their organisation will not get the outcomes it needs.

Recognition of the need for and value of ‘digital skills’ will be main precursor to becoming a mainstream career choice.

What are the main challenges for economic growth as the UK transitions to a knowledge-driven economy?

13. The growth and prosperity of economies internationally are driven by Information and Communication Technology (ICT) and organisations and individuals need to have trust in the systems they use and the software that runs on them to benefit from all that ICT and the Internet have to offer. A big challenge is to ensure the trustworthiness of the software that fuels this growth. An aim must be to improve cyber security by making software more secure, resilient, dependable and reliable by design. Trustworthiness of software needs to be an education mantra to allow business to operate efficiently while protecting it from the growing cyber security threats and risks.

14. Skill shortages are a major challenge for economic growth. The IET 2014 Skills Survey highlighted that despite 51% of engineering employers recruiting in 2014, more are finding it difficult to find the skilled workers that they need to grow their business. Leading engineering companies in the UK have told the Royal Academy of Engineering that they are now exporting a lot of high-value work (and in consequence Gross Domestic Product) because they cannot recruit enough staff to do the work in the UK.

15. Accreditation can play a key role in both ensuring a high calibre of workers and to help employers source highly skilled employees that they need. Course accreditation may help employers see more easily the differences between candidates for a job, their suitability, and likely performance.

16. Boards need to stop overemphasising the importance of time-to-market and thereby risk sacrificing software quality and cybersecurity.

17. There are serious deficiencies in the supply of core STEM skills, especially mathematics. One of the worrying dimensions is the gender imbalance, and it is worth noting that in 2013 it was reported that the proportion of mathematics professors in the UK who are female is in single digits 6%.

18. In-career continuous professional development (CPD) / lifelong learning are key, as the work force must continually adapt and re-skill to remain competitive.

What is the employment impact on the UK’s labour market? What are the regional differences?

19. The IET believes in the future it will be increasingly important for society to understand the potential and economic relevance of e-commerce, Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). Digital skills at varying degrees of capability increasingly will be required throughout all levels of education, careers, work and domestic life; see the UKCRC’s evidence and their generic five levels of digital skills.

20. Ofcom’s 2014 Communications Market Report identifies how technology confidence varies with age. This supports the view that individuals throughout their working life will need to update their digital technology skills to sustain their career.

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http://www.theiet.org/factfiles/education/skills2014-page.cfm
http://www.blitzadv.co.uk/LMS-BTL-17Report.pdf
http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr14/
21. The classic business model justification for technologically advancing economies is to increase efficiency, and to generate more output value with fewer people. One of the key challenges is to re-skill and gainfully re-deploy those displaced people within the work force.

Future workforce:

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?

22. Whilst we do not know for certain what digital skills will be required in the future within some areas of the economy, including parts of the public sector, there are some key digital skills that are needed now, and will be increasingly needed in the foreseeable future. The wider workforce works with the systems prepared by the following workers:

**Business Analysts:** essential to understand and capture business needs and requirements, and use this data to propose effective procedures. In the main these positions require in not only higher education qualifications (science, computer science, mathematics, and engineering) but also sector business acumen, strong communication skills and interpersonal skills.

**Systems Analysts:** essential for generating functional or technical specifications from the output of business analysis. At this stage the whole life cost or whole life longevity is greatly influenced which clearly impacts how competitive the UK is the global market. The extent to which functionality and data models can be specified for configurability, extensibility and reusability is particularly important.

**Data Scientists:** the skills required include mathematics, system thinking, creativity and curiosity, data manipulation to generate knowledge, insight and intelligence.

**Developers:** legacy technologies fade and new technologies emerge, so for developers there is a constant challenge of refreshing skills, learning the new languages and methodologies. Developers tend to be in very high demand and as such can be difficult to recruit, particularly into the public sector where salaries tend to be lower. There is a severe shortage of the skills and knowledge required to develop proverbially cyber-secure systems cost-effectively i.e. are trustworthy.

**System Assurance staff:** who can analyse a ‘system’, devise a rigorous and thorough ‘verification and test’ schedule which will exercise the system to identify weaknesses, implement the test schedule, document outcomes and feed them back to the designers to ensure the system is and remains robust with very high availability, and no catastrophic failures.

23. The supply chain can only meet the needs if business knows exactly what technical skills it requires, has good links with the local education system, at all levels, to convey its requirements, and if business is prepared to supply sector specific training for its workforce where necessary. Schools, government, universities and further education establishments need to listen to business and other stakeholders, to reduce the lead time between identification of requirements for new skills, digital or other, and the successful delivery of those skilled people into the work place. Workers will often be required to undertake retraining to acquire cutting edge skills that industry needs and as such, may need financial support for this from the state. All too often employers report graduates emerging from higher education lack practical skills, basic academic knowledge, and life skills necessary for work – the so called ‘skills gap’.

24. As cyberspace expands into an all pervasive interactive domain comprising digital networks / systems that are used to store, modify and communicate information, the UK needs a highly skilled workforce which understands how to design, develop, deliver, support and maintain these systems so they are operable, have a very high availability and remain safe. These domains not only include the Internet but also other information systems that support business, infrastructure and services. Digital networks underpin the supply of energy, water, the distribution of food and other goods etc.

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?

25. The IET has provided advice and evidence as a contribution to the new computing curriculum which is due to be implemented in September 2014. The IET welcomes the new computing curriculum as a means to enable students to learn key digital skills. It is important to ensure that students are able to apply a systems thinking approach and use their knowledge across the curriculum. There are many inspirational methods including interactive tools, by which students can be taught the new curriculum. There is also a need to ensure that workers are able to solve problems and apply their

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knowledge in a flexible manner. Students should also be taught how to learn independently and effectively to enable CPD throughout their career.

26. Apprenticeship and traineeship stages are important to attract young people and ensure that they are sufficiently motivated from the outset to pursue vocational rather than academic based careers. There are still too few digital / ICT apprenticeships, yet it would be beneficial for both employer and apprentice too.

27. The UK Government’s National Cyber Security Programme is sponsoring the Trustworthy Software Initiative (TSI) to provide tools, techniques and guidance in training both the current and future workforce in the production, supply and procurement of trustworthy software.3

How are schools preparing to deliver the new computing curriculum in an innovative way?

28. Teachers and schools will need significant support and resources to deliver the new computing curriculum as many have very limited experience of it, so would be challenged to ensure that the new curriculum has the most effective impact on students’ learning. Teaching the curriculum in an innovative way is important to ensure that students are inspired and engaged with the new content and as such encouraged to pursue careers in this field. There are various ways this can be supported, for example via the, ‘Computing at Schools’10 initiative.

29. Parents play a key role in influencing the career choices of young people and should be encouraged by employers, academia and the media to have a positive attitude towards STEM subjects.

How can the education system develop creativity and social skills more effectively?

30. The education system is at its best when the curriculum is broadly based, so that students who read STEM subjects at university have had considerable experience of expressing themselves fluently and students on arts courses have a sound appreciation of mathematics, science and engineering.

31. Following the report ‘Thinking like an engineer’11 by the Royal Academy of Engineering, it would be useful for employers to go into schools and discuss with students the Engineering Habits of Mind (EHoM) to develop skills relating to systems thinking, problem finding, visualising and problem solving.

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?

32. Careers advice is currently failing young people and employers. The advice should be relevant, unbiased and involve engagement with industry. Greater employer engagement with the education system will help to raise awareness about the range of careers available and help to inspire and equip students. Professionals in work should be supported and encouraged to provide mentoring and advice to young people. The Tomorrow’s Engineers initiative12 should be supported as a valuable aid for careers advice in a changing world.

33. Currently too few women are encouraged to take maths and physics A levels, which are enabling subjects to pursue careers in all areas of engineering, regardless of new developments.

34. Professor John Perkins’ Review of Engineering Skills13 has also highlighted the leaky pipeline that exists within the engineering profession. Many students who are inspired to follow the route into engineering are then lost along the pipeline, so that the end result is far fewer engineering professionals.

35. Vocational routes should also be seen as an equal and viable alternative to academia.

36. Future occupations will require many of the same skills and capabilities that current occupations require, so a broad based educational foundation will support many specialisms and provide the necessary flexibility in the workforce.

37. Serious games and simulations help to develop a valuable set of digital skills / tools to help young people understand how real world problems can be solved, in a safe environment where failure can be safely learned from. There are a number of players large and small all competing and collaborating in the digital virtual reality world which allows staff to create in-world challenging content that improves their skills in general, and digital skills in particular, within a practical business environment. It is believed evidence pertaining to such a system will be separately submitted to the Committee by a third party.

Short- and medium-term support to the digital sector:

9 http://ec2-54-72-253-87.eu-west-1.compute.amazonaws.com/wordpress/
10 http://www.computingatschool.org.uk/
12 http://www.tomorrowsengineers.org.uk/
13 https://www.gov.uk/government/publications/engineering-skills-perkins-review
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?

38. To address the skills gaps that exist, schools need greater engagement with industry. Employers should be prepared to bridge the gap by providing training and mentoring to up-skill their new recruits to meet the specific demands of the business.

39. Technician-level skills will be in high demand for the foreseeable future to install, configure and maintain digital equipment, networks and systems. Some of the focus on such skills was lost with the abolition of polytechnics. Despite the welcome increase in apprenticeships a mechanism needs to be found to support this career path more effectively.

40. The digital sector professional engineering institutions should be encouraged and supported to create high status for chartered engineers and technicians, and to establish clearer career pathways for staff at different levels of capability, education, training and experience.

41. The TSI has been responsible for launching a Publically Available Specification (PAS754:2014 “Software Trustworthiness – Governance and Management – Specification”) which has been used to develop undergraduate courses. This specification will help UK companies select the most secure, dependable and reliable software for their needs and provide them with the skills to use it effectively. Additionally the specification will find application in CPD for skilling the current workforce.

Is there a need for increased high skills immigration in the short-term? What are the implications of this?

42. The UK demand for skilled engineers outstrips the UK’s ability to create engineers. The demand is 87,000 engineers per annum for the next decade, whilst the current number of UK engineering graduates per annum is just 46,000. In addition, many, mostly foreign, graduates of UK engineering courses leave the UK within a few months. Without the necessary skilled workforce UK companies will need to put work overseas which will have a negative financial impact on the UK economy in the short term and additionally weaken it in the medium to long term due to expertise and intellectual property erosion. Clearly, appropriate immigration and student visa policies are required to mitigate this risk.

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?

43. Occupational segregation has to be tackled so that wider, deeper talent pools can be accessed.

44. The IET Skills Survey has found each year since 2006 that the number of women in engineering has not significantly changed from 6%. The number of women in IT roles is only 5%, a significant decrease since 2013. A concerted effort is needed to address the stereotypes that exists surrounding women in these roles. Steps must be taken to improve the negative perceptions that exist for parents when considering a career in this sector for their children, particularly daughters. Measures are needed to ensure that those with learning difficulties such as dyslexia are not disadvantaged through the increasing need for digital skills in the workplace.

What do the best local skills delivery models look like? What is the role for local Government, Local Enterprise Partnerships (LEPs) and the third sector?

45. No comment.

Industry:

What are the barriers for businesses, particularly small and medium enterprises (SMEs) preparing to operate in a knowledge-driven economy? How are these best overcome?

46. The UK can be an excellent place to start and grow a new knowledge-based company. But SMEs face the same staff shortage problems that larger companies do, and they have greater difficulty finding the time to become engaged in the education system, knowledge transfer programmes and innovation competitions. Access to finance on reasonable terms is a perennial problem in the UK because of a relative lack of angel funding compared with the USA. These and related issues have been widely discussed elsewhere.

47. There is a need to educate large sections of UK industry, academia, and commerce in general, the third sector, and public services about trustworthiness of software. This involves two major costs, and thus barriers for the enterprise: the costs of gaining the understanding; and the cost of

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14 [http://shop.bsigroup.com/ProductDetail/?pid=00000000030284608](http://shop.bsigroup.com/ProductDetail/?pid=00000000030284608)

implementing the remedial actions. The state may need to be involved in raising awareness that the knowledge economy’s highly skilled workforce must have skills pertaining to trustworthy software.

48. There may need to be action by the state to raise awareness of the issue of the highly skilled workforce in a knowledge-economy being one which is also competent in trustworthy software skills; and, for example, requiring that only organisations which are accredited as having these skills can bid for certain contracts.

How can businesses help equip the workforce with new skills in a rapidly changing environment?

49. Businesses should continually retrain and up-skill their existing workforce to meet the needs of the business. Employers should ensure that they develop and execute digital strategies that maximise opportunities for flexible working, that creates high value, and reaches into deeper talent pools. This will help address the current gender imbalance in science and engineering careers and thus digital skills in general. There might also be an accredited cross-business system of recognition for this.

50. In addition to businesses being responsible for their workforce skills, the professional bodies have a role to play through enforced member CPD requirements and the provision of learning opportunities.

Infrastructure:

Does the UK have a competitive infrastructure to support a knowledge-driven economy? How does the UK compare to other countries?

51. Some progress has been made across the UK to create the right infrastructure conditions and environment to be competitive in the knowledge-driven economy, however there is considerable scope to do more, especially in terms of creating hubs or clusters that bring together universities, government, established businesses and start-ups. Avoiding start-up failure needs to be supported and de-risked. The Technology Strategy Board is doing good work in this area, and there are already centres of excellence emerging such as those in Scotland for Renewables/ Energy, Life Sciences, Sensors and Informatics / Big Data. However, there is a long way to go, and targets to compare against the UK’s international comparators would be useful.

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Submitted by Paul Davies Head of Policy