

Written evidence submitted by EngineeringUK (GAP0067)

1. EngineeringUK is a not for profit organisation. Our aim is to raise awareness of the vital contribution that engineers, engineering and technology make to our society and economy, and inspire people at all levels to pursue careers in engineering and technology. We work in partnership with business and industry, Government, education and skills providers, the professional engineering institutions, the Engineering Council, the Royal Academy of Engineering and the wider science, technology, engineering and mathematics (STEM) community.
2. All of our activities are underpinned by thorough research and evaluation. We produce an annual research report, Engineering UK the **State of Engineering**, a definitive source of information, analysis and evidence. We run the Big Bang programme, consisting of the annual **Big Bang UK Young Scientists and Engineers Fair** which attracts 70,000 visitors, the **Big Bang Competition** and a series of **Big Bang Near Me** Fairs which attract 150,000 visitors a year. We run a co-ordinated nationwide programme of schools outreach and careers inspiration, **Tomorrow's Engineers**, which links schools with local employers, giving pupils the opportunity to learn more about the world of engineering work. It is designed to create the next generation of engineers, by doubling the number of young people choosing an engineering career, through a co-ordinated approach that will reach one million school children annually within five years. 1 in 10 state secondary schools have attended the Big Bang Fair and, in total, our programmes reached 70% of secondary schools in 2015/16.
3. Engineering is essential to the UK economy. The sector contributed an estimated £486 billion to the Gross Domestic Product (GDP) of the UK in 2015 – equivalent to 26% of total UK GDP. It has been estimated that every £1 in Gross Value Added (GVA) that engineering contributes to the UK economy goes on to generate a further £1.45 elsewhere in the economy. For every new engineering vacancy filled, a further 1.7 new jobs can be expected to be created throughout the UK economy. In 2015, engineering directly provided around 5.7 million jobs and supported over 10 million more in employment in the UK. STEM skills are vital to the engineering sector

The STEM Skills Gap

4. Our State of Engineering 2017 report will be published shortly. It finds that there is a significant STEM skills gap which is projected to grow, with an average demand for 265,000 jobs in engineering enterprises per year, of which around 186,000 will be in engineering occupations. This is based on replacing workers as they retire and expansion demand as activity grows. The total size of level 3¹ employment will shrink, but there will be significant replacement demand for around 57,000 entrants per year. At Level 4² or higher there will be a requirement

¹ Level 3 qualifications are: A level - grade A, B, C, D or E; access to higher education diploma; advanced apprenticeship; applied general AS level; international Baccalaureate diploma; level 3 award; level 3 certificate level 3 diploma; level 3 ESOL; level 3 national certificate; level 3 national diploma; level 3 NVQ; music grades 6, 7 and 8; tech level

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for just over 101,000 people annually for engineering occupations. The demand will be particularly acute in London and the South East of England, but there will be net demand in all UK nations and regions.

5. EngineeringUK has modelled the supply of entrants to engineering enterprises with level 4+ skills through higher education and high-level apprenticeships. We project that there will be around 41,000 entrants of UK nationality annually. Graduates from the EU and other nations could potentially add a further 40,000 to the engineering supply. This would give a total supply of workers with high level skills of just over 81,000. (This projection assumes that similar numbers of international students will continue to study in the UK and continue to be eligible to work in engineering in the UK).
6. Even with these assumptions, the projected supply will fall short of demand by around 20,000 per year. If the supply were to be limited to only UK-domiciles at level 4+, it would fall far below the projected requirement. The current supply of postgraduate-level skills in engineering and computing is highly dependent on international graduates studying in the UK - more so than any other major higher education discipline. This represents a distinct vulnerability. Although the implications of the UK's intention to leave the EU have not been modelled, it seems likely that this will affect both sides of the supply/demand equation, potentially with different rates of change. On the supply side, any tightening of immigration policy or reduction to the perceived attractiveness of studying and working in the UK will have immediate detrimental impacts on the supply of key skills.

Good news

7. There is some evidence that more positive attitudes towards STEM careers are having an impact. Against a fall in total A-level entry numbers since 2011, there have been significant rises in the number of entrants to mathematics, chemistry, physics and biology, although with some small fluctuations (including decreases in the last year). Further mathematics and computing, while not so large numerically, have seen even greater percentage rises in entrants over five years, at 24% and 56% respectively (although the latter must be seen alongside the strong decline in entrants to ICT).
8. Some of these rises have been fuelled by rising numbers of female entrants. The proportion of female entrants in the three science subjects has risen at least slightly over the period, but fallen back slightly in mathematics. Female entrants comprised just under 10% in computing, 22% in physics, 28% in further mathematics and 39% in mathematics, but half in chemistry and nearly two thirds in biology. Clearly, diversity remains an issue and there is much to do to ensure that barriers to women's access to STEM skills are removed.

² Level 4 qualifications are: certificate of higher education (CertHE); higher apprenticeship; higher national certificate (HNC); level 4 award; level 4 certificate; level 4 diploma; level 4 NVQ

What type of STEM skills do we need?

9. The type of skills the engineering sector requires is changing. Engineering and related industries will require a higher proportion of more highly skilled labour, as automation and technology and the growth of what has been termed Industry 4.0 reduces the need for those with lower level skills. This trend is already reflected in employers' reports of skills shortages. Our projections show that the supply of level 4+ skills will not meet demand.
10. These areas of increase are at the expense of the middle level of skills. The semi-routine nature of many middle-skilled occupations makes them especially vulnerable to automation, whereas many occupations that are traditionally low-skilled in terms of qualifications rely on other types of skill that are not readily automated. The prevailing predictions, particularly for economically developed nations, are for faster growth of higher- and lower-skilled jobs compared with middle-skilled jobs. This trend is expected to hold for the UK well into the next decade.
11. There is evidence that this hollowing out of the middle of the workforce and increased demand for those towards both the top and lower rungs of the skills ladder, is already happening. In the two decades to 2014, the number of high-skilled jobs in the UK has risen by 2.3 million and, in some occupations, employers are routinely reporting that they are struggling to fill positions. Demand for low-skill roles has also grown, with 1.8 million more jobs in areas such as care, administration and leisure. Consistently, employers in sectors like agriculture, and especially in health and social care, are having to rely on imported labour. Over the same 20-year period, there has been a significant decrease in the demand for middle-level skilled workers, with 1.2 million fewer jobs available for these largely 'routine' occupations.

Skills gap is not just about new entrants

12. The STEM skills gap will not be tackled solely by focussing on new entrants into the employment market. There is also a critical need to upskill the current workforce. At a time when new technology is changing industries and automation impacting on occupations, policymakers should note that up to 90% of the current workforce will still be in work in the next decade. Tackling productivity deficits for the economy as a whole must therefore be based on issues around job design, technology and progression for those who are already in work. It cannot rely on new entrants who have acquired the latest skills through education. There are significant portions of the existing workforce whose skills are currently underused by their employers, with employers themselves reported that over two million workers were in this position in 2015.

Big Data Skills

13. Big data refers to the handling of information and datasets that are so large, dynamic and complex that traditional techniques are insufficient to analyse their content. In 2012, it was one of the 'Eight Great Technologies'³ identified by the government to support UK science strengths and business capabilities. A massive global market for data analysis products and services is anticipated. A UK strategy was articulated in 2013.⁴ This will be incorporated in the forthcoming UK Digital Strategy, to enable the UK to capitalise on its world-leading data capabilities, and the public sector to develop the sustainable solutions promised by big data within a secure regulatory and practical framework. The government also needs to urgently address the current digital skills shortage, by supporting the development of 'data analytics' skills — a mix of technical skills, analytical and industry knowledge, and the business sense and soft skills to turn data into useful information and intelligence.

Brexit and STEM skills

14. There is a concern that the STEM skills gap may widen because of factors associated with the Brexit vote. Postgraduate taught courses and research programmes in engineering are highly dependent on international students for their viability. Were such programmes to become unviable, this would have a knock-on effect on the opportunities for UK graduates to study at these levels, but also potentially damage the future research and academic workforce, which is the destination for some of these postgraduates. The proportion of the academic engineering workforce which is of EU origin is higher than the average across all disciplines, especially amongst many high-performing universities in terms of research. There is a wider concern about the UK's ability to attract top researchers internationally, as it is accepted that the capacity and talent in the research base are much healthier with free mobility of researchers, especially into the UK.

STEM skills gap: aggravating factors

15. Too few young people are choosing to study the STEM subjects that keep the doors to highly paid engineering careers open to them. The choice to take a combined science GCSE, rather than Biology, Chemistry and Physics is in many cases taken without an understanding of the implications for future career choice or a proper awareness of careers options such as the broad range of engineering careers.

16. A City & Guilds study into career aspirations found young people's thinking to be ill-informed, and poorly matched to the actual opportunities of the projected labour market of 2020.⁵ When asked what occupations they would consider,

³ Department for Business, Innovation & Skills: Eight great technologies (speech by David Willets Minister for Universities and Science), 2013: <https://www.gov.uk/government/speeches/eight-great-technologies>

⁴ HM Government: *Seizing the data opportunity - a strategy for UK data capability*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/254136/bis-13-1250-strategy-for-uk-data-capability-v4.pdf

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young people selected from a relatively narrow pool of jobs that represented just 34% of the roles that will be available. Overall, almost two-thirds of the jobs were not selected by anyone. The jobs most frequently chosen were the jobs that young people would commonly be exposed to (secondary school teacher, police officer, doctor) or ones that they may have seen in media representations.

17. A recent Royal Academy of Engineering (RAEng) report found that pupils disengage with STEM through an inability to see its relevance to their current life and future directions.⁶ This could be exacerbated by IMechE's finding that there is a bias towards the natural world, rather than the 'made world' in school science. A report by the Institution of Mechanical Engineers (IMechE) urges a new focus in schools on the presence of engineering and the 'made world' at all stages from primary level upwards.⁷ Discounting major curriculum overhaul as unrealistic, the report recommends an approach that works within existing educational frameworks. It advises that enhancing teachers' confidence and ability to embed frequent references to engineering and engineering careers within their teaching would not only support their pupils in making choices but also emphasise that, although science and mathematics are the prevalent STEM subjects in schools, in the external world, it is engineering and technology that predominate.
18. The longstanding shortage of STEM teachers continues: 28% of head teachers in relatively affluent areas report that mathematics and science are covered by temporary teaching arrangements, rising to 61% in some challenging areas. Vacancies for teachers of STEM subjects appear to be particularly hard to fill. To meet its 2014/15 target for mathematics and physics trainees, the DfE needed to attract one in five of all mathematics and physics graduates into teaching, compared with one in 25 history graduates. In addition, leaving rates for existing mathematics and science teachers are above average, with the highest vacancy rates in 2014 being in computer science (1.5%), mathematics (1.4%), and science (1.4%), compared with an overall average rate of 0.3%.

Measures to address the STEM Skills Gap

19. Motivated by the need to increase the supply of engineers, EngineeringUK delivers and co-ordinates a number of different interventions aiming to close the STEM skills gap. We track and evaluate each of these interventions and assess them against the Engineering Brand Monitor (EBM) an annual survey of public perception of engineers and engineering conducted since 2010.

⁵ City and Guilds of London Institute: *Great expectations: teenagers' aspirations versus the reality of the job market*, 2015. <http://www.cityandguilds.com/~media/Documents/Courses-and-Quals/Apprenticeships/EMSI%20reports/cggreatexpectationsonline%20pdf.ashx>

⁶ Royal Academy of Engineering: *The UK STEM education landscape*, 2016. www.raeng.org.uk/stemlandscape

⁷ Institution of Mechanical Engineers: *Big ideas: the future of engineering in schools*, April 2016. <https://www.imeche.org/policy-and-press/reports/detail/big-ideas-report-the-future-of-engineering-in-schools>

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The Big Bang Fair

20. The Big Bang Fair is an annual event which has been running since 2009. It is now a four day event attracting over 70,000 visitors. Overall, findings indicate that the Big Bang Fair 2016 had a positive impact. Students report higher levels of knowledge and more positive perceptions of STEM careers than the overall population. These perceptions remain positive beyond the Fair itself. When students were asked how positively they viewed careers in STEM subjects two to four weeks after the Fair (in a post event survey), perceptions remained positive. The proportion of students agreeing that taking part in the Fair had inspired them to work in engineering also remained high.
21. The Big Bang Fair is also successful at demonstrating that engineering is a suitable career for both boys and girls: 84% of 11- to 14-year-olds attendees were convinced of this, compared with 71% in the general 11- to 14-year-old population. Among girls, the contrast was particularly marked: 87% surveyed at the fair believed this statement, compared with 67% of the population accessed through the EBM. The cost of delivering the Big Bang Fair is relatively higher than other interventions, but the reach is wider than the attendees at the Fair as the event attracts significant media and social coverage.

Tomorrow's Engineers

22. Tomorrow's Engineers is a brand name for a suite of interventions, including a Robotics challenge, the Energy Quest programme, the Big Bang Near me Programme and a programme which co-ordinates employer presence in schools, ensuring that young people get to meet a real engineer and understand what engineering careers are.
23. The Robotics challenge programme is a national competition in which teams of students build robots out of Lego and enter them into a competition. An evaluation based on surveys of participants showed that 70% say a career in engineering would be desirable, compared with 43% of the general population of 11-14 year olds. 78% of students 11-14 taking part in the EEP Robotics Challenge perceive a career in technology to be desirable while 74% perceive a career in science to be desirable, compared with 57% and 49% of the general population of 11-14 year olds. Approximately seven out of ten say they know what people working in engineering and technology do, compared with a third and nearly half of the overall population of 11-14 year olds respectively. 77% of students at the EEP Robotics Challenge say they know what people working in science do, compared with 42% if the general population.
24. Energy Quest events are organised by regional delivery partners and aim to get 11-14 year olds excited about STEM, based around the topic of energy. In 2015-2016 402 schools with 25,894 students participated with 222 STEM ambassadors in the Energiser event. 98 schools took part in the Classroom Challenge with just under 3,000 students participating. A survey at the end of the second year of the three year pilot project found that half of students participating in an Energy

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Quest event say they know what to do next in order to become an engineer (51%) or a scientist (49%), compared with a quarter (26%) and three in ten (31%) respectively of the general population of 11-14 year olds.

25. Big Bang Near Me Fairs are organised by schools and regional delivery partners and aim to get 11-14 year olds excited about science, technology, engineering and maths (STEM). Students taking part in a Big Bang Near Me Fair report higher levels of knowledge of careers in STEM compared with the general population of 11-14 year olds. Over half say they know what people who work in engineering do, compared with three in ten of the general population of 11-14 year olds. Three quarters say they know what people working in science do while 62% say they know what people who work in technology do, compared with 42% and 46% of the overall population of 11-14 year olds. Big Bang Near Me participants also hold more favourable views of STEM subjects compared with the overall population of 11-14 year olds.
26. Students at Big Bang Near Me Fairs are more positive about engineering (67% vs EBM15 47%), science (81% vs EBM15 64%) and technology (79% vs EBM15 71%) compared with the general population of 11-14 year olds. Over half of students (55%) participating in a Big Bang Near Me Fair say they know what to do next in order to become an engineer, compared with a quarter (26%) of the general population of 11-14 year olds. Six out of ten students say the Big Bang Near Me Fair has inspired them to work in engineering in the future.
27. There are myriad opportunities on offer that will allow schools to offer activities relating to STEM careers, but they struggle to differentiate between them. STEM-related learning and communication activities need to be better co-ordinated and evaluated, so that their use is optimised and they achieve greater reach and long-term impact on young people. There is strong evidence showing key ingredients of successful interventions. Students who take part in competitions were more likely to find a career in engineering desirable and to have a higher knowledge of what people working in engineering do. Similarly, students who meet an engineer are more likely to find a career in engineering desirable and to have a higher knowledge of what people working in engineering do.
28. The Royal Academy of Engineers UK STEM Education Landscape study found that more than 600 UK organisations run initiatives that seek to engage schools with STEM. However, the list was not thought to be exhaustive and many more small providers are likely to exist, providing various forms of support to young people. The mapping also did not include employers or universities, which provide significant support to the education system.
29. For employer engagement to have real impact activity must be more effectively co-ordinated and more extensive evaluation must identify which interventions have long-term positive impact on young people. That is what the Tomorrow's Engineers programme seeks to do, hosting the Schools Database which records

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employer outreach with schools, sharing best practise and encouraging employers to target interventions more effectively.

Conclusion

30. There remains a significant skills gap, despite the fact that interventions have led to small gains, the demand for STEM skills and particularly STEM skills mixed with soft employability skills continues to outstrip supply. There is a hollowing out of the workforce, with a continuing demand for higher level skills and lower skilled job and less demand for middle skilled jobs as automation takes over.
31. To address the skills gap, more work is needed on reskilling the current workforce. In terms of new entrants into the job market, a significant challenge exists in ensuring that young people understand the full suite of actual and yet to be invented STEM careers that are available to them, before they narrow down their options with subject choices.
32. STEM engagements which allow young people to meet an actual engineer are the most effective at encouraging young people to understand the potential of STEM careers. Employers and others are doing an enormous amount to work towards a shared goal and investment in the co-ordination of this work, through Tomorrow's Engineers, is key to success.

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