Engineering Skills

A submission to the House of Commons Science and Technology Select Committee inquiry into Engineering Skills

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The Engineering Professors' Council (EPC) represents the interests of engineering in higher education. It has over 1600 members in virtually all of the UK universities that offer engineering. They are all either professors or senior managers. It has as its mission the promotion of excellence in engineering higher education teaching and research.

"Britain's higher education is a major contributor to the economic success and social well being of the country. Higher education is a national asset, whose excellence in teaching and research is world recognised."

This quote from the Department of Business, Innovation and Skills web site has informed our responses to all of the questions.

"The European Commission's commitment to the new skills for new jobs agenda. It is a sign of our belief that the employment and the education worlds must join forces. The two worlds must work closely together if we are to make a successful exit from the current economic crisis and provide inclusive, innovative growth in the decade ahead.

The crisis has speeded up the pace of change in our economies and societies. And as the world changes, work is changing too. Some types of jobs are vanishing. Others are opening up, in the 'green economy' for example, or in the health and care sector, as our population ages.

The skills needed are different too. Technical knowledge will always be essential. But equally important are the cross-cutting skills that enable people to cope with and develop new knowledge, while pursuing more flexible career paths. In the face of global competition, we need the skills to innovate."

This quote from Androulla Vassiliou, Member of the European Commission responsible for Education, Culture, Multilingualism and Youth in 201 0 reinforced the view of BIS that education and research are essential to the economy and that agenda requires a focus in innovation and employability skills and gives an indication of the direction that higher education will take.

This response has been partly informed by the response from E4E but provides additional information based on the experience of the Engineering Professors' Council.

Does the current engineering skills base meet the needs of employers?

1. Based on the experience of members of EPC, industry finds it difficult to articulate the skills base it requires of graduates. This was an issue identified in the last Government's report *Higher Ambitions*. However, engineering skills are highly valued across many sectors, not just those directly or indirectly involved in engineering because of the inherent blend of numeracy, critical thinking and problem solving which characterise an engineer. This is encouraging for two reasons. Students entering tertiary education may not have reached a decision as to their choice of career and, since engineering skills are valued by a range of sectors, it is a suitable choice for those students yet to decide on their future. This deals with the individual student but there is also a much wider societal issue which is related to the need to understand engineering principles to cope with changes ahead. Increasing the number of engineers in all areas of society helps society to appreciate the challenges that we face and the decisions that will have to be taken to meet those challenges. Of course this also creates a corresponding challenge for the engineering industry to retain the best skilled graduates against competition from other sectors such as financial services.

2. It also has to be recognised that engineering covers many disciplines (e.g. the number of professional engineering institutions) and in each discipline there are numerous sub sets of engineering specialists. There is a range of skills generic to engineering and a significant number of combinations of skills sets for the different engineering disciplines in addition.

3. The formation of a professional engineer is a two-stage process. Most engineers complete tertiary education and then undergo a period of initial professional development to reach a level of competency set by the Engineering Council. This formation is a combination of education and training both formally and in the workplace with greater emphasis on education in further education (FE) and higher education (HE); and greater emphasis on training in the workplace. Those educational programmes that are accredited are audited by licensed professional engineering bodies against a set of guidelines produced by Engineering Council in consultation with academia and industry. Therefore the skills of graduates should meet employers' needs, provided they articulate what those needs are and are engaged in the auditing process.   Industry should also accept its role in training the new graduates, as they train other types of recruits.

4. Data from various Government sources can be used to estimate the demand for engineers and the supply of graduate engineers. However, the demand-led data (e.g. Standard Occupational Classification (SOC) codes) is based on different criteria to the supply data (e.g. that collected by the Higher Education Statistics Agency - HESA). This reflects the fact that higher education focuses on the disciplines that underpin engineering sectors while Government is more interested in the jobs created. There is some alignment between the two descriptions but they cannot be assumed to be reliable. This is further complicated by the fact that people enter the engineering professions through a variety of routes (e.g. cognate degrees, apprenticeships).   These were the findings of ConstructionSkills which has developed a demand-led model to predict the number of people that the construction industry needs and is currently developing a supply-led model to identify the training provision in the UK.

5. The Royal Academy of Engineering (RAEng) in its recent analysis[1] estimates that 820,000 *SET professionals* will be required by 2020 with 80% of these required in engineering.   There is a further breakdown of those required within sectors from the relevant Sector Skills Councils (e.g. ConstructionSkills).

Do employers in the engineering sector prefer an academic or a vocational profile?

6. It is important to be clear that these terms are not necessarily mutually exclusive. Indeed this misconception may underlie some of the difficulties that the engineering sector has faced in attracting appropriately skilled and talented staff in recent years.

7. A key message from employers is that they prefer graduates who have some work experience. However, the decline in sandwich programmes and the reduction in opportunities for work placements mean that students are finding it increasingly difficult to gain work experience. Paid internships should be provided by most of industry as part of their commitment to securing the future skills base and their commitment to corporate social responsibility.

8. Engineering education has always contained a mix of education and training with a greater focus on education. This covers the underlying scientific and engineering principles creating graduates with a 'habit of mind' that means that they can adapt to change. However, graduates will have experience of a variety of skills including the generic skills identified in the Dearing Report and the more specialist skills stated in the accreditation guidelines produced by Engineering Council. The recent focus on employability skills within tertiary education is leading to the development of new methods of teaching and learning some of which are funded by HE STEM, RAEng, Sector Skills Councils and Professional Engineering Institutions.

9. A challenge for leaders of tertiary education programmes is to balance the demands for change (e.g. management skills) with the demands for tradition (e.g. underlying scientific principles). This

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[1] The Royal Academy of Engineering analysis used a combination of UKCES predictions for 2010-2020 (UKCES Working Futures 2010-2020) and LFS occupational population data for 2009. This estimate is based on a 7:1 ratio of replacement demand to expansion demand.

can create unnecessary stress within programmes creating a perception that they may not be fit for purpose. However, on the positive side, there is a diverse range of education and training found within tertiary education, which means that the engineering skills particular employers require can be found somewhere. This drives their recruitment policy which is often to focus on particular programmes at particular universities.

10. Employers want <u>competent</u> engineers and technicians. In the UK, engineers and engineering and ICT technicians cannot be registered until they have sufficient working experience to demonstrate competence. Competence is developed through doing the job, underpinned by theory ('academic' or 'vocational' learning though not necessarily certificated). It is this integrated learning which develops competence. Industry needs to focus on the ongoing encouragement, development and support of its employees to achieve incorporated and chartered status, and not simply on the skills base of new graduates entering the profession.

11. Paths taken to professional engineering include:
    - Work-located training - e.g. Advanced Apprenticeships – an *integrated* vocational and work-located learning path; accredited Further Learning programmes
    - FE college-based vocational education/training - vocational learning path – which may be classroom based learning only – plus working experience;
    - University-based education - general or 'academic' path – which may include a 'sandwich' working placement – plus working experience;
    - Non-formal and informal learning;
    - Flexible work-based route to professional qualification, *Engineering Gateways[2]*.
    - A combination of the above over a working lifetime.
    - There should be an increased emphasis on apprenticeships at Levels 6 and 7 of the Higher Education framework.

12. Periodically, the Engineering Council surveys employers to ascertain if UK-SPEC remains in line with employers' needs. The most recent survey in 2007 involved 830 employers. These employers were selected as representative across engineering sectors, firm size etc from 8,755 firms in the filter phase. The report[3] concludes:

    "5.1   The most valuable finding from this study was that UK-SPEC largely reflected employer competence needs, the additional competences identified as desirable being mentioned by only small percentages of employers (the highest being 7% for IT skills).

    5.2   Organisations with registered staff tended to require higher standards than those without registered staff at the same level, suggesting that the presence of registrants 'raises the bar' in terms of valuing areas of competence. This was particularly true at Engineering Technician level."

13. The Royal Academy of Engineering has undertaken a number of major studies into how best to prepare engineering undergraduates for industry. The reports[4,5] highlight the importance of providing students with real-life problems to solve and to develop greater links with industry for the teaching of engineering at university. Initiatives such as the Academy's Visiting Professors scheme where industrialists lecture to students at university and explain current practice and the challenges being faced by engineering companies have been shown to add real value to undergraduate provision.

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[2] Engineering Gateways – www.engineeringgateways.co.uk

[3] UK-SPEC Baseline Project 2007. Engineering Council http://www.engc.org.uk/about-us/publications

[4] *Educating Engineers for the 21st Century*. The Royal Academy of Engineering. www.raeng.org.uk

[5] *Engineering Graduates for Industry*. The Royal Academy of Engineering. www.raeng.org.uk

What impact will recent changes relating to engineering qualifications in England have on the uptake of technical subjects and the skills base needed by the engineering sector?

14. A broad and balanced general education is necessary for the formation of engineers and technicians. Mathematics and technical subjects - mathematics, sciences, design & technology and computing underpin the core engineering subjects. Art & design, the humanities and performing arts and languages are also important formative components for many professional engineering disciplines. This is especially the case in the emerging skills agenda which requires greater emphasis on the qualitative skills to deal with social aspects of engineering.

15. Entrants to higher education come from a variety of backgrounds and have a variety of qualifications. This has always been the case and makes for a rich learning experience within universities and colleges. However, it creates a challenge for higher education because there is a need to undertake remedial teaching, provide additional support and ensure that at the end of the first year students have a reached a common standard. This means that they can then go onto to complete their formal engineering education. Therefore any changes to engineering qualifications sub degree level will have to be accommodated as they always have been.

16. The introduction of engineering qualifications pre 19 is important, however, as it gives students an insight into engineering and the skills needed to become successful engineers.

Could the Government and others do more to raise the status of technical subjects?

17. The Government has an ambition for growth which rebalances the economy in favour of productive industries. All Government policy should be supportive of that ambition.

Schools

18. The Education Secretary should make public his support for high quality technical education in schools. His announcement should include Design & Technology, ICT with emphasis on Computer Science and engineering-related qualifications valued and respected by employers which lead to progression to further learning and employment.

Higher Education

19. The effect of the funding reforms on higher education is uncertain. A recent report by the EU suggests that the UK has moved to a commodity model for higher education. It is not certain whether students will choose engineering as a career, whether they will learn then earn or earn and learn, and whether employers will recognise this shift and how it will affect them.

20. The best graduates are those who have authentic experience-led learning programmes and employer engagement in offering placements and internships. These programmes require significant additional resources. There should be more financial incentives available to industry offering Level 6 and 7 apprenticeships and to engage in the design and delivery of undergraduate programmes

21. The integrated Masters Degree is recognised by the engineering sector as the premier route to an engineering career. It is also recognised across Europe as a 2nd cycle degree. It is possible that students following this programme will decline because of the funding placing greater emphasis on workplace learning. This may prove unacceptable as it could lead to a loss of higher skills normally found at Masters level.

22. The Home Office policy on non-EU immigration may be discouraging many overseas students from applying to UK universities. Fees from overseas students are an essential funding stream of the diverse sources of funds for engineering departments.

23. Increasingly European Universities are offering degrees in English reducing the competitive advantage the UK has had in the past.

24. There is evidence that European Universities are also encouraging UK students to study in Europe. This will create a problem for the professional engineering institutions because each graduate will have to go through the individual case procedure for Chartered Recognition as the European degrees are generally not accredited.

Public Sector

25. Engineering role models in the public sector are limited. There are no chief engineering advisors to Government; there are only three engineers in Parliament; engineering career paths in the Civil Service are limited.   The ability of Government departments to take informed decisions on engineering-related matters is said to be constrained owing to the background and experience of civil servants.

What more should be done to attract and retain a more diverse technically skilled workforce?

26. Analysis of sciences and mathematics subjects at Key Stage 4 in England shows that a higher proportion of females achieve A*-C grades in at least two science GCSEs and in mathematics GCSE compared with males. Yet, only around 20% of the cohort for physics A level is female. In Higher Education, the proportion of women in engineering subjects falls to around 12%.   The issue therefore appears to be one of interest rather than ability.

27. There is considerable variation in participation and attainment in sciences and mathematics at Key Stage 4 across different ethnic groups. For example, there is under-representation of black pupils in high attaining maths and science cohorts at GCSE while there is substantial over-representation of Chinese and Asian pupils in high attaining science and maths cohorts at GCSE.

28. Analysis of Department for Education National Pupil Data by the RAEng shows that socio-economic status is the underlying driver for participation and achievement in sciences and mathematics, but it is not the only factor. And even where there is attainment, there is still a lack of progression to study STEM subjects post-16.

29. There are deeply embedded cultural factors at play here; public (and media) perceptions of what engineering is[6], early gendered role-stereotyping, a strongly class-based society.

30. The answer to the problem is complex, multi-faceted and all efforts to date have not made significant impact. However, it seems likely that the culture of education and training in engineering (all phases) and in engineering workplaces and the lack of diverse representation within them provide little 'pull'. Additionally, lack of retention of engineers and technicians from more diverse backgrounds that do make it to the engineering workplace may indicate gaps in staff development and retention practices in companies and organisations that employ engineers and technicians.

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[6] The 2011 Engineers and Engineering Brand Monitor. EngineeringUK www.engineeringuk.com