

**Innovation Universities and Skills Committee Inquiry into Engineering:
Joint written evidence from the Professional Engineering Community¹,
March 2008**

1. Introduction and Executive Summary

1.1 The engineering community welcomes the Committee's inquiry into engineering. The deployment of engineering and technology has allowed mankind to enjoy a quality of life unknown hitherto. Engineering can be the creative process which converts science into products and processes. It can also generate inventions ahead of scientific understanding. Through engineering the UK can continue to develop new 'solutions' to many of the current and future challenges facing society and hence strengthen the UK's economic competitiveness.

1.2 Working in partnership, the engineering community is already playing a leading role in providing:

- Careers support and advice
- Engineering scholarships and research bursaries
- Endorsement for training and professional development
- Activity to raise the profile, and change perceptions, of engineering and engineers through public engagement.

1.3 There is still more to do. Addressing each of the Inquiry's terms of reference, this paper provides an overview of UK engineering and the challenges facing it, and makes recommendations on what extra can be done to maximise engineering's and engineers' contribution to meeting these challenges.

1.3.1 The role of engineering and engineers in UK society:

- The various schemes for inspiring young people and changing perceptions should be better coordinated, with a view to building upon best practice and recognising an important role for the Shape the Future initiative.

1.3.2 The role of engineering and engineers in the UK's innovation drive:

- We recognise recent and ongoing efforts to ensure that public sector procurement encourages innovation in the delivery of products and services, including the Small Business Research Initiative (SBRI), but question the extent of their success. In view of the significant power of the public sector, procurement has an important role to play in fostering new technologies in the UK.
- A review of the current industry / academia technology transfer programmes should be undertaken with recommendations for change. The engineering community is ideally placed to lead this.

1.3.3 The state of the engineering skills base in the UK:

- We are aware of the ongoing TRAC(T) review of funding of undergraduate education. Recognising the strategic economic importance of engineering, the real cost of producing engineering graduates should be fully funded.
- STEM course uptake (both HE and FE) should be incentivised by progressively writing off student debt for home students who follow careers which meet STEM skills shortages.
- Efforts to raise professionalism among engineering technicians should be increased. The unions will have a key role to play in achieving this.

¹ The list of signatories is attached as an Appendix.
The Royal Academy of Engineering has also seen this submission and is supportive.

- The engineering community and businesses are already engaged with education providers on the content and structure of new qualifications, e.g. the Engineering Diploma. This should be continued and supported by consistency from Government over the future of new and existing qualifications.
- Sector Skills Councils should work closely with the Engineering Council UK and the engineering profession to exploit the benefits of our internationally recognised competence standards for professional engineers and engineering technicians.

1.3.4 R&D:

- Public funding of engineering R&D which looks to the longer term, including environmental and sustainable technologies, should be continued, e.g. the carbon capture and storage competition. However, this support should not be too narrow in its scope e.g. not restricted to just post-combustion technologies in this case.
- There should be a greater use of Engineering Doctorates, as compared with PhDs, and the scheme should be extended to include Engineering Masters.
- Just as the Research Assessment Exercise incentivises excellence in research, so first-class teaching and first-class knowledge transfer should also be incentivised.

1.3.5 Roles in promoting engineering skills and the formation and development of careers in engineering:

- Subject specialists for each STEM subject should be introduced for every secondary school student, encouraged by increased incentives for practising science teachers subject to their achievement of agreed performance standards. There should also be additional reward and recognition for the most inspirational teachers of science and mathematics.
- Minimum standards for STEM careers advice should be set, improving the training of careers advisers and the information resources available to them, as recognised by recent DCSF initiatives.
- There should be an increased drive to raise mathematics standards at primary and secondary school. To this end, we welcome the undertaking of a review of primary school mathematics teaching by Sir Peter Williams. We recommend that every primary school Science Coordinator should be a science graduate.
- Industry should work more closely with education providers, engineering institutions and with EPSRC and HEFCE to explain its skills needs, feed into course design and provide students with practical experience of engineering.
- Schools should be supported, as outlined above, with key potential contributions being to improve under-19 mathematics and physics skills.
- As currently happens with Science (through the Chief Scientist), appropriate recognition should also be given to Engineering and Technology in the policy making process.

2. The role of engineering and engineers in UK society

Engineering continues to make a vital contribution to the UK economy and to UK and international society and well being. Engineering underpins virtually every aspect of modern life, from defence to health and construction. UK successes to be celebrated include the Channel Tunnel Rail Link, Airbus, plastic electronics and Formula 1. Engineering also provides the backbone of all IT. Moreover, engineers are at the forefront in tackling many of the challenges facing the international community e.g. scarcity of clean water, climate change and sustainable and secure energy sources. However, UK engineering is now part of a global economy. As a recent report² by the think tank, Demos, noted:

"Products are assembled along global supply chains. Savings flow through global financial markets. Something similar is happening to how ideas and technology develop. The rise of China and India means US and European pre-eminence in science-based innovation cannot be taken for granted. Nor can the knowledge jobs that have depended on it."

2.1 Engineering, with approximately 0.5 million professional engineers, brings technology, products and services to market and in doing so directly contributes (through SET-intensive sectors) approximately £250 billion³, 27% of the total UK GDP (2002). In 2006 engineering services⁴ directly contributed £3.2bn in exports to the Balance of Payments.

2.2 More needs to be done to communicate the extent of engineering's and engineers' centrality / contribution to UK society and to improve the perception of both amongst young people – our potential future engineers - and within the media. This contribution is quite separate from a strong and internationally recognised science base. To correct misconceptions, Government, business, the engineering community and education providers are all undertaking awareness-raising, outreach and education programmes, particularly for young people. Even though this activity reaches over 50,000 young people per year, more understanding is needed to ensure that such activity reaches the 'unconverted'.

- ***The various schemes for inspiring young people and changing perceptions should be better coordinated, with a view to building upon best practice and recognising an important role for the Shape the Future initiative.***

3. The role of engineering and engineers in UK's innovation drive

The engineering community agrees with the content of the Government's 'Next Steps' policy. However, emphasis on a skills base is a necessary but not sufficient precursor to innovation. While, as previously stated, the UK enjoys a science base second only to the US (measured by numbers of citations and papers), the UK continues to be less successful than many of our competitor nations in translating this research into commercially successful products – although progress is being made, as noted in Lord Sainsbury's recent review of science and innovation policies '*The Race to the Top*'⁵. Professional development of engineers in the UK does not offer sufficient opportunity to engage with university research. It is also much rarer in

² The Atlas of Ideas: How Asian innovation can benefit us all, Charles Leadbeater and James Wilsdon, Demos, January 2007

³ The Frontiers of Innovation: Wealth Creation from Science, Engineering and Technology in the UK, the ETB 2004

⁴ http://www.statistics.gov.uk/downloads/theme_economy/PinkBook_2007.pdf

⁵ The Race to the Top: A Review of Government's Science and Innovation Policies, Lord Sainsbury of Turville, October 2007

the UK than in other nations for senior management to transfer between industry and academia.

- ***We recognise recent and ongoing efforts to ensure that public sector procurement encourages innovation in the delivery of products and services, including the Small Business Research Initiative (SBRI), but question the extent of their success. In view of the significant power of the public sector, procurement has an important role to play in fostering new technologies in the UK.***
- ***A review of the current industry / academia technology transfer programmes should be undertaken with recommendations for change. The engineering community is ideally placed to lead this.***

4. The state of the engineering skills base in the UK, including the supply of engineers and issues of diversity (for example, gender and age profile).

The UK's engineering and technology skills base is essential for inward investment. Employers regularly report shortages of engineers and gaps in their skills and recent reports suggest that the number of engineering graduates needs to double over the next ten years.⁶ According to one report, in 2007 nearly 50% of engineering employers had recruited from overseas in the preceding 12 months to cover specific skills shortages.⁷

4.1 Higher Education (HE)

Significant numbers of engineering graduates are lost to the profession, although this varies between disciplines. Whilst some 'leakage' to financial services and other professions should not necessarily be a cause for concern, more work is needed to understand better which other professions engineering graduates and postgraduates enter and why they do so.

Key constraints on entry to degrees are a lack of mathematics skills and a lack of physics skills. With mathematics, this reflects reducing numbers of well-qualified mathematics teachers, and changing syllabi for national examinations. For example, teacher recruitment targets have generally been missed by 15% or more each year since 2000/01⁸. Two recent developments are however welcome. Firstly, the Further Mathematics Network has enabled further mathematics to be studied by many who would not otherwise have such opportunity. Secondly, development of the Engineering Diploma at Level 3 to include an applied mathematics unit will help to promote it as an equally relevant qualification for engineering as mathematics A Level.

A recent small-scale study also identified that the cost of engineering teaching is not being fully met with current funding, with the average shortfall of the departments surveyed in the study being 14%.⁹ The continuing TRAC(T) review of funding of undergraduate education is therefore welcomed.

One important trend that should be recognised is the increasing proportion of international students in engineering HE in the UK, especially at Masters level. In the year 2005-2006, nearly 30% of Engineering and Technology HE students were from

⁶ Shaping up for the Future, CBI 2007

⁷ Engineering and Technology Skills and Demand in Industry, IET 2007

⁸ "The UK's Science and Mathematics Teaching Force" Royal Society 2007

⁹ The Costs of Engineering Degrees, ETB / EPC 2007

outside the UK.¹⁰ We should therefore look to encourage more home students through expanded financial incentives e.g. debt cancellation for those following careers with skills shortages.

4.2 Further Education (FE) and vocational skills

There is evidence that the UK lags far behind the continent in developing and nurturing technician skills, resulting in significant shortfalls at Level 3 in the workforce. Although it will vary across engineering disciplines, we believe that generally it is at the vocational and intermediate skills level that attention should be focused. Although there were 559,000 non-work based learners in 2006/07 these numbers contain an element that is 22% down in FE since 2005. It is important that full advantage is taken of the opportunity offered by the recent apprenticeship review. Moreover the advanced apprenticeship frameworks now have the potential to link to the existing professional standard of Engineering Technician.

4.3 Diversity

The profession has a white male bias, meaning that there is an untapped reservoir of potential talent. Gender issues are particularly acute. In 2005-2006 only 15% of students on Engineering and Technology HE courses were female. This compares with an overall female participation rate in HE of 58%¹¹.

Similarly, there are also issues surrounding disability and ethnicity – the latter in terms of specific Black and Minority Ethnic groups (Black Caribbean and Bangladeshi).¹²

There are many organisations working, often independently, on separate parts of this problem and yet little progress has been made in recent years.

4.4 All these figures - on HE, FE and diversity - should be seen in the context of a projected decline in the 16-18 year old cohort. In 2004 the proportion of working population aged under 40 was 12% higher than those aged over 40, but by 2020 the number of those under 40 will be 4% lower than those over 40.⁷

4.5 Soft skills

One area in which anecdotal evidence suggests engineers do currently lack skills is the misleadingly entitled 'soft skills' which are so valued by employers. These skills include communication, team work, project management and the more basic skills of work readiness. Employers often develop these relevant to their needs but more work placements during FE and HE could also address this. Companies will nevertheless continue to have a key role to play in supporting graduates with development of their soft skills as part of Initial Professional Development. It is encouraging that once their employees then reach the standard for professional registration that companies believe these issues have been largely addressed.¹³

- ***We are aware of the ongoing TRAC(T) review of funding of undergraduate education. Recognising the strategic economic importance of engineering, the real cost of producing engineering graduates should be fully funded.***

¹⁰ Engineering UK 2007, The Engineering and Technology Board (ETB)

¹¹ Patterns of higher education institutions in the UK: Seventh Report – Universities UK, September 2007.

¹² Science, Engineering and Technology in the UK's Ethnic Minority Population, Royal Society 2005

¹³ UK SPEC Baseline Project, Final Report, EC^{UK} November 2007

- ***STEM course uptake (both HE and FE) should be incentivised by progressively writing off student debt for home students who follow careers which meet STEM skills shortages.***
- ***Efforts to raise professionalism among Engineering Technicians should be increased. The unions and employers will have key roles to play in achieving this.***
- ***The engineering community and businesses are already engaged with education providers on the content and structure of new qualifications, eg the Engineering Diploma. This should be continued and supported by consistency from Government over the future of new and existing qualifications.***
- ***Sector Skills Councils should work closely with the Engineering Council UK and the engineering profession to exploit the benefits of our internationally recognised competence standards for professional engineers and engineering technicians.***

5, The importance of engineering to R&D and the contribution of R&D to engineering

Engineering R&D tends to take place in industry and hence is often funded commercially rather than by Government. Where it is publicly funded, HEFCE is proposing changes to the way its quality is measured. The consequences appear to be that in future there will be even greater emphasis on pure science rather than applied engineering. As before, there is also still no explicit recognition of the value of first-class teaching and first-class knowledge transfer.

5.1 Currently there is also a lack of engagement between engineering graduates and the research their universities undertake (or could undertake). The Engineering Doctorate is a scheme that provides an indication of how much better this could be done. As well as expanding this scheme, the lessons learnt could easily be used to create a similar Engineering Masters programme

- ***Public funding of engineering R&D which looks to the longer term, including environmental and sustainable technologies, should be continued, e.g. the carbon capture and storage competition. However, this support should not be too narrow in its scope e.g. not restricted to just post combustion technologies in this case.***
- ***There should be a greater use of Engineering Doctorates, as compared with PhDs, and the scheme should be extended to include Engineering Masters.***
- ***Just as the RAE incentivises excellence in research, so first class teaching and first class knowledge transfer should also be incentivised.***

6. The roles of industry, universities, professional bodies, Government, unions and others in promoting engineering skills and the formation and development of careers in engineering.

This is already an active area. All of these bodies have a role to play in promoting engineering skills and careers. To ensure maximum impact and consistency of message and approach, these activities must be well coordinated. The engineering community working together on this response and the Royal Academy of Engineering leadership of Shape the Future are examples of what can be done to good effect.

6.1 Schools

Engineering's profile in UK secondary schools as a career choice is low and often poorly understood by non-specialist teachers and careers advisers. While the investment in the Science Learning Centres, the National Centres of Excellence in the Teaching of Mathematics, and the appointment of a National Director for STEM are welcome, their potential will only be fully realised if they are properly funded, applied across the whole of the school system and supported by well-informed and well-resourced teachers and careers advisers. Action to achieve this should include:

- ***Subject specialists for each STEM subject for every secondary school student, encouraged by increased incentives for practising science teachers subject to their achievement of agreed performance standards. There should also be additional reward and recognition for the most inspirational science and maths teachers.***
- ***minimum standards for STEM careers advice, improving the training of careers advisers and the information resources available to them, as recognised by recent DCSF initiatives.***
- ***an increased drive to raise mathematics standards at primary and secondary school. To this end, we welcome the undertaking of a review of primary school mathematics teaching by Sir Peter Williams. We recommend that every primary school Science Coordinator should be a science graduate.***

6.2 Universities should:

- ***be funded to ensure adequate practical education, and to embrace new methods of teaching and learning, for example Conceive, Design, Implement and Operate (CDIO).***

6.3 Industry should:

- ***work more closely with education providers, engineering institutions and with EPSRC and HEFCE to explain its skills needs, feed into course design and provide students with practical experience of engineering.***

6.4 Government

In addition to the recommendations made earlier in this report, e.g. on harnessing the potential of procurement as an innovative force:

- ***schools should be supported, as outlined above, with key potential contributions being to improve under-19 mathematics and physics skills.***
- ***As currently happens with Science (through the "Chief Scientist"), appropriate recognition should also be given to Engineering and Technology in the policy making process.***

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Appendix

The Professional Engineering Community Signatories

Institute of Acoustics
Royal Aeronautical Society
Institution of Agricultural Engineers
Chartered Institution of Building Services Engineers
Institute of Cast Metals Engineers
Institution of Chemical Engineers
Institution of Civil Engineers
British Computer Society
Energy Institute
Institution of Engineering and Technology
Institution of Engineering Designers
Society of Environmental Engineers
Institution of Fire Engineers
Institution of Gas Engineers and Managers
Institute of Healthcare Engineering and Estate Management
Institute of Highway Incorporated Engineers
Institution of Highways and Transportation
Institution of Lighting Engineers
Institute of Marine Engineering, Science and Technology
Institute of Materials Minerals and Mining
Institute of Measurement and Control
Institution of Mechanical Engineers
Institute of the Motor Industry
Royal Institution of Naval Architects
British Institute of Non-Destructive Testing
Institution of Nuclear Engineers
Society of Operations Engineers
Institute of Physics
Institute of Physics and Engineering In Medicine
Institute of Plumbing and Heating Engineering
Institution of Royal Engineers
Institution of Railway Signal Engineers
Institution of Structural Engineers
Chartered Institution of Water and Environmental Management
Institution of Water Officers
The Welding Institute
The Engineering and Technology Board
The Engineering Council UK