Submission to IUSS Select Committee

By the Engineering Council UK

1. This submission is intended to supplement the engineering profession's joint submission, which we support. It looks in more detail at those issues where we feel we can offer additional insight and analysis.

2. Key points we make are:

    - The engineering profession has established strong criteria for assessing professional engineers and engineering technicians (paragraphs 3-5, 11-13)
    - Engineering and the economy may suffer from failure to distinguish between engineering and science (paragraphs 6-9)
    - We suggest some reasons why the relatively healthy numbers of engineering undergraduates do not translate into adequate numbers of professional engineers, and explain how we are addressing this. (paragraphs 14-19)
    - We emphasise concerns about the supply of engineering technicians, while acknowledging promising developments with apprenticeships. (paragraphs 20-22)
    - In acknowledging the considerable effort and resource being applied to curriculum support and STEM outreach, we recommend more emphasis on evaluation of programme effectiveness. (paragraphs 23-25)
    - Mathematics is fundamentally important to engineering. School-leavers rarely have the mathematics skills of previous generations in those aspects of mathematics most important to the study of engineering. Various steps have been taken by the profession and by universities to address this, but concerns remain. (paragraphs 26-27)

About the Engineering Council UK

3. Created as a result of the 1980 Finniston Report[1], the Engineering Council UK (EC^{UK}) regulates the engineering profession in the UK by licensing 36 professional engineering institutions who are then able to place suitably qualified members on EC^{UK}'s Register of Engineers. The Register has three sections: Chartered Engineer, Incorporated Engineer and Engineering Technician. The UK's Register of around 250,000 professional engineers and technicians is the largest such register in the developed world.

4. EC^{UK} has developed standards for registration which reflect employer needs. We work closely with employer organisations, and with the education sector, to ensure that the competences needed to practice engineering are understood, and that qualifications to underpin these are identified, and where possible accredited.

[1] Cmnd 7794

5. EC[UK] works with national regulatory bodies in many parts of the world, and has a good understanding of the standards applied in other developed and developing countries.

The role of engineering and engineers in UK society

6. We believe that engineering often suffers from its association with science. While a good grasp of science and maths is essential to practise engineering at every level, engineering also requires creative talent, and usually a greater ability to communicate with people not directly involved in the science – customers, fellow professionals and those who create and market engineered artefacts.

7. Hence engineers require a broader education than scientists, and their careers are far less likely to be in academia. Engineers from apprentices to senior managers require professionalism and communication skills – particularly as business and industry are placing greater responsibilities on technicians as well as professional engineers. Unlike the situation in the sciences, pathways exist for engineering technicians to progress into the highest echelons of the profession, and there are many examples of this - 8 of the last 25 IMechE Presidents served apprenticeships, for example.

8. These differences often lead to engineers being underappreciated; their contribution to the national science base is inevitably more muted, and the role of the engineer, the imaginative problem-solver, relegated to a support act (the idea that rocket scientists put the spaceship up – engineers fix it when it goes wrong). This highlights the need for engineering to be differentiated from science as a different, but equally worthwhile career.

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

9. Because of the differences in the way professional engineers are trained and educated (professional formation), it is far less likely that they, unlike scientists, will come into contact with leading edge university research. It is much rarer in the UK than on the continent for senior engineering management to transfer between industry and academia. Despite much effort to improve knowledge transfer/exchange and technology transfer, industry/academia contact is limited – especially for SMEs.

The state of the engineering skills base in the UK, including the supply of engineers and issues of diversity

10. We introduced UK-SPEC, as a national standard for registration of professional engineers, in December 2003. This was a changed approach, less prescriptive than before and deliberately designed to encourage innovative HE provision, and recognise the widening variety of pathways to engineering technician practice.

11. Many of the issues facing engineering (recruitment, retention, maths skills) are global, and the UK has arguably been more successful than many other developed countries in addressing some of them[2]. However we are only too

[2] FEANI Position Paper: *Engineering Skills in Europe* (2007);

aware that much more could be done within UK engineering to tackle widespread and complex diversity issues[3].

Higher Education

12. Transition issues meant that the effects of the standard are only just starting to be felt, with new types of HE courses appearing. We require that industry is always involved in accreditation processes. UK-SPEC gives credibility to education programmes with strong industrial involvement – and these are the types of universities increasingly targeted by employers in their graduate recruitment. The Higher Education Academy Engineering Subject Centre has provided significant help in creating the circumstances in which good practice can flourish, and we work closely with it.

13. In order to keep pace with industry requirements, we encourage the professional institutions we license to embrace issues of systems design, sustainability and ethics.

14. We have also encouraged engineering academics in both further and higher education to become professionally qualified – we are concerned that many young learners are being taught engineering by those with limited engagement with the engineering profession. We are aware that the pressures of the Research Assessment Exercise can deter those in their early academic career from working towards professional qualifications. We would like to see engineering professional qualifications recognized in the next RAE/REF.

15. Significant numbers of engineering graduates are lost to the profession, although this varies between disciplines. There is some evidence this may be due to poor postgraduate training prospects. It is also possible that some entrants to undergraduate programmes lack the mathematics and science to cope.

16. Statistics indicate that the numbers of engineering graduates (home students only) has grown 6% in the past five years, reaching 16,300 in 2006[4]. With ONS identifying 425,000 professional engineers in the working population[5], this implies a 53% higher replacement rate than would be required, assuming an average 40 year working life. The calculation is necessarily crude as many pure scientists become engineers, and many of those who are claimed to be professional engineers are probably underqualified, but the ONS does not necessarily include individuals who have other job titles – managerial, military or other public servants. On the other hand there are indications of immigration of engineers from Eastern Europe – especially into construction, and retention of at least some of the non-UK graduates, particularly in academia. Clearly significant numbers of graduate engineers are not joining the profession.

[US] National Academy of Engineering Report: *The Engineer of 2020: Visions of Engineering in the New Century* (2004)

[3] E.g. extensive research by the Equal Opportunities Commission (now EHRC), UK resource centre for women in science, engineering and technology (including Athena/Swan datasets) http://www.ukrc4setwomen.org.uk/ Bagilhole et al. 2007; Faulkner, 2006

[4] *Engineering UK 2007*: ETB: page 40

[5] *Engineering UK 2006*: ETB: page 58

17. Strong evidence for the declining availability of graduate training was found in the surveys conducted by DTI and Barclays Bank in the early 2000s. These showed successive decline in the numbers of engineering graduates finding graduate training programmes (to 32% in 2002)[6], while an in depth study by Maillardet and Eraut (LiNEA)[7] seemed to indicate that much graduate engineer training was narrow and of poor quality.

18. The HESA Longitudinal Survey for 2007[8] reflects recent first destination surveys of graduates (6 months after graduation) in showing that engineering graduates are experiencing higher unemployment than the average for all graduates (11% in 2006). However, the same survey finds that engineering graduates experience amongst the lowest unemployment rates - at 1% - by three years after graduation. It seems very possible that, faced with a dearth of good engineering-related graduate training, and few jobs in engineering being available for those without experience, engineering graduates have reluctantly sought jobs in other sectors.

19. EC[UK] is currently working to develop a wider range of work-based qualifications that place emphasis on enabling more diverse access to HE, responding both to the government's prioritisation of employer engagement, and a perception that the availability and quality of industrial training has not kept pace with the need for professional engineers.

Further education sector and vocational skills

20. The FE sector, including related work-based learning programmes supply a crucial and substantial part of the engineering skills base. Industry places increasing responsibility on levels 3 and 4 technical staff – technicians. However there is evidence that the UK lags far behind the continent in developing and nurturing technician skills, resulting in significant shortfalls at levels 3 and 4 in the broad engineering workforce[9]. LSC data indicates that engineering and manufacturing technologies (EMT) remained the most popular work-based learning sector subject area in 2006/07 (92,100 learners) – and there were 166,700 learners across EMT, construction, and ICT. In non work-based further education in 2006/07 there were nearly 559,000 learners across the same engineering disciplines.

21. However these numbers appear to be dropping year on year – around 22% down between 2005 and 2007 in FE, and 5% down in work-based learning. Moreover not enough are at level 3 or 4. It is important that full advantage is taken of the opportunity offered by the recent Apprenticeship review, including its welcome focus on diversity issues (only 2% of engineering apprentices are female and only 4% are from ethnic minority communities). The revision of Apprenticeship frameworks offers a timely opportunity to develop more Advanced Apprenticeship

[6] *The Graduate Experience 2002 Report*: March 2003: CEL (final of a series)
[7] *Early Career Learning at Work: LiNEA*: Eraut and others: 2005
[8] *Destination of Leavers: Key Findings Report 2007*: HESA: page 14
[9] See for example Leitch Review p15

frameworks which link to EC[UK] standards for professional registration as an Engineering Technician.

22. Engineering benefits from significant numbers of adult learners, who often bring experience valued by employers. It is important that funding systems in both HE and FE provide adequate support for adult learners wishing to enhance their education and skills.

The role of professional bodies in promoting engineering skills and the formation and development of careers in engineering

23. There has long been in the engineering profession[10] a widespread view that the best way to ensure a steady supply of engineers for the future is through supporting a broad and balanced curriculum – which reaches all young learners. This particularly includes mathematics, design & technology, and physical sciences, but is not by any means limited to these. Major programmes such as those funded by Gatsby, Nuffield, professional engineering institutions, and relevant subject associations (particularly mathematics, design and technology, and science), have been collected together and widely disseminated through the Shape the Future Programme directory. Together these form a set of outreach activities that might be scaled up to provide high quality first hand experience of inspirational and challenging engineering to every child. The work of these organisations and many others in similar fields is underpinned by the Science and Engineering Ambassadors scheme and the SETPOINTS run by STEMNET with Government funding. More work is needed, however, on ensuring that such activities reach more young people.

24. A call by the Engineering Education Alliance[11] and more recently by the STEM Programme that all activities should have independent evaluation built in from the start needs to addressed to ensure that limited resources are being applied where they may have most effect. No major longitudinal study of progression choices, and curriculum and other influences upon these, has been attempted since 1980[12] and such qualitative and quantitative insight would be of considerable benefit[13].

25. We believe it would be wise to invest in such research into the long term efficacy of the various schemes, and to strongly encourage integral independent evaluation of relevant projects, so that future resource can be applied where it will have most effect.

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[10] e.g. Assistant Masters' and Mistresses' Association and The Engineering Council (1988). *Schools Institution Working Group* (*1999*), and National Institute for Careers Education and Counselling *Interim Report to the Engineering Council*, (2000)

[11] EEA guidelines (2004): http://www.the-eea.org.uk/project_archive/resource_guidelines.cfm

[12] Berthoud, R. and Smith, D. J. (1980). *The education, training and careers of professional engineers*: prepared for The Committee of Inquiry into the Engineering Profession by the Policy Studies Institute. Department of Industry. London: HMSO

[13] EEA report into the barriers to engineering (2006): http://www.the-eea.org.uk/project_archive/barriers_into_engineering.cfm

Mathematics

26. As the joint response has indicated, a significant constraint on entry to engineering degrees (and a possible reason for relatively high drop-out rates) is lack of mathematics skills. This reflects shortages of well-qualified mathematics teachers[14], and the changing nature of national examinations such as AS and A2. These serve a variety of purposes and we would not expect their syllabi only to be appropriate for those requiring extended mathematics skills in later life. However, the Engineering Professors' Council has stated that "one of the problems facing all engineering departments [is] mathematics fluency of their new students…" It has also noted that "there [is] also a problem because of the downturn in the numbers taking the now-optional mechanics modules." [15].

27. Universities have striven to accommodate change, and most engineering departments now offer some form of supplementary mathematics support during the first year. However this cannot be the only response. There are two developments which particularly merit wide support. Funding from DCSF has allowed the Further Mathematics Network (which EC[UK] has supported from its original pilot by the Gatsby Trust) to enable Further Mathematics A level to be studied by many who would not otherwise have such opportunity. It is important that the Network can continue to grow and that all involved in engineering – the profession, industry and universities – support it. The second development is the work done by a number of engineering educators and bodies to develop an applied mathematics unit to provide additionality to the new Engineering Diploma at level 3. This could develop into a more relevant qualification for engineering than Maths A level and should be strongly supported.

EC[UK]/ 14 March 2008

[14] *The UK's Science and Mathematics Teaching Force*; Royal Society 2007
[15] Notes from the meeting with Jacqui Smith, Minister for Schools: 22nd March 2006: www.epc.ac.uk