Research Report

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Progress through partnerships

Engineering UK 2007

A Statistical Guide to Labour Supply and Demand in Science, Engineering and Technology

produced in association with

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> Foreword

Welcome to the 2007 edition of Engineering UK, the Engineering and Technology Board's (ETB) guide to labour market supply and demand in science, engineering and technology (SET).

We believe that Engineering UK will play a vital role in supporting evidence-based policy making across public-sector stakeholders, as well as providing useful information for employers, partner bodies, associations and institutions at home and abroad.

With the implementation phase of 'Leitch' now firmly underway, we look forward to the creation of the UK Commission for Employment and Skills with effect from April 2008. The Commission will play a vital role in achieving the Government's ambition of a world class profile on skills by 2020, the aspiration of an 80% adult population employment rate, and ensure that employers play a pivotal role in the UK's employment and skills system.

A number of important initiatives are being undertaken across the UK to foster interest in, and development of, high quality employees in the Science, Engineering and Technology (SET) sector. For example, in England the launch of the new 14-19 Diplomas covering the first five of what will be a total of 14 employment sectors includes an Engineering Diploma. The aim is to give learners a solid foundation in engineering principles and provide them with the thinking and learning skills needed for future employment and self development. The Diploma will combine theoretical and practical learning with English, Mathematics and ICT and will provide an opportunity for learners to incorporate other courses of study such as vocational qualifications, GCSEs and GCE A Levels.

The new Scottish Government's *Skills for Scotland, A Lifelong Skills Strategy*, published in September 2007, highlighted the need for skills valued and required both by employers and individuals and outlined the responsibilities and expectations of all those involved in skills development. As part of this Strategy it has been announced that Careers Scotland and Learndirect Scotland will merge to form a single skills body. The ETB looks forward to the continuing evolution of this new strategy.

The need for employers to up-skill their workforces has never been more urgent and the potential payback for investing more in training and workforce development never greater. Policy imperatives are increasingly focused on raising employer ambition and demand for skills, and investing in their management, leadership and HR practices in particular.

Major new projects, such as the £3 billion new aircraft carrier programme, are generating significant demand for more high-quality apprentices – in this case a 50% increase in shipyard apprentices in Scotland. Scottish Enterprise has launched a new Scottish Marine Technologies Training Project, bringing together private and public sectors, to maximise future skills and training opportunities in the industry. The ETB welcomes such initiatives.

These developments now present a once-in-a-generation opportunity to ramp up the skills base of SET businesses in the UK to enable them to compete on the global, as well as local, stage.

The creation of continuously developing skilled employees and leaders of the future takes time and we should not underestimate the effort and resources that will be required to make significant progress in this area.

Research into public perceptions of engineering and engineers contained in this report has shown that although many of the problems now faced by the world – such as those created by pollution – may be perceived as a biproduct of engineering and technology-enabled progress, the solutions to these problems are widely recognised as being critically dependent upon the successful application of SET.

Therefore, the public expects the SET sector to find the answers to disposing of nuclear waste, providing clean water and sanitation for all, reducing air pollution, improving water quality and mitigating climate change.

Commercial application of SET will make a significant contribution to solving the problems of today and of tomorrow. We need to help a secure future for all mankind that benefits individuals, businesses and UK plc.

Our partners each have their own role in helping to achieve up-skilling to meet the needs of business in the twenty-first century. Sector Skills Councils have been tasked as being the voice of the employer. Within this landscape the ETB's duty will be as the voice of the employee; the chartered engineer, the incorporated engineer, the engineering technician, the apprentice and the future engineer.

We will rise to the challenge and hope you will too.

Dr John Morton
Chief Executive
The Engineering and Technology Board (ETB)

> Introduction

Engineering UK 2007 is the tenth in the series of statistical digests published annually by the Engineering and Technology Board (ETB). It is aimed at anyone with an interest in labour market supply and demand within the science, engineering and technology sectors.

Each edition of *Engineering UK* is designed to build on the information contained in previous versions of the publication and this year is no exception. With a wealth of data and analysis based on published sources and our own research, this compendium aims to provide an insight into key issues and changes impacting on the science, engineering and technology labour market.

The report has been a collaborative effort and in particular we would like to thank our colleagues at Engineering Council UK (EC^{UK}) for their support in the creation of this report.

We hope you find this report useful, interesting and stimulating. Further copies can be downloaded from our website **www.etechb.co.uk** together with additional data and research briefings on a wide range of research topics.

We welcome all the feedback we receive and if you have any comments or suggestions as to how the report or its contents can be improved or expanded upon, please contact us.

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> Executive Summary

As competition both within the UK and internationally continues to become more intense, world-class engineering and technology innovation and creativity will be a crucial element in maintaining the UK's economic prosperity.

As well as underpinning prosperity, new technology and innovation will play an important part in addressing key global and domestic challenges, such as climate change and security. They can also deliver improvements in other areas such as education, health and culture.

The UK Government has a long-term vision for the country to be in the upper quartile of Organisation for Economic Co-operation and Development (OECD) skills rankings by 2020 by meeting the recommendation by the Leitch Review of Skills[1], which proposed a series of stretching objectives for the UK to reach by 2020.

These objectives are that by 2020:

- The total number of Apprenticeships will double to 500,000
- 95% of adults will achieve basic functional literacy and numeracy
- Over 90% of adults will be qualified to at least Level 2
- 68% of adults will be qualified to Level 3
- Over 40% of adults will be qualified to Level 4 and above.

The Government has made it clear that "Achievement of the targets… and the longer-term vision will depend on a shared ambition with individuals and employers; it is not a matter of public investment alone."[2]

It has also made clear the need for a "strong supply of scientists, engineers and technologists" that will be essential if the UK is to have "sustainability of the research base giving UK businesses and public services the drive and capability to innovate".[3]

Engineering UK 2007 sets out to examine some of the key quantitative aspects of engineering and engineering-related education and employment in the UK. Some of the key findings are summarised overleaf.

1 **Leitch Review of Skills:** Prosperity for all in the global economy – world class skills – December 2006

2 **HM Treasury PSA Delivery Agreement 2:** Improve the skills of the population, on the way to ensuring a world-class skills base by 2020 – October 2007.

3 **HM Treasury PSA Delivery Agreement 4:** Promote world class science and innovation in the UK – October 2007

Secondary Education

- There will a substantial decline in the number of school-leaving-age pupils over the next decade that will see around a one-in-six reduction in that age group. This will have significant implications given the Government's stated desire to double the number of apprentices and encourage still more to enter Higher Education (HE) as a result of a Department for Information, University and Skills (DIUS) initiative to partner every secondary school with a university[4].
- Given the Government's policy commitment to improving functional numeracy it is of concern that although entry volumes for GCSE Mathematics have been rising steadily year-on-year, the pass rate (A* to C grade) remains a disappointing 55%. Far more must be done to raise the pass rate otherwise a substantial minority of pupils will continue to be excluded from pursuing a career in engineering.
- Volumes of GCE A Levels and Higher Grade Chemistry and Physics candidates continue to grow albeit slowly, with in England a 50:50 male:female ratio, and a 96% pass rate in Chemistry and a 78:22 male:female ratio, and a 95% pass rate in Physics. The pass rates for Highers were 76% and 73% respectively.

Further and Higher Education

- In England over the last three years the volume of engineering learner numbers in Further Education (FE) has fallen by a quarter. This must be a concern to the sector as a whole and especially those seeking to employ technicians.
  - Achievement rates for engineering and related subject Apprenticeships are around or just above three-in-five. There is clearly capacity for improvement in completion rates, which would have a significant impact on the volume of available technician-grade engineers.
  - The proportion of female engineering apprentices in learning is as low as 3%. This strand of education exhibits the greatest gender imbalance of all and provides the greatest opportunity to correct this disparity.
- HE participation rates across the UK are getting closer to reaching the Government target of 50%; however, this policy focuses on HE and risks diverting learners who might otherwise follow a more appropriate and equally important vocational path through FE.
  - The volume of UK-domiciled 18-22 year olds is forecast to fall significantly in the decade after 2010, which may impact on university admission policies for UK and overseas students at first degree level. This effect is the lag of the drop off in school leaver volumes described earlier.
  - The number of engineering and technology undergraduates has remained stable over the last six years at just under 100,000. However, the growth of other subject areas has resulted in a significant decline in the share of all students that engineering and technology subjects account for, from just over 9% to just over 6%.

4 Government calls on universities to partner schools to tap into talent – http://www.dius.gov.uk/press/10-10-07a.html – DIUS – 10th October 2007

- Whilst the proportion of non-UK students in engineering and technology has increased steadily over recent years, well over half of students across all taught postgraduate engineering at UK universities, are domiciled outside the EU. In some engineering strands non-EU domiciled students account for as many as two-thirds of places.
- UK-domiciled Electronic and Electrical Engineering acceptances have fallen sharply over the last five years, and now approach half the volumes achieved at the beginning of the decade. Most other stands of engineering have remained stable over the period.
- In recent years the proportion of female students reading engineering and technology subjects has remained stable at about one-in-six, with no improvement in the gender imbalance.

Employment

> The unemployment rate of engineering and technology graduates six months after graduation is one of the highest of any subject category at around 8%. Within engineering and technology the rate varies with Civil Engineering enjoying the lowest rate at less than 4%. This begs the question as to why such unemployment exists when there is a claimed shortage of engineers.

> Around three-in-ten engineering and technology graduates and about one-in-four postgraduates enter work with employers in the finance and business sectors (SIC 2003 Code Sections J and K), although this category does include a number of activities that can be classed as engineering or engineering related. This indicates that a large proportion end up working in non-engineering occupations.

> The majority of engineering and technology graduates take up positions in SOC Code Professional Occupations, with a further one-in-six in Associated Professional and Technical Occupations.

> The proportion of graduates entering professional engineering occupations six months after graduation has risen over the last three years, with Civil Engineering graduates most likely to do so (74%).

Professional Registration

> The total number of registered engineers has fallen by 21,500 or by 8% in the last decade. The survey of registered engineers data suggests that recognition, enhanced remuneration, other benefits and workforce development opportunities would encourage more engineers to become registered.

- The mean age of Chartered and Incorporated Engineers is 55, whilst Engineering Technicians' mean age is 50. Over a quarter of Chartered Engineers are aged over 65. This illustrates the age profile for registered engineers, which has been getting steadily older over the last two decades.
- Starting salaries for engineers compare very favourably with those for most graduate occupations, with Civil Engineering leading the way on £23,000 pa, although accountants, solicitors and investment bankers typically begin on 25-50% more.
- Mean salary levels for Chartered Engineers, Incorporated Engineers and Engineering Technician grades of registered engineers have grown significantly over the last decade.
- The proportion of female registered engineers is growing, but very slowly, so that they account for just over 3% of the total only. All the growth is at Chartered Engineer grade.

Public Engagement

> Awareness and knowledge of engineering amongst the general public is relatively poor – especially amongst women, those aged 16-19, and those of a lower social grade.

- Well over half of the public think they are either not very well informed or not at all informed about the work of engineers. Just one woman in twenty, and the same proportion of 16-19 year olds, considers themselves to be very well informed about the work of engineers.
- Over half of adults agreed that 'hardly anyone knows what engineers do', and four-in-five adults agree that there are 'so many types of engineer, it is confusing for the average person to understand'. This indicates a significant knowledge gap about engineering and engineers.
- Around five-out-of-six adults agreed with the statement that 'engineering is essential for all human development' and that 'engineering is a well-respected profession'. However, a far lower proportion of 16-19 year olds agreed with the former (68%), which suggests that the contribution of engineering to human development is not as widely recognised among the young.
- Communication with the public about engineering and what contribution it can make to society needs to be straightforward and relevant to their interests and concerns. It also must be focused on the benefits accrued from solving problems facing mankind in the twenty-first century.

Skills and the Lisbon Agenda

> The key role that skills play in raising participation in employment and productivity – alongside capital investment, innovation and enterprise – needs to be better understood and communicated.

> There is a widely recognised need to increase sectoral productivity which can be facilitated by raising skills levels.

> The likelihood that the revised Lisbon R&D expenditure target of 2.5% of UK GDP will be reached is low. Both private and public sector R&D investment performance must be improved in order not only to hit the Lisbon target, but also to raise productivity and profitability in the longer term.

> The key to success in meeting the skills challenge is in the development of management and leadership skills at all levels from first-line supervisory level right to the top.

The need to better match supply and demand for suitably qualified engineers and technicians is clear. All parties with an interest in the success of UK PLC will need to address this need through their areas of responsibility. This must involve not only public sector interventions, but also employers, training providers, educational establishments – from primary school to business school – professional bodies and associations, campaigning groups and all other stakeholders with an interest in the success of engineering and technology and the part it can play in the success of the wider economy. We all have a part to play to inform, educate, support and inspire the engineers and technicians of the future.

The managers and leaders in the engineering and technology sector of today and tomorrow will need to grasp their critical role in making this happen.

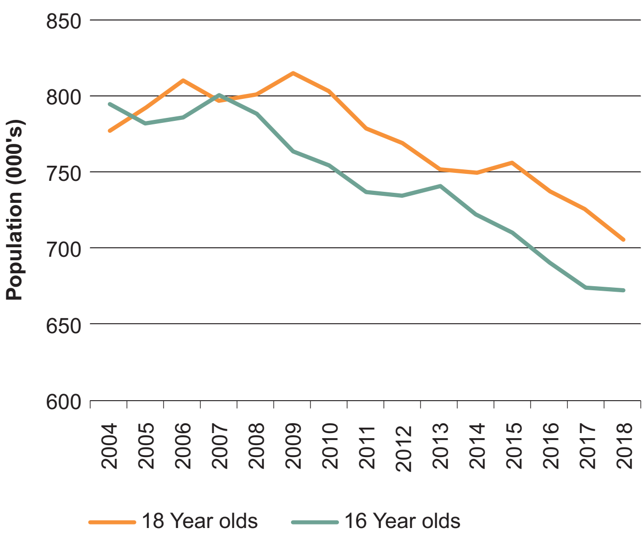
1. Secondary Education

This chapter reviews secondary education level qualifications that prepare learners for further and higher level qualifications in the various Science, Technology, Engineering and Mathematics (STEM) subjects. Examination outcomes are considered for subjects that are key to meeting the future demand for related skills in the workplace, and consideration given to the impact of demographic trends on the future supply side.

1.1 The Cohort: 16- and 18-Year-Old Populations of the UK

Population estimates and projections for the numbers of 16- and 18-year-olds living in the UK are shown in Figure 1.1. From 2007 onwards Government estimates suggest that the population of 16-year-olds will decline fairly steadily for the next decade with the population of 18-year-olds following likewise.

Figure 1.1: Population Projections for 16- and 18-Year-Olds



Source: ONS and Government Actuaries Department – Populations Estimates Base 2004

From a peak of 800,000 in 2007 the volume of 16-year-olds is set to fall by 127,000 (-16%) by 2018, whilst the volume of 18-year-olds will peak in 2009 at 815,000 falling by 109,000 (-13%) by 2018. This reduction in the population of young people coming through the education system will have a significant impact on workforce supply. In 2004 the proportion of the 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. To put this in context, the Government Actuaries Department (2005) forecasts that the population of working age (allowing for changes in retirement age) will rise from 37.1 million in 2004 to a projected peak of 40.5 million (+9.2%) by 2020, remaining stable thereafter.

1.2 GCSEs/Standards

The General Certificate of Secondary Education (GCSE) is the primary qualification taken by secondary school pupils aged 14-16 in England, Wales and Northern Ireland. GCSEs can be taken with other awards, such as General National Vocational Qualifications (GNVQs). In Scotland the equivalent qualification is the Standard Grade, commonly known as 'Standards'.

There are alternative qualifications gaining currency in some schools, including the International GCSE (or IGCSE). For 2006 and 2007 the Qualification and Curriculum Authority (QCA) decided not to recognise the IGCSE for league table or funding purposes, although an exception was made this year (2007) for the IGCSE in Mathematics, the results for which were included in the Level 2 Mathematics totals for 2007. The IGCSE is gaining in popularity because it can be structured to more closely follow the perceived greater academic rigour of the former GCE 'O' level, abolished in the late 1980s.

1.2.1 England, Wales and Northern Ireland

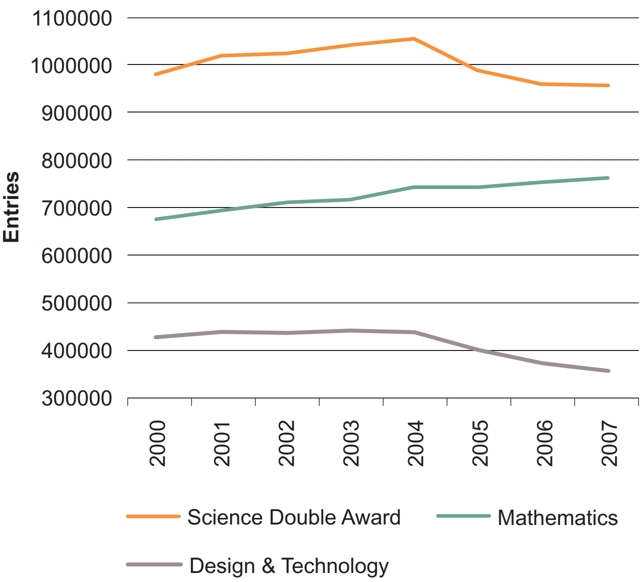
GCSE candidate numbers have fluctuated between STEM subjects over recent years. The Double Science Award has remained easily the most popular of the GCSE science subjects with around half a million candidates taking this exam 'pairing' each year over the last eight years. This reached a peak in 2004 with a 9% decline to 2007 (Figure 1.2 overleaf). In 2006 substantial numbers of candidates took the Applied Science (Double Award) GCSE, and in 2007 the single Applied Science GCSE instead.

There have been recent policy moves to encourage more candidates to take the 'single sciences'; Physics, Chemistry and Biology GCSEs, as separate subjects. Concerns have been expressed that because candidates may not take all three of these separate sciences, individual progression options may be limited to those subjects they chose to study at GCSE. However, numbers of candidates have grown, with around 60,000 taking at least one of these single sciences in 2007 (see Figure 1.3 overleaf).

A similar trend has been experienced with Design & Technology, which has seen a fall in candidate numbers since it ceased to be a statutory subject at Key Stage 4 (ages 14-16) in the National Curriculum (England) in 2004. However, it remains by far the most popular of all optional GCSE subjects, with around 355,000 UK candidates in 2007. Furthermore, A* to C pass rates in Design & Technology improved (provisionally) by 1.2% to 59.8% in 2007 from 2006.

The number of GCSE Mathematics entries has risen steadily; up 13% over eight years to 760,000 in 2007 and it is the most popular single subject. Although the Level 2 pass rate (grades A* to C) was up (provisionally) by 0.9% from 2006, it is a disappointing 55.2% in 2007. Science Double Award A* to C results rose by 0.3 % (provisionally) to 58.6% in 2007.

Figure 1.2: GCSE Full Courses Entries - All UK Candidates (a) (2007 Provisional)

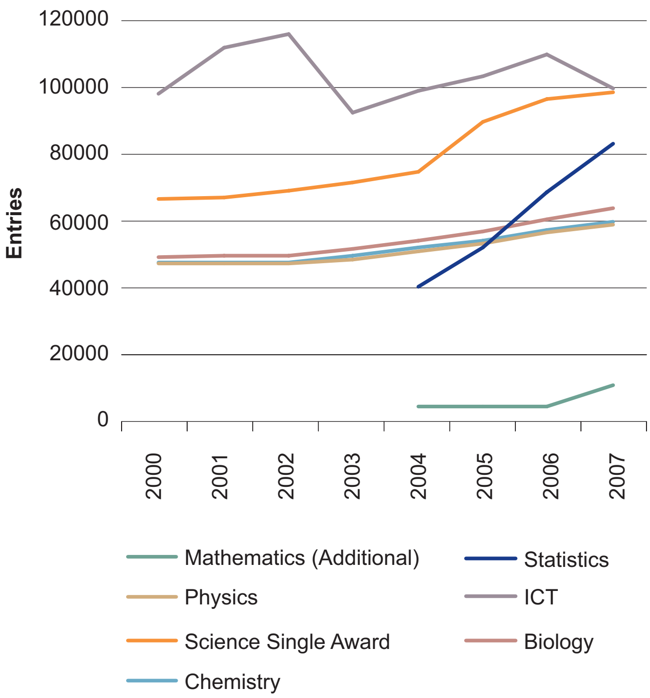


Source: Joint Council for Qualifications 2001-2007
NB - Science Double Award candidate numbers are counted twice.
2007 candidate numbers were approximately 478,000.

As can be seen in Figure 1.3 other STEM single subject GCSEs experience lower entry volumes. Whilst annual ICT GCSE levels have remained broadly unchanged, candidates for Single Science Awards are up a third and those taking Statistics have more than doubled since 2004.

Pass rates for Biology (89%), Chemistry (90%) and Physics (91%) remain very high and continue to grow very slightly. In contrast the pass rate for Additional Mathematics fell from a very strong 91% in 2006 to 79% in 2007 – due perhaps in part to a tripling of the number taking the exam in 2007 to a total of 9,793 (provisional) in 2007. The A* to C pass rate for Statistics has risen very slightly to 71% (provisional), despite a steady and rapid increase in candidates, totalling 82,682 in 2007. Having already overtaken Biology, Chemistry and Physics in volume terms, at its present rate of growth, Statistics will overtake Single Science and ICT in popularity within a couple of years. With respect to the Single Science Award, only a quarter of the 100,000 entries attained a pass grade (A* to C), which may indicate that this subject is seen as something of a second choice.

Figure 1.3: GCSE Full Courses Entries - All UK Candidates (b) (2007 Provisional)



Source: Joint Council for Qualifications 2001-2007

1.2.2 Scotland

The Scottish Qualifications Authority (SQA) has responsibility for the development, assessment and certification of most qualifications in Scotland, excluding university degrees.

Standard Grades are the primary qualification taken by students aged 14-16 in Scotland and broadly align with GCSEs. There are three 'tiered' levels at which Standard Grade examinations can be taken; Foundation, General and Credit. Typically students sit either the Foundation and General level papers together or the General and Credit level papers together, at one sitting. The Standard Grade examination is being phased out with gradual realignment to Scottish Credit and Qualification Framework (SCQF).

Table 1.1 shows the volume of entries for the different Standard Grade examinations by STEM subject in 2007. SCQF Level 5 is roughly equivalent to NQF (England, Wales and Northern Ireland) Level 2. It is evident that STEM subjects remain very popular in Scotland.

Table 1.1: Standard Grade Entry Volumes (SCQF Levels 3-5) 2007

	Standard Grade	Access 3 Foundation Standard Grade SCQF Level 3	Intermediate 1 General Standard Grade SCQF Level 4	Intermediate 2 Credit Standard Grade SCQF Level 5
Biology	22,787	2,798	5,146	6,615
Chemistry	20,077	2,182	2,479	3,724
Computing	16,040	769	2,024	2,682
Engineering Craft Skills	n/a	n/a	73	354
Information Systems	n/a	n/a	n/a	1,993
Mathematics	53,973	10,791	11,434	18,987
Physics	15,940	1,637	2,092	3,350
Science	4,205	n/a	n/a	n/a
Technology Studies	1,771	n/a	n/a	n/a

Source: Scottish Qualification Authority (SQA), Scottish Credit and Qualification Framework (SCQF) – 2007

1.3 GCE A Levels/Scottish Highers

The General Certificate of Education Advanced level (GCE A Levels) is the primary post-GCSE qualification taken in the last two years of secondary school, sixth-form college or Further Education (FE) college in England, Wales and Northern Ireland. The Advanced Supplementary (AS) Level examinations were first introduced in 1987 and since 2000 have represented a milestone examination at the end of Year 12 (Year 13 in Northern Ireland). The equivalent qualifications in Scotland are the Higher Grade or Advanced Higher Grade, usually known as 'Highers' – which are set at SCQF Level 6, roughly equivalent to National Qualifications Framework (NQF) Level 3.

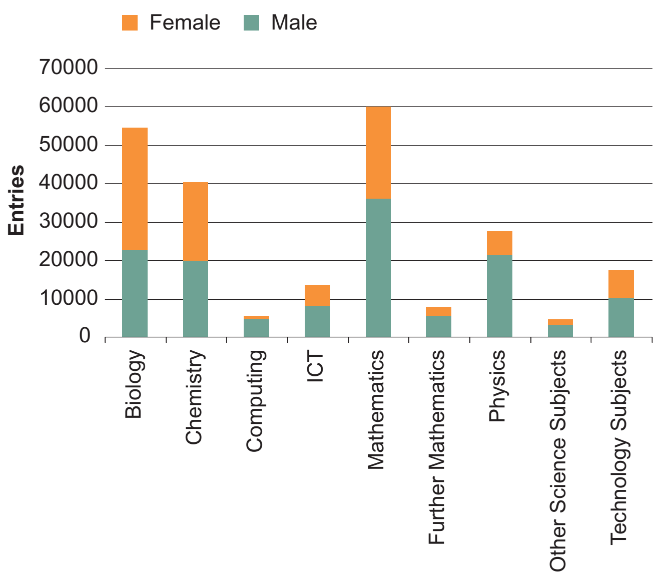
Of more 'niche' qualifications, the 'Pre-U' is offered as a post-16 qualification which is designed to prepare students with the skills and knowledge they need to make a success of their subsequent studies at university. Cambridge International Examinations (CIE) – the University of Cambridge Local Examination Syndicate – submitted its Pre-U syllabuses to the QCA for accreditation in June 2007 with the intention to have the Pre-U placed in the National Qualifications Framework (NQF). The CIE is working to deliver the first Cambridge Pre-U syllabuses available for first teaching in September 2008.

The International Baccalaureate (IB) Diploma Programme is a two-year curriculum, primarily aimed at pupils aged 16-19. The Welsh Baccalaureate, for example, has a core syllabus and options including GCSE, VGCSE, GCE AS/A Levels, VCE (Vocational GCE A Levels), GNVQ, NVQ, and BTEC.

1.3.1 England, Wales and Northern Ireland – A and AS Levels

An analysis of the selected STEM subjects shown in Figure 1.4 shows that the total number of candidate entries for these GCE A Levels subjects is provisionally 1% higher in 2007 than in 2006, explained entirely by an increase in female candidates. Mathematics remains the most popular of these subjects, with Biology close behind – enjoying a higher proportion of female candidates with a male:female ratio of 2:3. Chemistry is firmly in third place.

Figure 1.4: GCE A Level Entries 2007 by Gender (Provisional)

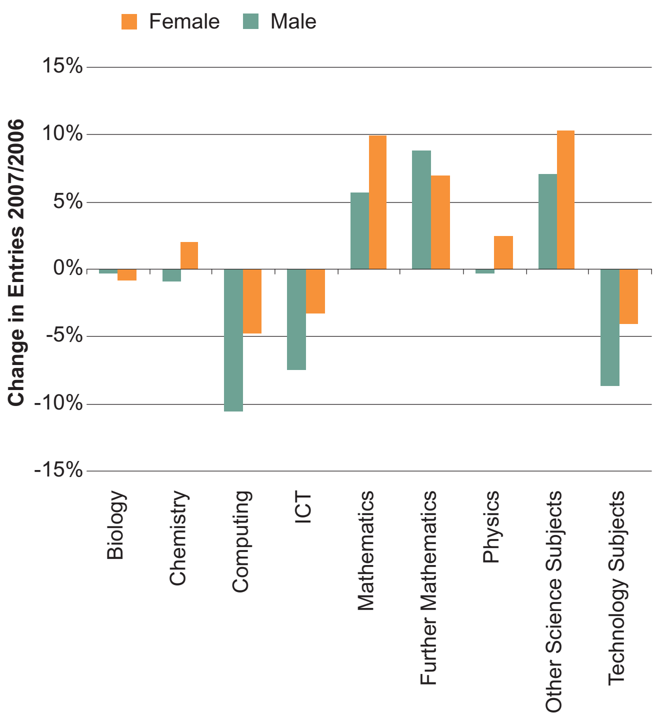


Source: Joint Council for Qualifications 2007

Whilst the ratio of male to female candidates varies somewhat from subject to subject, taking these selected subjects as a whole the proportion of males is 57% and female 43%. However, within this there are stark differences, for example in Physics, and Computing/ICT, where the gender ratios remain very unbalanced. Provisional figures for 2007 do however indicate a small rise in the numbers of females taking GCE A Levels Physics, up by 149 candidates over 2006.

Figure 1.5 shows increases in GCE A Levels candidate volumes for Mathematics and Further Mathematics in the provisional 2007 data compared to 2006, but a fall in entries for Computing/ICT and in Technology Subjects among both genders, and even more so for male students. The continuing fall in Computing/ICT may reflect a return to a more stable long-term level following a surge in entries around 2002. After a consistent rise over the last decade to 2006, unique among GCE A Levels subjects, Technology Subjects have experienced a fall, no doubt a reflection of the downturn in GCSEs taken in the subject in the run-up to removing the GCE A Levels subject from the statutory curriculum (England) in 2004.

Figure 1.5: Change in GCE A Level Entry Volumes 2007 by Gender (Provisional)



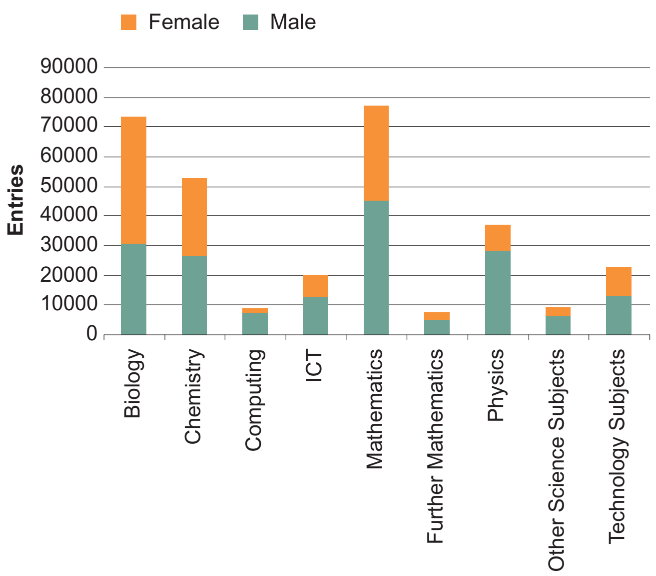
Source: Joint Council for Qualifications 2007

Entry volumes for Chemistry and Physics show a slight shift towards female candidature with a small upward trend in overall volumes from 2006 to 2007 (provisional).

JCQ[5] figures for GCE AS Levels show a similar pattern to that of GCE A Levels. Total entries for the selected subjects have risen 3% compared to 2006 and the male:female ratio remains at 57:43.

A consideration of GCE AS Levels subject data (JCQ 2007) shows a similar overall pattern to that found with same subjects in GCE A Levels (Figure 1.6). Biology enjoys a female-biased profile (58%), although Chemistry is almost exactly in gender balance. Both Mathematics and Technology Subjects see a male:female ratio of about 3:2 with Further Maths and Other Science Subjects running at 2:1. There has been little change in these ratios between 2006 and 2007.

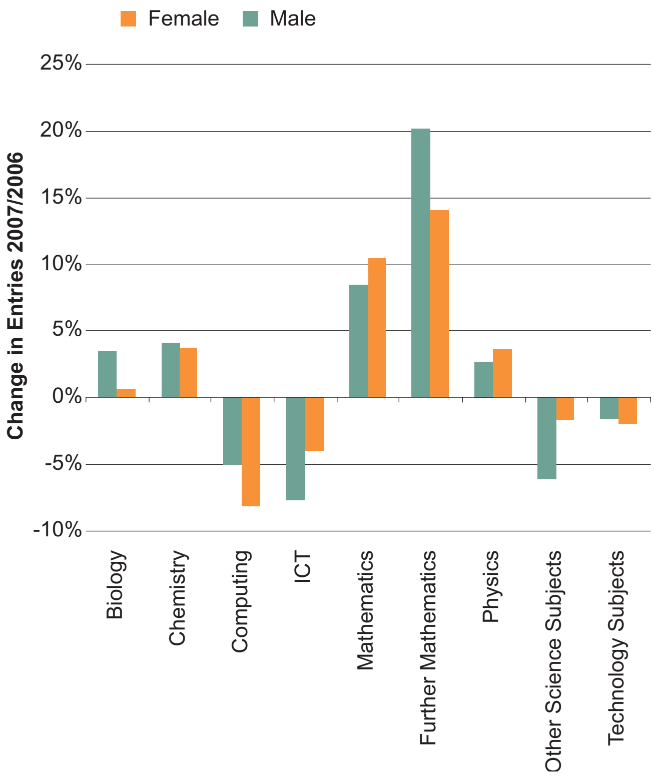
Figure 1.6: GCE AS Level Entries 2007 by Gender



Source: Joint Council for Qualifications 2007 (provisional)

As can be seen in Figure 1.7, Biology, Chemistry, Mathematics and Further Mathematics all enjoyed a healthy rise in entry volumes in 2007 compared to the previous year, whereas entry volumes for Computing, ICT, Other Sciences and Technology Subjects have witnessed declines on 2006 levels.

Figure 1.7: Change in GCE AS Level Entry Volumes 2007 vs 2006 by Gender (Provisional)



Source: Joint Council for Qualifications 2007

5 Joint Council for Qualifications – Results 2007 – 16th August 2007

1.3.2 Scotland

Table 1.2 shows the volume of entries for Highers and Advanced Highers in 2007 with changes on 2006 and pass rates for 2007.

Table 1.2: Higher and Advanced Higher Entries and Passes (SCQF Levels 6-7) 2007

	Higher			Advanced Higher		
	Volume	Change on 2006	Pass Rate	Volume	Change on 2006	Pass Rate
Applied Mathematics	n/a	n/a	n/a	285	+2%	71%
Biology	9,169	+2%	68%	1,927	+2%	73%
Chemistry	9,489	+4%	76%	2,039	+1%	79%
Computing	4,177	-4%	64%	349	-22%	71%
Human Biology	3,710	n/c	68%	n/a	n/a	n/a
Information Systems	1,653	-13%	62%	80	-20%	50%
Mathematics	18,786	+1%	70%	2,484	-4%	65%
Physics	8,580	n/c	73%	1,380	-4%	76%
Product Design	2,139	-5%	67%	76	+13%	50%
Technology Studies	770	n/c	65%	97	-24%	69%

Source: Scottish Qualification Authority (SQA), Scottish Credit and Qualification Framework (SCQF) – 2007

1.4 Young Apprenticeships

The Young Apprenticeship (YA) was introduced in England by the former Department for Education and Skills (DfES) on a trial basis in September 2004 as a new option at Key Stage 4. It enables 14- to 16-year-olds with average or above results from the national tests in Mathematics, English and Science to study part of their time for vocational qualifications not only in the classroom but also in college, with training providers and in the workplace. The programme includes a requirement for 50 days work experience. The first cohort of around 1,000 pupils embarked on YAs in specially selected partnerships in a small range of sectors, including Engineering. The cohort and range of sectors has increased year on year so that the 2007 cohort includes around 9,000 learners.

Ofsted's *Evaluation of the Young Apprenticeship Programme* (2006) offered a positive evaluation suggesting that there was very good knowledge and understanding of the course among parents and pupils and a high proportion of students were motivated by and enjoyed the programme, particularly where engagement of all parties existed and the quality of advice and guidance was high. However, gender imbalance in engineering was highlighted as an issue, it being dominated by male students.

1.5 Specialist Diplomas

This England-only initiative developed as a key element of the 14-19 vocational reform agenda comprises a suite of qualifications offered in at least 14 employment sectors at three levels: Foundation (Level 1), Higher (Level 2) and Advanced (Level 3), plus a Progression Diploma (Level 3). The first five lines: Construction & Built Environment, Creative & Media, Engineering, Information Technology, and Society, Health & Development will be offered in selected consortia of schools, colleges and work based learning providers, from September 2008 onwards.

It is planned that at least fourteen Diploma lines, seven of which will be of relevance to engineering, will be available to all aged 14-16 learners by 2013. A policy target is that 40% of aged 14-16 learners will be taking a Diploma. This has major implications because at Levels 1 and 2 a Diploma will account for about 50% of curriculum time, the other half being spent in mandatory studies such as Physical Education, Personal and Social Education, Citizenship, Mathematics, English and ICT. At Level 3 an Advanced Diploma takes up the time of, and is broadly equivalent to, three GCE A Levels.

In addition to the acquisition of understanding about the relevant employment sector – including some work-related experience – the core curricula will include functional skills in Mathematics, English and ICT, an extended project, and personal, learning and thinking skills. The current focus for Diploma development includes ensuring possibilities for progression, for example; from Level 2 to general curriculum (e.g. GCE A Levels), or to a vocational college course or Apprenticeship, or from Level 3 to university, or to an Advanced Apprenticeship or to other employment.

The Department for Children, Schools and Families' (DCSF) *The Diploma – What Teachers Need to Know* pamphlet published in 2007 states that "the qualifications will be understood and respected by employers and universities". However, there is some evidence that awareness and understanding of Diplomas needs to be improved. In March 2007, the QCA published research which showed that 52% of current GCE A Levels and GCSE candidates, 64% of parents and 29% of teachers knew nothing about the new qualifications (Source: *The Guardian*, 21/03/07). With awarding bodies now considering whether to offer particular diplomas, it follows that the marketing effort needs to be optimised in preparation for the first cohort who start in September 2008.

1.6 Summary and Conclusions

> The forecast decline in the 16- and 18-year-old cohorts over the next decade will pose significant challenges in the provision of meeting employer demand. This will, of necessity, require a re-evaluation of recruitment and workforce development to take account of potential new sources of engineers through up-skilling and career changers.

> At GCSE/Standards level, volumes of key STEM subject entries have been increasing over recent years, although the impact of withdrawal of Design & Technology from the Key Stage 4 statutory curriculum is being felt and the picture on some sciences is complex.

> GCSE A* to C results in STEM subjects have seen a gradual improvement, although achievement rates in Mathematics remain disappointing.

> A number of traditionally niche subjects such as Statistics and Additional Mathematics have gained in popularity and enjoy high A* to C rates.

> At GCE A Levels/Highers the gender balance is slowly reaching overall parity, although it remains a cause for concern in some subjects.

> Provisional figures for GCE A Levels in 2007 saw a rise in Mathematical subjects, Biology, Chemistry and Physics candidate numbers across the UK.

> Computing and ICT candidate numbers have declined significantly at GCE A Levels and Highers.

> A number of vocationally-oriented curriculum offers such as YA and Specialised Diplomas have been developed in England, but their impact on learners' career prospects is yet to be fully assessed.

> Some alternative qualifications are gaining some currency in the 14-19 age examinations marketplace – especially at independent schools.

1.7 Comment

The impending demographic decline in the 16-18 cohort will impact on all sectors and may well intensify the competition for high ability young people needed to fill engineering roles in the future. Whilst competence in Mathematics is important for engineering progression, and increased uptake and achievement in Mathematics is welcome news, we do not yet know what progression issues for engineering may arise as a result of changes in the take up of the various science options at GCSE. Nor can we predict the impact of the decline of Design & Technology at GCSE, AS and GCE A Levels. Neither do we yet know whether increased Government commitment to Apprenticeships and the introduction of Diplomas will, in time, lead to greater take-up of further and Higher Education in STEM subjects.

The once straightforward qualifications system continues to become more fragmented through a combination of alternative qualifications and Government initiatives. With a perception that the quality of mainstream offerings may have declined, some of the alternative academic qualifications are gaining currency, leading to greater complexity and confusion. It also remains unclear how the YA programme will continue in light of the Government's commitment to Specialised Diplomas in England.

The Specialised Diploma has some risk attached to it given the additional complexity it brings in the already complex 14-19 qualifications arena. Their credentials will need to be demonstrated swiftly if they are not to be marginalised in the qualifications marketplace.

2. Further Education, Vocational Education and Training

Skills at technician level underpin the entire fabric of UK engineering. The supply of technician level skills is an area often overlooked in previous analysis. This section looks at the state of engineering and technology within the Further Education and vocational sectors; the main supply route for skills at the technician level.

The Further Education (FE) sector has often been seen as being the poor relation of Higher Education (HE), but much is being done to encourage learners, employers, and public-sector stakeholders to recognise the worth of the FE sector, placing it on a more equal footing with HE than has been the case in the past. The FE sector's role in supporting the Science, Engineering and Technology (SET) and innovation ambitions across the UK is vital.

Ofsted's report; *Further Education Matters* [2005] highlighted the importance of FE and its essential contribution to improving skills and providing qualifications that will enhance employability and promotional prospects. The contribution of FE extends far beyond equipping employees with the skills demanded by today's employers, making a significant contribution to the economic, social and cultural life of the UK as well. Furthermore, the contribution of the FE sector is also highlighted in the *Leitch Review of Skills – Prosperity for all in the global economy – world class skills*, published in December 2006. The Government's response to this in England; *World Class Skills – Implementing the Leitch Review of Skills in England* was published in July 2007. At the time of writing (October 2007) the responses from the devolved national bodies are still awaited.

In September 2007 the Qualifications and Curriculum Authority (QCA) announced a consultation of FE providers in England to canvas their opinions on the role of providers in contributing to the national qualifications system; specifically looking at whether the current demarcation between teaching, assessing and awarding is the most appropriate model in the post-Leitch environment. Following the consultation the QCA will be conducting pilots of different models and approaches, which may see colleges making awards and awarding bodies deliver teaching. In March 2008 recommendations will be made to Government on the possibilities of accrediting and recognising provider training and qualifications.

This chapter looks at the state of SET within the FE sector and the related 14-19 landscape; this is the main route for the development of skills and qualifications and work-based learning at technician level. This section also includes findings from the ETB's own research into FE.

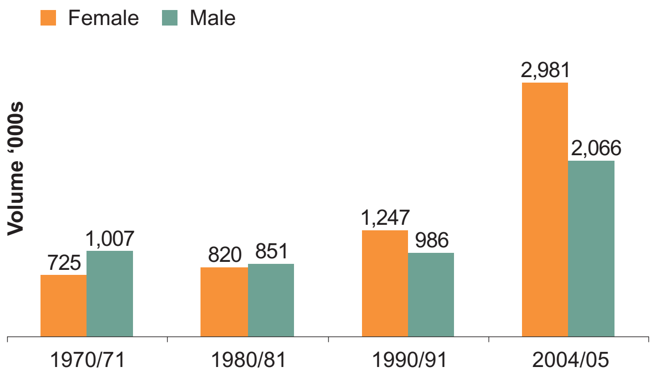
2.1 FE Overview

It is important to note that publicly-funded FE provision can be either college-based or through a wide range of private-sector providers – including employers – which may or may not make use of colleges as part of their provision. The world of FE in the UK is complex and multi-faceted covering an extensive range of work-based learning opportunities from as early as the age of 14 upwards. Significantly, FE is also devolved across England, Scotland, Wales and Northern Ireland and encompasses a wide range of colleges, training providers, awarding bodies, funding bodies, Apprenticeships and inspections regimes.

Statistics show that the volume of engineering students in learning in FE across the UK far exceeds the volumes found in HE. We go on to explore this in greater detail in the remainder of this chapter.

The proportion of learners in FE overall has increased significantly over the last three decades with a doubling of male and tripling of female students (Figure 2.1). The increase has been particularly marked over the last ten years as a result of Government policy changes and an increased demand for skills overall.

Figure 2.1: Total Volume of UK Learners in Full- and Part-Time Further Education 1970-2005



Source: ONS Social Trends 37 (2007), DfES, SE, WAG, DELNI, HESA

2.2 FE Provision in England

In England, since June 2007, the responsibility for FE is shared mainly between the Department of Innovation Universities and Skills (DIUS) and the Department for Children, Schools and Families (DCSF), as a result of the 14-19 policy agenda. The DIUS in particular sees one of its roles as being to "increase the supply of people in science, technology, engineering and mathematics (STEM)". An example of this can be seen in the establishment of 16 pathfinder Centres of Vocational Excellence (CoVEs) as long ago as 2001. By March 2006 more than 400 CoVEs had been established, including no fewer than 379 engineering and technology areas of learning.

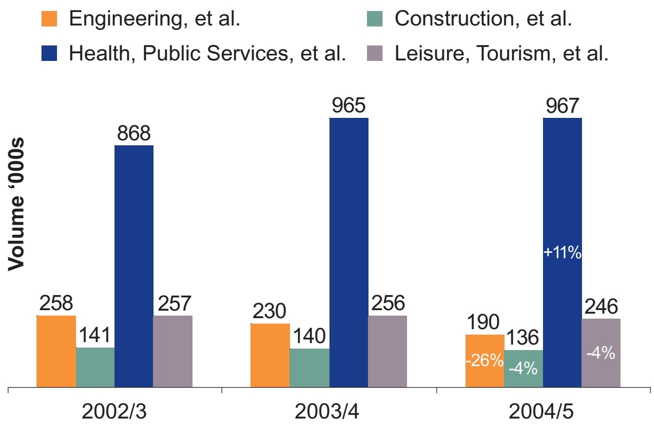
The *New Standard* (http://www.newstandard.co.uk/) assessment framework open to all organisations involved in the delivery of training and development solutions to employers, be they public or private, colleges, companies, or universities, was introduced from June 2007. It combines the Quality Mark with revised CoVE criteria and is a significant opportunity to build on the quality and delivery improvements attained in recent years. The Quality Improvement Agency (QIA) is working with the Learning and Skills Council (LSC) to help providers that wish to meet the requirements of, and be accredited to, the *New Standard* – including the former CoVEs.

The public funding of the FE sector is largely within the remit of the LSC, which is responsible for planning and funding education and training for adults in England, other than those in HE. In the summer of 2007 it was announced that 16-18 funding for sixth forms and colleges will be delivered through local authorities in the future, subject to consultation and the passing of the necessary legislation. In the interim, the LSC will remain responsible in law and practice for the allocation of funds to all forms of post-16 education and training in England, other than HE. As part of its remit the LSC also collates much data on the FE sector in England.

2.2.1 Learner Numbers

ETB analysis of LSC statistics in England (Figure 2.2) shows that the number of learners in Engineering, Manufacturing and Technologies (EMT) has fallen by over a quarter since 2002. The numbers in Construction and Planning have fallen also, but not as quickly at just -4%. Meanwhile, Health and Public services volumes have jumped 11%. It is worth noting that from an employment perspective engineers and engineering technicians may be employed in the Health and Public sectors as much as anywhere else (source: EC^UK Baseline Survey 2007).

Figure 2.2: Further Education Learner Numbers – England 2002-2005



Source: LSC

2.2.2 Survey of Colleges

An ETB survey of 25 colleges has indicated confirmation of a fall in EMT learner numbers. The most common stated reasons for this were the perception that career opportunities were declining and there was less interest in engineering courses from students. In addition, capital investment requirements were noted as an issue for engineering departments combined with a refocus on other courses at and by colleges. Over half of the colleges surveyed work mainly with small employers.

The research highlighted a number of challenges facing FE colleges providing EMT courses;

1. Finance: Perhaps the most significant in terms of decision making, the viability of courses is critical and this is reflected in high capital equipment cost issues (to maintain teaching with evolving levels of technological development) and the important matter of teaching staff pay. The department's 'fitness for purpose' in delivery is a significant factor in its performance.
2. Staff Recruitment: Difficulty in recruiting teaching staff is a problem for most colleges and two-thirds of the higher-performing colleges noted the contribution that highly skilled and experienced lecturers can make to performance and success. Such staff need to be:
   - a Equipped with the appropriate level of skills and expertise
   - b Flexible enough to teach in a vocational and academic context
   - c Approachable and personable
   - d Dedicated and committed
   - e Able to forge professional working relationships with each other.

3 Employer Engagement: Strong links with local employers are commonly seen as a critical success factor, not least because of the college's commercial imperative. Such links can bring credibility to courses with students (potential and actual) as well as other employers in the area and help achievement of the quality standard.

4 Student Engagement: The attractiveness of courses and colleges to students cannot be underestimated. The success of the Young Apprenticeship (YA) programme and the introduction of the specialised Diplomas will assist in widening the appeal of EMT courses by offering new progression pathways. In September 2008 the 'Construction and the Built Environment' and 'Engineering' Diplomas will be introduced with the 'Manufacturing and Product Design' Diploma following in September 2009.

5 Decline of the EMT Sector: A significant minority of respondents suggested that the decline in UK manufacturing and engineering employment is having a depressing effect on certain categories of training.

The research highlighted concerns around levels of numeracy amongst a proportion of students, and the remedial work necessary to support learners with difficulties in this area. The research suggests that additional support is required to improve competence in Mathematics.

The recruitment of more experienced engineers into the FE sector workforce is also vital if the quality of courses is to be maintained and improved. Such recruits can also be advocates for careers in the sector based on their knowledge and experience. Pay levels need to be considered in this context.

2.3 Apprenticeships

Apprenticeships offer the learner on-the-job training and learning towards the attainment of an accredited qualification, such as an Scottish and National Vocational Qualifications (S/NVQ), whilst being paid. Apprenticeships are administered in different ways across the four home nations and data on Apprenticeships across the UK are collected in variety of ways and in formats that are not always easy to compare and contrast.

A pilot programme started in England in September 2007 to test the development of Apprenticeships into a qualification. The pilot covers Engineering, Construction *et al*, and Administration Apprenticeships which is being monitored and evaluated by the QCA, Learning & Skills Council (LSC) and Sector Skills Development Agency (SSDA). If the pilot is successful Apprenticeships will no longer be certified but awarded as a qualification instead as an integrated programme of learning, rather than a series of individual certificates, to deliver all skills, knowledge and competencies needed to function in the workplace. Essentially, this is the model being applied in specialised Diplomas.

The core Apprenticeships programme in England has covered the 16-24 age group. In the 2006 White Paper on FE reform the Government announced the introduction of a new entitlement for those aged 19-25 to free training to achieve their first full Level 3 qualifications, which can be of any type, but the mechanics of this are still to be defined.

Since 2005 a trial 14-16 YA programme has been run through selected partnerships. The YA programme has been shown to be very successful at engaging students at a younger age and encouraging them to consider working in sectors which, by the time they are 16 or 17, they may otherwise have discounted as potential career options. In August 2007 the LSC announced the removal of the Apprenticeships age restriction of 25 for funding and has begun rolling out its Apprenticeships for Adults programme nationally.

The total number of all apprentices in England has reached over a quarter of a million and the Government has stated its aspiration for this to rise to 500,000 by 2020.

2.3.1 Learner Numbers

An examination of learner numbers for the year ending July 2007 (Table 2.1) shows a wide gender imbalance for engineering and technologically-based Apprenticeships.

Three-out-of-ten of all 125,000 learners at Level 2 are undertaking engineering and technology-based Apprenticeship frameworks. However, this equates to 55% of all male apprentices, but just 2% of all female apprentices on all frameworks.

Of all 55,000 in Apprenticeships at Level 3, 43% are undertaking engineering and technology-based Advanced Apprenticeship (AA) frameworks, but again this translates into 73% of male and just 2% of female apprentices on all AA frameworks.

Table 2.1: National (England) In Learning Engineering and Technology-Related Apprenticeship Frameworks* 2006-7

	Gender	Volumes	Proportion of All Frameworks
	Female	1,003	2%
Apprenticeships (Level 2)	Male	35,687	55%
	Total	36,690	29%
	Female	525	2%
Advanced Apprenticeships (Level 3)	Male	23,073	73%
	Total	23,598	43%
	Female	1,528	2%
All Apprenticeships	Male	58,760	61%
	Total	60,288	33%

Source: LSC (*Selected Frameworks: 103, 105,106, 107, 111, 113, 116, 117, 202, 206, 211, 212, 232, 234, 235, 254, 265, 278, 282, 283, 287, 288, 294, 327, 328, 329, 330, 335, 343, 347, and 348).

Clearly engineering-related frameworks account for a high proportion of Level 2 and 3 Apprenticeships and dramatically so for male learners. The male domination of these frameworks is overwhelming with the male share of Level 2 and of Level 3 both being 97%.

The Equality and Human Rights Commission (EHRC) has researched and reported on occupational segregation in Apprenticeships and associated pay and progression differentials.

2.3.2 Achievement rates

As can be seen from Table 2.2, when looking at the success rates in LSC funded work-based learning provision in the twelve months up to July 2007, the success rates for Apprenticeships are only very slightly higher than the overall average for all Apprenticeships for men (59%) and women (60%).

With Advanced Apprenticeships the mean figures are 52% for women and 55% for men, thus the success rates in construction and engineering are somewhat higher than average at this level.

Table 2.2: Overall Success Rates in LSC-Funded Work-Based Learning Provision – England 2006/7 – Full Framework Achievements

	Gender	Construction, Planning and the Built Environment	Engineering and Manufacturing Technologies
	Female	53%	62%
Apprenticeships	Male	62%	61%
	Total	62%	61%
	Female	65%	58%
Advanced Apprenticeships	Male	56%	62%
	Total	56%	62%

Source: LSC

It should be noted that EMT frameworks have an above-average proportion of learners pursuing learning aims that exceed 24 weeks.

2.3.3 Apprenticeships in Scotland

In Scotland, Apprenticeships are aimed at those aged over 16 and all apprentices must have employed status throughout. In Scotland, the term Modern Apprenticeships (MA) remains in use with delivery through Scottish Enterprise (SEn) or Highlands and Islands Enterprise (HIE), depending on the living place of the apprentice.

Currently, each Modern Apprenticeship framework is specific to the particular industry or sector, and is made up of three parts:

1. SVQ Level 3: The occupational S/NVQs for the sector at Level 3 are the core of every framework. Some frameworks may specify progression routes, which allow apprentices to work towards a Level 2 initially, and then progress to the Level 3 and Level 4 SVQ.
2. Core Skills:
   - a Communications
   - b Working With Others
   - c Numeracy
   - d Information Technology
   - e Problem Solving
3. Additional Components: These vary from sector to sector and may include additional SVQ units or industry-specific or academic qualifications such as HNCs or HNDs.

A review of participation data illustrates once again the significance of engineering and technology-related frameworks within the MA system in Scotland. The total volumes are higher in the Scottish Enterprise area as compared with the HIE area.

Table 2.3: Scottish Enterprise Modern Apprenticeship Selected Frameworks Participation from Top 30 – 31st December 2006

Ranking	Framework	Apprentices in training
1	Construction	6,783
2	Engineering	2,579
3	Electrotechnical	2,433
4	Motor Vehicle	2,331
7	Plumbing	1,805
13	Vehicle Maintenance and Repair	411
15	Heating and Ventilation	374
17	Engineering Construction	281
24	Gas	142
26	Engineering (OPITO)	106
30	Agriculture and Garden Machinery	92
Total	Total from Within Top 30	17,337

Source: SSAScot

Furthermore, gender imbalance issues are similar to those found in England. SSAScot data shows that the overall ratio of male to female MA is 72:28. This imbalance is significantly reduced when looking at those MAs over the age of 25, but volumes are also significantly lower. The overall ratio of male to female MAs aged 25 and over is 45:55.

Table 2.4: Scottish Enterprise Modern Apprenticeship Adults Aged 25+ Selected Frameworks Participation from Top 10 – 31st December 2006

Ranking	Framework	Apprentices in training
3	Construction	341
8	Electrotechnical	131
9	Engineering	113
10	Plumbing	104
Total	Total from Within Top 10	689

Source: SSAScot

In the HIE region volumes of apprentices are lower reflecting relative population levels, but the make-up of the top 30 frameworks is once again similar to that found in the SE regions with a notable prevalence of engineering and technology-related frameworks.

Table 2.5: Highlands & Islands Enterprise Modern Apprenticeship Selected Frameworks Participation from Top 30 – 31st December 2006

Ranking	Framework	Apprentices in training
1	Construction	1,240
2	Plumbing	239
3	Electrotechnical	232
4	Engineering	226
5	Vehicle Maintenance and Repair	208
9	Motor Vehicle	65
15	Electricity	24
16	Heating and Ventilating	22
18	Engineering Construction	21
22	Vehicle Body and Paint Operations	15
26	Marine Engineering	9
27	Electronic Servicing	9
Total	Total from Within Top 30	2,310

Source: SSAScot

The gender imbalance is more marked with the overall ratio of male to female MAs at 82:18 according to SSAScot data, but again when looking at those aged 25+ the difference is redressed, although volumes are significantly smaller.

Table 2.6: Highlands & Islands Enterprise Modern Apprenticeship Adults Aged 25+ Selected Frameworks Participation from Top 10 – 31st December 2006

Ranking	Framework	Apprentices in training
2	Construction	68
6	Plumbing	24
7	Electrotechnical	22
Total	Total from Within Top 10	114

Source: SSAScot

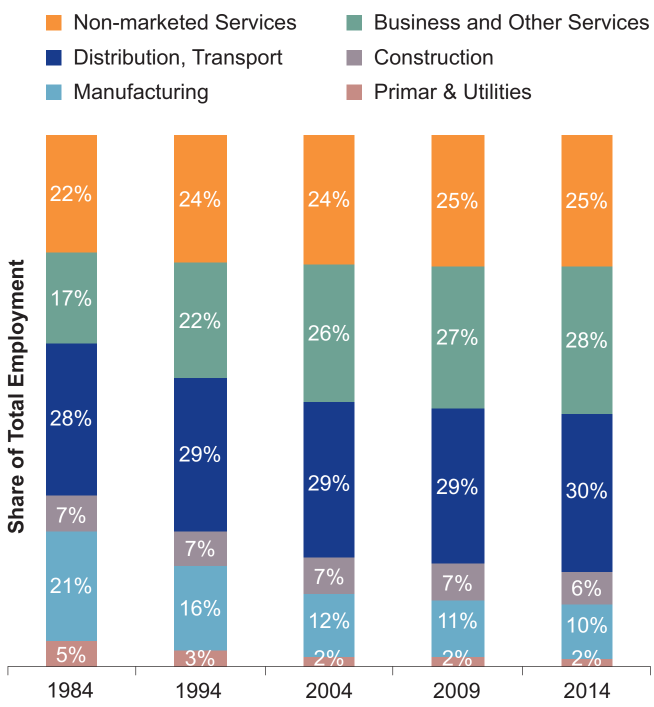
The overall ratio of male to female MAs aged 25 and over is 53:47

2.4 Employment

A review of changing sectoral employment can help provide a context for the shifting demand for apprentices.

The demand for and supply of skills in the UK economy is in flux as the economy adjusts to changing internal and external economic and business imperatives. Figure 2.3 describes the changing employment patterns across the economy between 1984 and forecast to 2014.

Figure 2.3: Share of Employment by Broad Sector in the UK 1984-2014

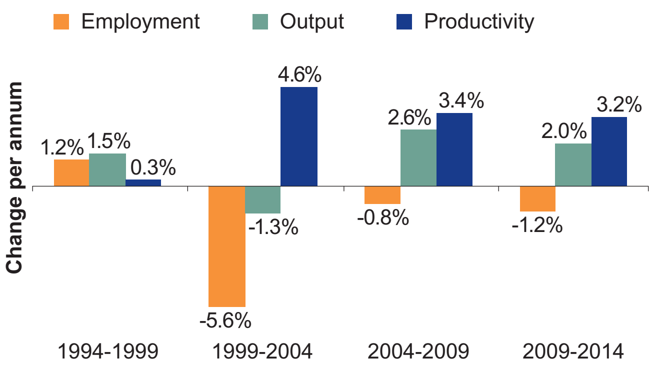


Source: Working Future – CE/IER Estimates 2006

This well-documented relative growth of the business and services sector has been mirrored by the decline of overall manufacturing employment over the last two decades and this is forecast to continue for the foreseeable future. It should be remembered that declining employment volumes in part reflect increasing capital investment and that engineers and technicians may be employed across virtually all sectors.

Taking a closer look at engineering in Figure 2.4, it can be seen that that whilst employment in the sector rose 1.2% between 1994 and 1999, since then the levels of employment across the UK have continued to fall. However, this is as much a function of new technology replacing lesser-skilled occupations no longer required, which can be seen by the steady and significantly positive improvements in productivity. Output too is forecast to grow significantly over the next six or seven years.

Figure 2.4: Rate of Change in Engineering Employment, Output and Productivity 1994-2014



Source: Working Future – CE/IER Estimates 2006

2.5 Comment

The ETB believes it is important to support Level 3 Apprenticeships and welcomes the Government's commitment to a new entitlement for a qualification at this level. This, combined with the removal of some age restrictions on funding and Sector Skills Council support for employer-focused, fit-for-purpose qualifications may provide an unique opportunity to match supply and demand in SET occupations in a post-Leitch environment.

In addition, the planned rise in the volume of apprentices in the medium term must be seen as an opportunity to increase the number taking-up engineering-related Apprenticeships.

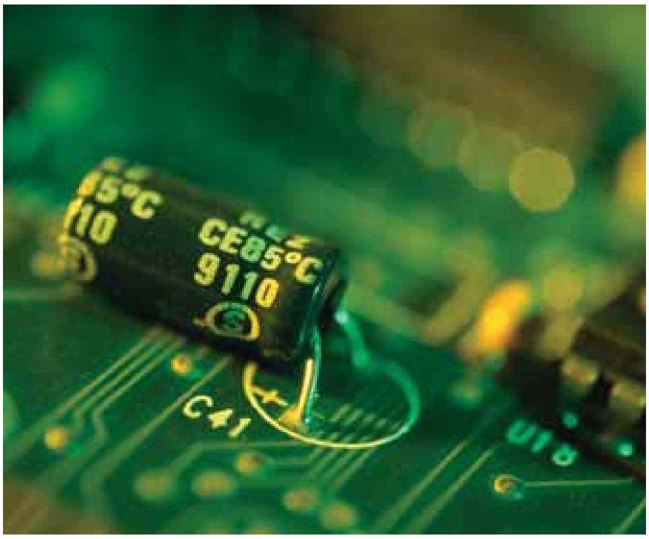
FE colleges need to continually raise their game to meet the needs of employers and learners as they develop and change and many are already doing so. Almost by definition engineering and technology are continuously evolving and becoming more complex and sophisticated and learning provision must keep pace with this rate of change. EMT and engineering-related provision in the FE sector is capital and resource intensive and requires commitment by colleges and private sector providers (including employers) to invest in equipment, learning resources and teaching staff needed to deliver the training demanded.

The ETB would encourage FE providers to gain accreditation to the *New Standard* in order to give employers the confidence they need to use the high quality FE provision available all around England.

With the publication of the Scottish Government's *Skills for Scotland – A Lifelong Skills Strategy* in September 2007, a commitment has been made to extend Apprenticeships to S/NVQ Level 2 (SCQF 5) and phase out the *Skillseekers* programme. This is an important opportunity too for increased employer and learner engagement with Vocational Education and Training (VET) in addition to the high quality Level 3 provision already available.

FE provision has a key role to play in satisfying increasing demand for skills and qualifications from employers stimulated by policy initiatives and business imperatives – not least the desire to nearly double the number of apprentices. At the same time it must be recognised that these skills and competencies are only valuable economically if utilised in, and developed to meet, the requirements of the workplace i.e. be 'fit for purpose'. This can be achieved by a more cohesive approach to training and workforce development that utilises all HE and FE provision where appropriate as it meets needs of employers and employees (potential and actual).

3. Higher Education



The UK's Higher Education (HE) sector has a vital role in supplying the next generation of the professional engineers and scientists contributing towards innovation in engineering. This chapter looks at trends within HE and their implications for engineering and technology as a whole.

The report begins with a description of the characteristics of HE institutions providing Science, Technology, Engineering and Mathematics (STEM) education, and leads into an analysis of the student population on STEM programmes within UK HE. Trends in first degree population and postgraduate population are discussed, including trends in gender participation and foreign student participation. The chapter also looks at the international aspects of STEM HE. This involves an analysis of comparative STEM degree awards in several countries across the world and highlights the growing dependence of the HE systems of all industrialised countries on foreign graduate STEM students.

3.1 Introduction

The UK's HE sector in STEM is widely seen as one of the vital contributors to innovation and economic growth and development. This highlights the significance of (STEM) HE in creating the higher level skill base needed for a competitive workforce in the twenty-first century global market place.

In recent years, demographic trends and the rapid expansion of UK HE have had an impact on the numbers and types of students taking STEM courses in the UK. Since the 1990s the UK HE sector has seen a massive increase in student participation; driven in part by the UK Government's target of having 50% participation in HE by 2010. As a result, participation amongst university age students in HE in England and Wales has increased to 43% (Source: DfES, 2006) and 47% in Scotland (Source: Scottish Executive Lifelong Learning Statistics). This rapid growth of HE has had an impact on the demographic mix of the university population with the students from a wider cross-section of economic and social backgrounds now participating. However, the expansion of UK HE has had a differential effect on specific subject areas; individual STEM subjects have each fared differently in terms of student demand over the last decade.

The last decade has also seen a growth in the numbers of foreign students coming to the UK for HE study. This growth has been particularly prevalent within the STEM subjects, and is particularly strong phenomenon within STEM post-graduate study. Coupled to this is the increase in global competition in HE.

The UK has historically been one of the world leaders in the provision of broad access HE and has done well in attracting foreign students. However, our position is now under threat as many other countries are expanding their own HE systems, providing comparable educational access to their own population and attracting large numbers of foreign students. In recent years, a number of countries, including the United States, Japan, Canada, Australia, and Germany, have expanded their recruitment of foreign STEM university students. In addition HE sectors within newly developing economies, such as India and China, who have historically been one of the main sources of foreign students within developed countries HE sectors, have grown as well.

3.2 The Structure of UK Higher Education

HE in the UK is diverse in terms of the size and type of institutions offering degrees. At present the HE sector offers a wide variety of different levels of qualification offered across different modes of study; full-time, part-time or distance learning. These broadly include foundation degrees, first degrees, postgraduate certificate and diplomas, masters degrees (taught or research), and doctoral programmes. The size and diversity of the UK HE sector is reflected in the fact that there is a wide range of course options available for students. In 2006 there were over 330 institutions offering HE courses in the UK with nearly 316,000 first degrees awards being made during the year; 85,000 of these were awarded in STEM subject areas. In addition, over 125,000 postgraduate degrees were awarded at masters and doctoral level in 2005, with 35,000 being awarded in STEM subjects.

3.3 The Supply of Students in Higher Education in the UK

The UK has witnessed a rapid expansion of participation in HE over the last 10 years; the number of undergraduate programme entrants has risen by nearly 40% from just over 273,000 in 1995 to 381,000 in 2006 (Source: UCAS, 2007). This increase in the admission of students has led the UK student population to a level of just over 2.3 million students in 2006 (Source: HESA 2007).

Whilst the number of UK students entering university has increased dramatically over the last decade, the introduction of student tuition fees in 1998 appears not to have seriously influenced the number of young people entering HE. However, the introduction of increased tuition fees in 2004 may have some impact on admission numbers or choice of course.

The UK Government has set itself a target of achieving a 50% HE participation rate for the 18-year-old population by 2010. Figure 3.1 details the HE initial participation rate for students in England over the last six academic years. Participation according to these figures has been rising slowly to a provisional figure of 43% in 2005/06. However, this falls short of their 50% target.

Figure 3.1: Higher Education Participation Rates 1999-2006

Source: Universities UK 2007/DfES/SE/DELNI

England: Higher Education Initial Participation Rates (HEIPR) for 17-30 year-olds

Scotland: Age Participation Index (API) for those aged <21 in full-time HE as a proportion of 17-year-olds

Northern Ireland: HEAPINI for those aged <21 in full-time HE as a proportion of 18-year-olds.

These data suggest that participation is increasing somewhat erratically. However, during the same period there has been a growth in the total HE student population in UK, as described in data from both HESA and UCAS. The continued growth in actual student numbers over the last decade has been supported by growth in the 18-year-old cohort volume. The future size of this cohort is the subject of discussion in the next section.

3.4 Demographic Change in School-Leaving Age Cohort

Work carried out by the Higher Education Policy Institute (HEPI) suggests that the UK's HE sector cannot rely on an expanding cohort to fuel future growth in student numbers (HEPI, 2005). The main conclusion of the HEPI study is that between now and 2010-11, the population of young school leavers (18-22 year-olds), who have always provided the majority of full time HE entrants, will increase, leading to a continued growth in student numbers. However, after 2010-11, the number of these young people will begin to decline until the end of the next decade. This analysis is confirmed by work from the ETB which is highlighted in Figure 3.2.

Figure 3.2: Projected 18-22 Year-Old Population 2004-2021

Source: Government Actuaries Department (Base year 2004)

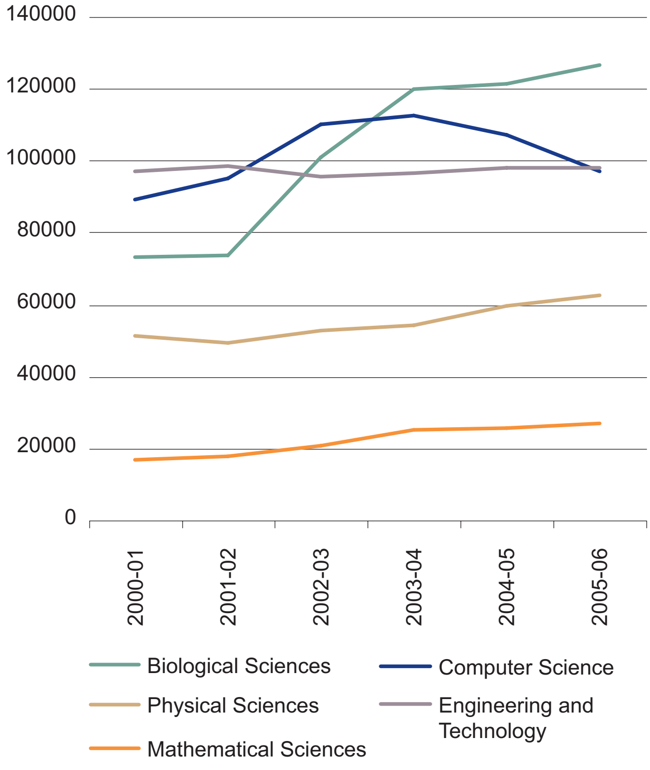
The ETB's analysis suggests that there will be a 12% decline in the 18-22 population cohort between 2010 and 2021. However, the work by HEPI also suggests that this will be particularly associated with those social groups who have the lowest participation rates in HE, resulting in a less severe effect on student demand than would otherwise be the case. The demographic challenge over the next 15 years will mean that UK universities will have to manage an increase in student numbers followed by a reduction. As for Government policy, the HEPI data calls into question the likelihood of the UK achieving the 50% participation target by 2010.

3.5 Trends within STEM Subjects

The last five years has seen an expansion in overall student numbers taking STEM subjects within UK HE. STEM student numbers have increased by over 24% from 424,000 in 2001 to just over 527,000 in 2005. This shows that STEM is flourishing in comparison to the rest of HE (over the same period the overall average increase in student population for all subjects was 17%). However, there are significant variations between subject groupings within STEM and differences in trends between levels of qualification.

Figure 3.3 overleaf indicates broad trends for the undergraduate population studying STEM subjects. It is worth noting that these data include all undergraduate students, both home and foreign. For the purpose of this analysis the STEM subjects have been split in line with the Joint Academic Coding System (JACS) codes used by both Universities and College Admissions Service (UCAS) and Higher Education Statistics Agency (HESA). This breaks STEM into five distinct subject groupings; Biological Sciences including all the Life Sciences; Physical Sciences including Physics and Chemistry; Mathematical Science, Computer Science including all the IT disciplines, and Engineering and Technology including all the traditional engineering disciplines and Material Science.

Figure 3.3: Undergraduate Student Population studying in UK HE by STEM subjects

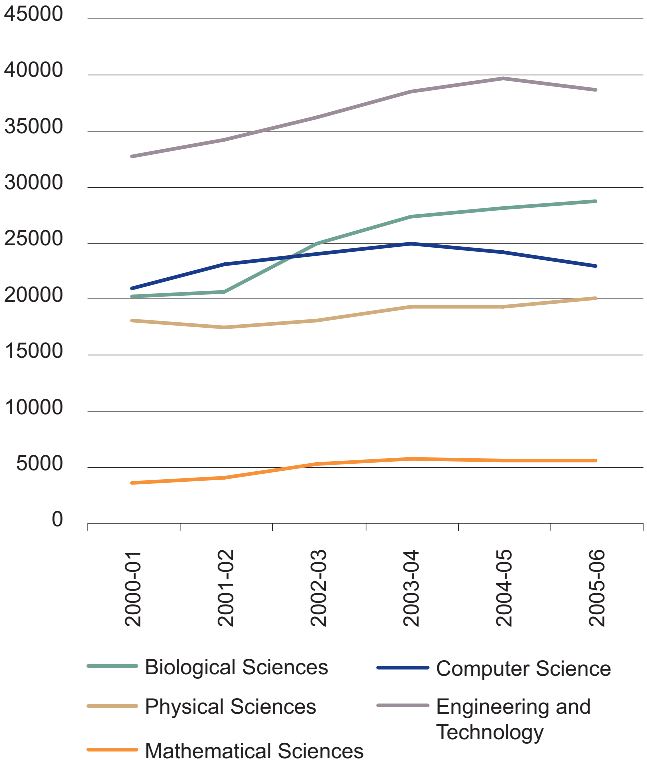


Source: HESA 2006

The development of these five main branches of STEM has varied over the last five years. The undergraduate student population undertaking Biological Sciences has grown by over 72% with student numbers rising from 73,000 to over 126,000. Mathematical Sciences have also seen a growth in student numbers of 60% up to over 26,000 students. More steady growth has been seen in the Physical Sciences with a growth of 22%, Computer Science has also seen a growth of 19% over the period, although over the period the subject has seen a significant rise and subsequent fall in student numbers. However, undergraduate student numbers on Engineering and Technology courses have been static with nearly 98,000 students in 2006. These figures highlight the massive growth in Biological Sciences over the recent period which has served to skew the apparent growth in STEM subjects. There has also been encouragingly high growth in the Mathematical Sciences, albeit from a low base. Of more concern is that fact that Engineering and Technology, whilst maintaining a steady level of student numbers, does not appear to have enjoyed the growth in student numbers seen within other STEM subjects and in UK HE more widely. This means that relative to the undergraduate population, Engineering and Technology undergraduates are falling.

Figure 3.4 outlines the student postgraduate population amongst the five main STEM subject groupings. The picture for the STEM subjects at postgraduate level is quite different from that seen at undergraduate level. The biggest subject grouping by far is engineering and technology with just under 39,000 students, representing an 18% growth in student numbers over the last five years. The expansion in undergraduate student numbers in the Biological Sciences and Mathematical Sciences has also been matched at postgraduate level with the postgraduate student population increasing 41% and 48% respectively. It is worth noting that the Physical Sciences have had a relatively small increase in postgraduate student numbers at just under 11%. This compares to the overall growth of the postgraduate sector at 21%. The number of doctorates being awarded has increased in all STEM areas in the last 5 years. Computer Science has seen a huge increase of 93%, though it was starting from a low base. The number of doctorates awarded in Engineering and Technology has increased by 18% since 2001 and Mathematical Sciences, Physical Sciences and Biological Sciences have seen rises of 15%, 12% and 11% respectively.

Figure 3.4: Postgraduate Student Population studying in UK HE by STEM subjects



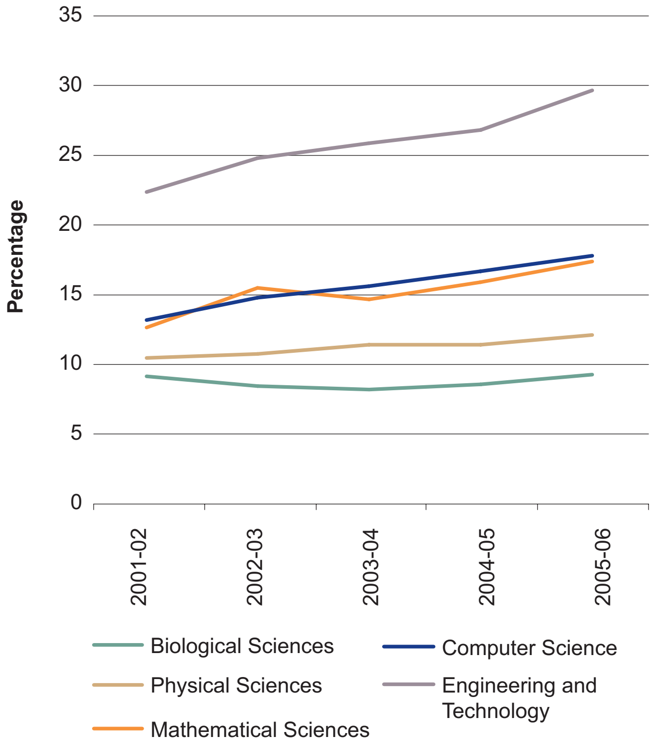
Source: HESA

Further analysis of the postgraduate population in STEM subjects is required as there is anecdotal evidence that suggests that the majority of the students studying Engineering and Technology are non-UK students. This has major implications in terms of knowledge transfer and the ability of the UK HE sector to provide the skills to meet the needs of UK industry.

3.6 Non-UK Students

The internationalisation of the HE system has had a major impact on foreign student participation levels within STEM subjects in the UK. The percentage number of foreign student by STEM subject is detailed in Figure 3.5.

Figure 3.5: Proportion of Non UK Students (EU and Non-EU) by STEM subject in UK HE (All Degrees)

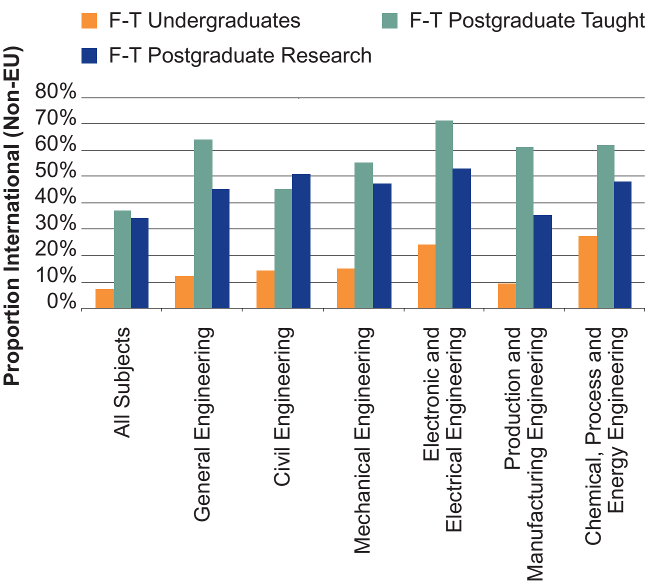


Source HESA

The data paints an extremely interesting picture. Engineering and Technology leads the way with nearly 30% of its students being from outside the UK. This has seen steady growth from the 22% non-UK student participation in 2002. The rest of the STEM subjects are much more typical of the university population as a whole, with 14% foreign student participation. Biological Sciences and Physical Sciences both appear to have steady numbers of non-UK students at 9% and 12% respectively in 2006. Both Computer Science and Mathematical Sciences have seen an increase in the proportion of foreign students over the five year period, both reaching 18%.

Foreign student figures alone do not tell the whole story. EU students pay the same fees as UK students and non-EU foreign students pay substantially higher fees, which makes them especially attractive to universities. Figure 3.6 illustrates the proportion of students on engineering undergraduate and postgraduate courses whose domicile is outside the EU. This clearly shows the substantial bias towards overseas students in postgraduate taught engineering courses in particular, where in many cases the majority of students come from outside the EU.

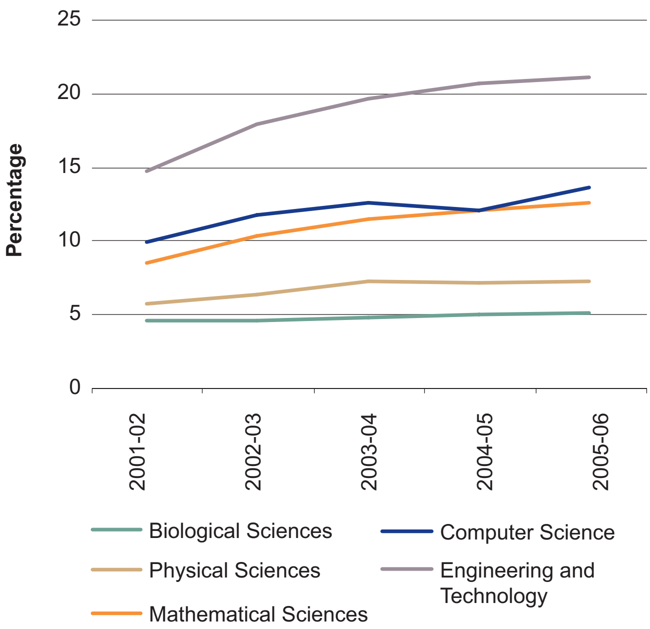
Figure 3.6: Non-EU Enrolments by Domicile 2005-6



Source: UKU/HESA

Looking at the figures over the last five years shows that the total figures for overseas students has been rising.

Figure 3.7: Percentage of Non-EU Foreign Students by STEM subject in UK HE



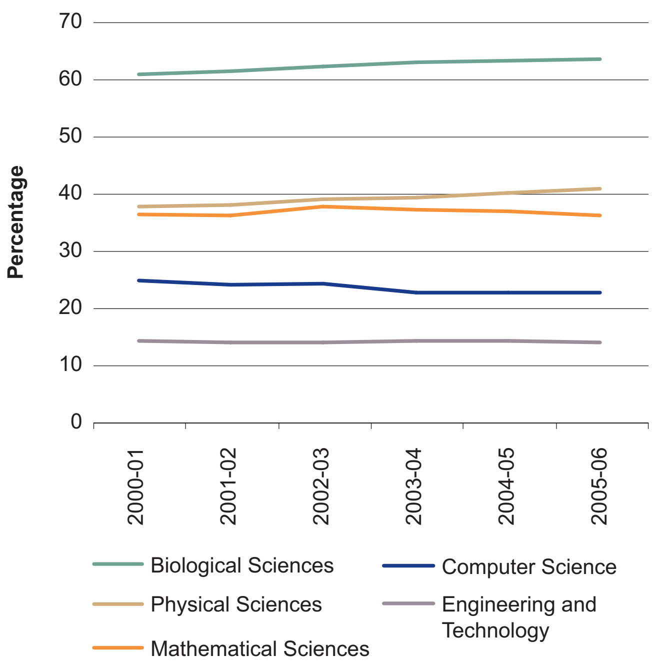
Source:HESA

The data indicate that Engineering and Technology has the largest proportion of non-EU students and the proportion is growing year on year.

3.7 Female Participation in STEM

One of the key issues facing the STEM community is encouraging female participation to a level more representative of HE as a whole (the current participation of females in HE stands at 58%). In some cases increasing the number of females studying STEM courses may, in the future, be one of the main strategies available to teaching departments to expand the numbers of students studying STEM courses. Nowhere is this more obvious than within Engineering and Technology where female participation hovers at just above 15%. This is highlighted in Figure 3.8 which outlines female participation on all STEM courses in UK HE.

Figure 3.8: Percentage of Female Students by STEM Subject in UK Higher Education



Source: HESA

Clearly, STEM subjects have markedly different levels of female participation. At 24%, Computer Science fairs better than Engineering and Technology, whereas in Biological Sciences female participation is at 64%. Mathematical Sciences and Physical Sciences have mid levels of female participation at 37% and 42% respectively. One worrying aspect of the levels of female participation within the STEM subjects is the fact that participation levels have remained relatively static across all of STEM. This in itself suggests that attempts to increase the numbers of female students studying STEM subjects should be reviewed as they appear to have made little if any impact upon female participation in recent years.

3.8 Individual Engineering Disciplines

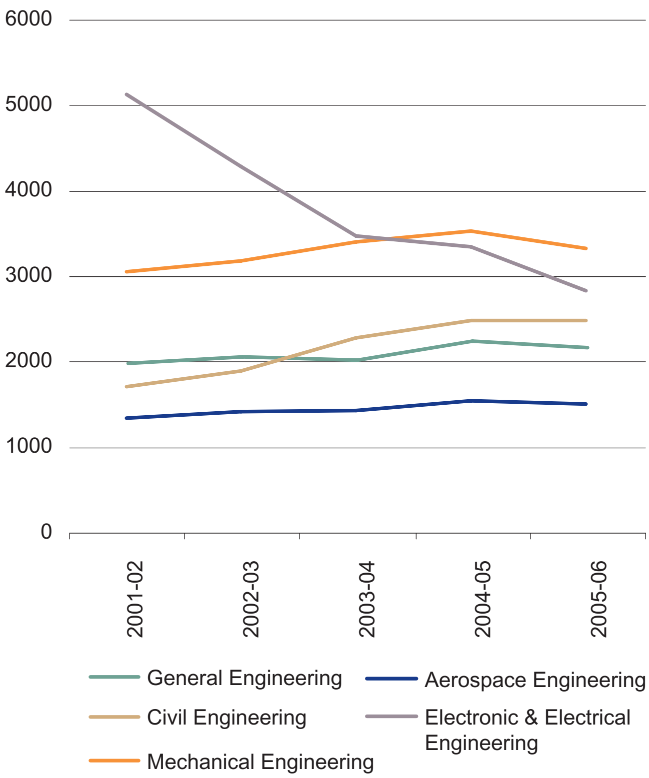
As this report illustrates, one of the problems of looking at trends within STEM HE is that specific differences between subjects are often disguised. Nowhere is this better illustrated than within Engineering and Technology where the various disciplines have experienced a range of trends over recent years. The following section begins with an examination of acceptance rates onto engineering courses as a whole and then examines trends within each of the main branches of engineering.

3.9 Acceptance Rates on Engineering Courses

Engineering and Technology as a whole has seen increases in home student numbers of 6% over the five year period, rising to 16,300 home acceptances in 2006. It is worth noting however that home acceptances in Engineering and Technology fell by 5% last year. The data suggest that new students are selecting their particular engineering field based on future employability; undergraduates are therefore becoming more selective about the type of engineering they follow, which may, account for the sharp 44% decline in Electronic and Electrical Engineering entry from 5,110 in 2001 to 2,884 in 2006. If students are making their engineering course selection as part of long term career decisions then it is possible that the numbers of students following general engineering courses will increase as students keep their options open. If this is to happen then there might be an increase in acceptances onto general engineering degree courses.

The numbers of students accepted through UCAS to Engineering and Technology degree courses by discipline over the last five years is shown in Figure 3.9.

Figure 3.9: Home Acceptances onto Engineering Courses 2002-2006



Source: UCAS

The trends in admission onto individual engineering disciplines vary. Civil Engineering has been leading the way over the last five years with a 45% increase in acceptances to just under 2,500. Some growth has also been seen in Aerospace Engineering (+12%), Chemical and Process Engineering (16%), General Engineering (9%) and Mechanical Engineering (9%). One of the most striking trends is that of Electrical and Electronic Engineering which saw a dramatic increase in acceptances to a peak in 2002. However, since then they have dropped back significantly with a 45% decline in acceptances in the last five years; this contraction in demand may in part be in line with negative public perceptions associated with the IT industry and particularly the collapse in the 'dot com' boom of the late 1990s, or, as some allege, the increasing disparity between the demands of Electronic Engineering and the content of Mathematics and Physics GCE A Levels.

3.9.1 Aerospace Engineering

HE in Aerospace Engineering has seen a 12% increase in home acceptances over the last five years, to a level just under 1,500 per year. The overall undergraduate population studying the subject has also increased by 26% to over 6,300 and early indications are that Foundation Degrees are becoming a popular route into the sector as well. Healthy growth has also been seen in the postgraduate population studying Aerospace Engineering with 21% growth over five years to 1,300 in 2005.

Table 3.1: Student numbers in Aerospace Engineering

Aerospace Engineering	2005-06	Annual Change	5 Year Change
Home acceptances	1,483	-2.6%	+11.8%
Undergraduate population	6,330	+1.1%	+26.3%
Postgraduate population	1,255	-6.7%	+21.2%
Percentage of female students	10.4%	+3.0%	-3.3%
Percentage of foreign students	20.2%	+12.5%	+9.8%

Source: HESA, UCAS

The proportion of females studying Aerospace Engineering increased by 3% in the last year. However, even with this increase there has been an overall drop of 3% over the five year period; this also needs to be tempered by the fact that overall student female student numbers have grown by 19% over the five year period. The percentage of foreign students studying the subject rose to just over 20% a continuation of the increasing trend in foreign students studying the subject.

3.9.2 Chemical, Process and Energy Engineering

The undergraduate population in Chemical, Process and Energy Engineering has grown by just over 2% over the last five years. The subject has also enjoyed a 30% increase in home acceptances, reaching a record high since 2000 of 855.

Table 3.2: Student Numbers in Chemical, Process and Energy Engineering

Chemical, Process & Energy Engineering	2005-2006	Annual Change	5 Year Change
Home acceptances	855	+11.3%	+29.5%
Undergraduate population	3,710	+6.0%	+2.3%
Postgraduate population	2,505	-2.9%	+27.8%
Percentage of female students	20.5%	-25.5%	-27.3%
Percentage of foreign students	41.1%	+6.3%	+32.1%

Source: HESA, UCAS

The postgraduate population has also increased by almost 28%. Increases in student numbers may have been influenced by the massive increase in foreign students studying the subject, reflected in a 32% increase in foreign student participation over the five years. Female participation in this subject group is however extremely strong relative to the rest of engineering at 20.5% despite a dramatic fall over the past 5 years (from 28% in 2002).

3.9.3 Civil Engineering

Civil Engineering has seen a massive increase in home acceptances over the last five years, with acceptances up by over 45% to just under 2,500 per year. This is reflected in an increase in the undergraduate population over the same period of 29%.

Table 3.3: Student Numbers in Civil Engineering

Civil Engineering	2005-06	Annual Change	5 Year Change
Home acceptances	2,458	+0.4%	+45.4%
Undergraduate population	14,100	+0.2%	+29.3%
Postgraduate population	5,730	+7.9%	+18.6%
Percentage of female students	16.7%	-1.7%	+1.7%
Percentage of foreign students	29.6%	-3.8%	-7.2%

Source: HESA, UCAS

The postgraduate population saw an increase of 29% over the last five years. Foreign student numbers are also on the increase to nearly 30%, in 2006. Although female participation remains stubbornly low, the overall health of this branch of engineering appears to be good, perhaps reflecting the buoyant state of the UK construction and civil engineering labour market.

3.9.4 Electronic and Electrical Engineering

As the largest branch of engineering, Electronic and Electrical Engineering has been an important measure of the health of the sector as a whole. However, the last five years has seen a 45% decline in home acceptances to just over 2,800. This has led to a reduction in the undergraduate population of 7.4% over the last five years to just under 23,000.

Table 3.4: Student Numbers in Electronic and Electrical Engineering

Electronic & Electrical Engineering	2005-2006	Annual Change	5 Year Change
Home acceptances	2,824	-15.3%	-44.7%
Undergraduate population	22,980	-5.5%	-7.4%
Postgraduate population	9,810	-4.6%	25.0%
Percentage of female students	11.9%	-0.8%	6.2%
Percentage of foreign students	39.6%	0.8%	41.4%

Source: HESA, UCAS

On a more positive note, the postgraduate population increased over the five year period by 25% to 9,810. Whilst the focus for concern in this subject area should be the falling numbers of undergraduate students, of equal concern is the high proportion of foreign students which increased by 41% over the five year period with nearly 40% of students domiciled from outside the UK.

3.9.5 General Engineering

The uptake of General Engineering courses in the UK is increasing. Over the last five years, home acceptances have increased by 9%, to just under 2,200.

Table 3.5: Student Numbers in General Engineering

General Engineering	2005-2006	Annual Change	5 Year Change
Home acceptances	2,176	-3.1%	+9.0%
Undergraduate population	14,120	-1.2%	+13.9%
Postgraduate population	6,915	-2.4%	+30.6%
Percentage of female students	15.0%	+8.7%	-12.7%
Percentage of foreign students	27.5%	+2.5%	+32.4%

Source: HESA, UCAS

The postgraduate population and percentage of foreign students studying General Engineering have also increased by 30% and 32% respectively. Unfortunately the 9% increase in percentage of female students last year was insufficient to fully off-set the five year declining trend of 13%.

3.9.6 Mechanical Engineering

Mechanical Engineering has seen a 9% increase in home acceptances over the last five years to just over 3,300. However, this has had only a marginal impact on the undergraduate population which has remained relatively static over the same period, at just under 18,000.

Table 3.6: Student numbers in Mechanical Engineering

Mechanical Engineering	2005-2006	Annual Change	5 Year Change
Home acceptances	3,311	-5.8%	+9.3%
Undergraduate population	17,920	+3.7%	+4.9%
Postgraduate population	4,035	+2.5%	-16.5%
Percentage of female students	8.5%	-1.4%	+2.4%
Percentage of foreign students	26.3%	+27.3%	+33.5%

Source: HESA, UCAS

The postgraduate population in Mechanical Engineering saw a reduction of 16.5% over the last five years to just over 4,000. Mechanical Engineering saw an increase in the percentage of foreign students reaching 26% in 2006. It is worth noting that the proportion of female students at over 8% is the lowest female participation rate across the branches of engineering.

3.9.7 Production and Manufacturing Engineering

Production and Manufacturing Engineering has seen declining home acceptances, undergraduate and postgraduate populations. These have all fallen by 50%, 41% and 5% respectively.

Table 3.7: Student numbers in Production and Manufacturing Engineering

Production & Manufacturing Engineering	2005-2006	Annual Change	5 Year Change
Home Acceptances	677	-24.7%	-50.7%
Undergraduate population	4,800	-8.8%	-41.4%
Postgraduate population	2,455	-9.6%	-5.6%
Percentage of female students	16.7%	+7.5%	+22.8%
Percentage of foreign students	28.3%	+4.4%	+73.6%

Source: HESA, UCAS

Over the 2005/6 period the percentage of foreign students increased to 28%. The picture painted here for this subject area is not too healthy; the statistics indicate a subject in decline perhaps reflecting the changing nature of the manufacturing industry in the UK. Nevertheless, over five years there has been a massive increase in the percentage of foreign students and a healthy upturn in female participation.

3.10 Summary and Conclusions

- In 2006 there were over 330 institutions offering HE courses in the UK with over 316,000 undergraduate degrees awards being made during the year; 85,000 (27%) of these were awarded in STEM subject areas. This proportion has increased from 25% in 2001.
- Over 125,000 postgraduate degrees were awarded at masters and doctoral level in 2005, with 35,000 (28%) being awarded in STEM subjects. This proportion has remained fairly static in the past 5 years where it was 27%.
- The last five years has seen an expansion in overall student numbers taking STEM subjects within UK HE. STEM student numbers have increased by nearly 25% from 424,000 in 2001 to over 527,000 in 2006.
- Engineering and Technology as a whole has seen increases in home student numbers of 6% over since 2001, rising to 16,400 home acceptances in 2006, however, there has been an rise in home acceptances of 13% for all of HE.

3.11 Comment

The picture for STEM in HE is a varied one. The student population has increased by 40% over the past 10 years and some STEM subjects, namely Biological Sciences and Mathematical Sciences, have enjoyed significant growth in student numbers with increases of 6% and 49% respectively since 2001. However, over the past 5 years, numbers in Engineering and Technology have remained fairly static with the undergraduate population growing by just 0.8% since 2000. In reality this means a smaller proportion of students are choosing this subject at HE. In 2000 Engineering and Technology undergraduates accounted for 6.3% of all undergraduates, by 2006 this proportion had dropped to 5.5%. Female participation in Engineering and Technology remains low, and encouraging more girls into the area could be a way of expanding home student numbers. The proportion of girls choosing Engineering and Technology at HE has remained fairly static at around 15% over the past five years which suggests that more needs to be done to encourage women into this area.

Engineering and Technology also has a high proportion of non-UK students (30% compared with the 14% average for all areas) mostly from outside the EU. Anecdotal evidence suggests that many HE engineering departments are dependent upon this income stream as higher tuition fees are paid by non-EU students. Further research into this area is required to establish the degree to which this evidence is true. Further work is also required in this area to determine the impact of foreign students on postgraduate programmes. Of particular interest is the percentage of these students who leave the UK at the end of their studies and are lost to the UK economy. This could have a major impact upon knowledge transfer, and the ability of the UK economy to produce and retain the high level skills needed to compete in the 21st century.

4. Graduate Recruitment

A key interface between the supply and demand of graduate engineers occurs at the point which graduates enter the workplace. This chapter examines trends relating to engineering graduates after they leave HE and enter the workforce. The analysis also looks at where graduates work and what salaries they are likely to earn.

4.1 Expansion in Higher Education

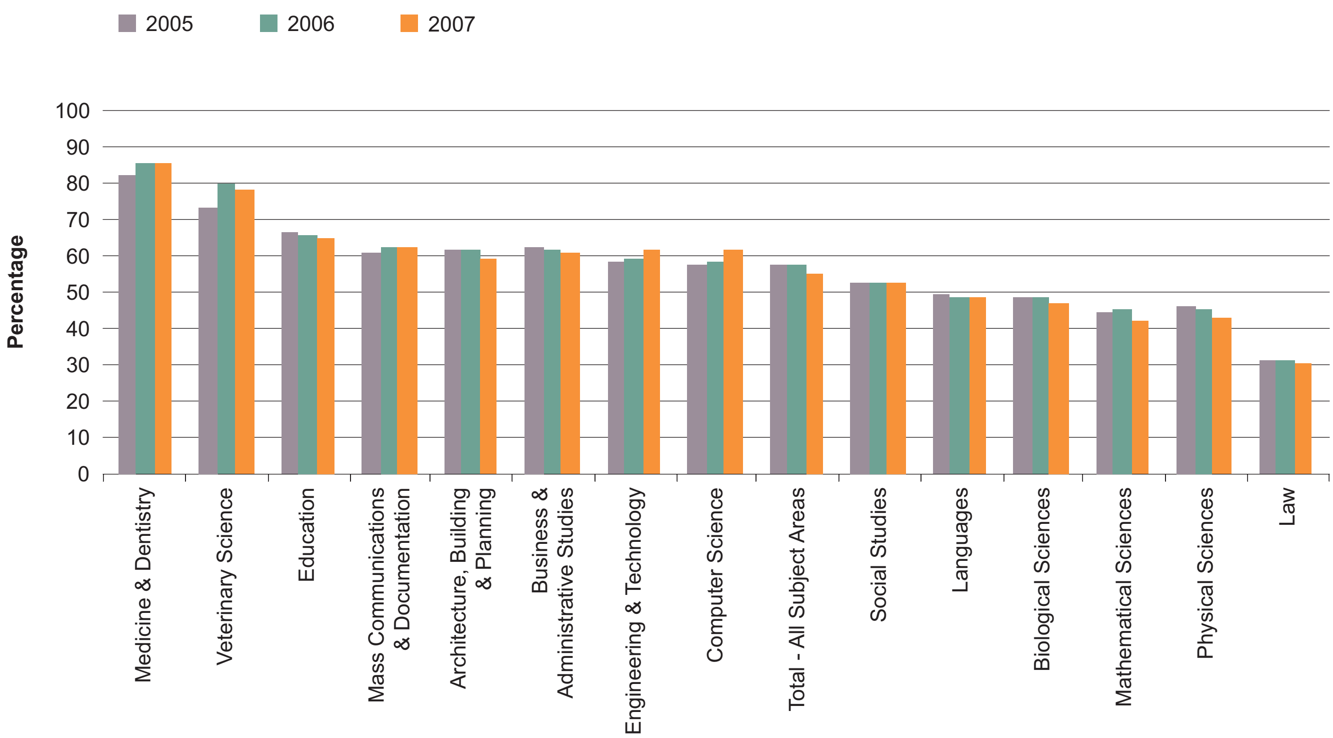
This chapter provides a perspective on the demand side of the SET skills agenda; by examining the trends facing graduates after they leave HE and enter the world of employment. The chapter begins by setting out some of the main findings from the latest version of the graduate *Destinations of Leavers from Higher Education* (DLHE) survey, published annually by the HESA. This looks in particular at where SET graduates work in the UK economy. The second half of the chapter examines some of the data published by HESA and the Association of Graduate Recruiters (AGR), on salaries and working conditions of SET graduates.

The rapid expansion in HE during the last decade, together with a shift to a more open and diverse HE system has created a wider range of choice for potential students. It has also posed challenges to universities and colleges with respect to their marketing and recruitment strategies. Students are increasingly seen as customers with individual needs and preferences and there has consequently arisen a competitive market for HE with an allied greater emphasis put by the HE institutes on marketing. The choice of a HE institution to enhance future employment prospects is becoming a more important factor in applicants' minds these days, particularly as student debt levels and course fee increase. The employment prospects of SET students are an important issue for both HE and UK industry. For the HE sector the graduate employment market can be seen as an important performance indicator on its ability to supply talent for UK industry; the role of universities is vital in providing sufficient numbers of appropriately trained graduates to meet the demand of UK industry. It is important that the patterns of graduate recruitment facing SET students are captured and recorded so that long term trends relating to graduate recruitment can be benchmarked.

4.2 Destination of Leavers from Higher Education Survey

HESA produce the *Destinations of Leavers data from the Higher Education* (DLHE) survey, which is updated on an annual basis; the main aim of the study is to look at the employment status of graduates six months after the end of their studies. The study looks to sample both undergraduates and postgraduates. In the most recent study published in June 2007 the results from the 2005/06 cohort are presented; the study received over 260,000 responses from full time students, up 20,000 since 2003. This represented a response rate of over 78% from full time postgraduate and undergraduate students. The full time employment rate of the undergraduates in January 2006 for the cohorts of 2003/04, 2004/05 and 2005/06 are detailed in Figure 4.1. For the cohort of 2005/06, the highest employment rate is seen in Medicine and Dentistry (86%). Veterinary Science (79%) and Education (65%) also saw high levels of employment; which is not surprising due to the vocational nature of these courses. At the other end of the scale Law has the lowest employment ratio at 31% for the third consecutive year, with Languages, Biological Sciences, Mathematical Sciences and Physical Sciences all with employment rates lower than 50%. It is worth noting that Law is an exception in this analysis; many Law graduates go directly into low paid training contracts, or take part in legal practice courses, thereby reducing the employment levels for Law students.

Figure 4.1: Percentage of Students in Full Time Employment by Subject 6 Months After Study

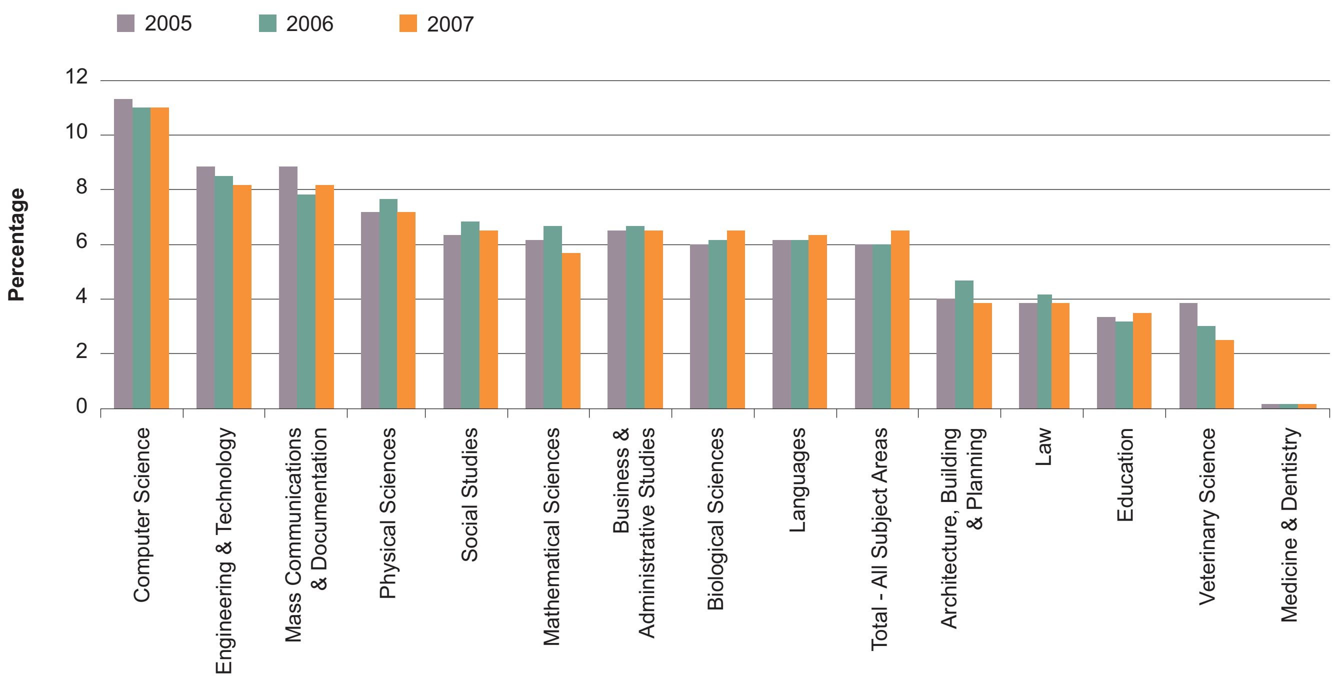


Source: HESA (2007)

With full-time employment rates increasing annually for Engineering and Technology (62%) and Computer Science (62%), both of these applied subjects stand above the average for all subject areas of 55%. However, it should be noted that these data do not include those students continuing full time education, or those entering part-time employment, voluntary or unpaid work. A review of unemployment rates by subject is shown in Figure 4.2. Here the picture is less positive for Computer Science (11%) and Engineering and Technology (8%), both subjects having the highest levels of unemployment. Physical Sciences still has a 7% level of unemployment despite improvements in 2004.

At the other end of the spectrum, Medicine and Dentistry have an unemployment level of just 0.2% with Veterinary Science having a similarly low rate of below 3%. Generally, there has been a trend of declining unemployment rates since 2003 in all subjects. However, the overall rate increased slightly between 2006 and 2007. It is clear that the interaction between employment rates and unemployment rates requires further study. As one would expect, subjects like Medicine have high employment and low unemployment rates. Engineering and Technology and Computer Science have above average employment rate but a high unemployment rates, this clearly requires further investigation.

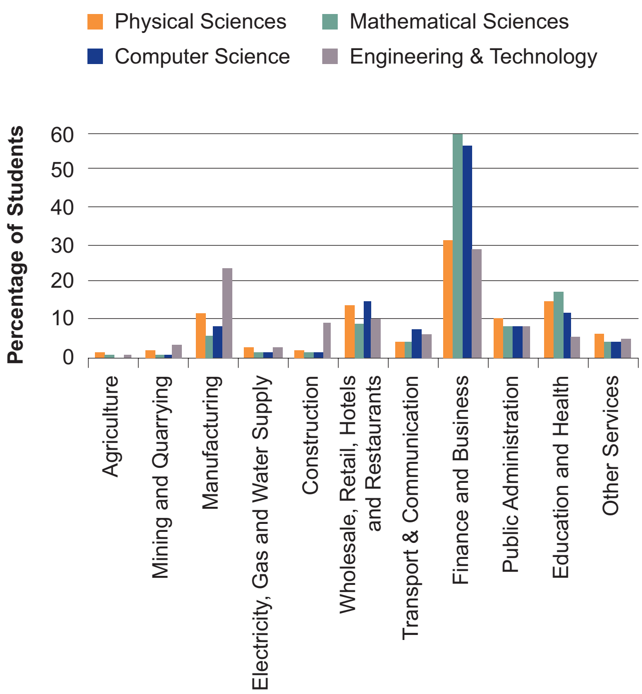
Figure 4.2: Unemployment Rate by Subject 6 Months After Study



Source: HESA (2007)

The Destinations of Leavers from HE data can be examined by subject area by the SIC codes. This allows analysis of where in the economy graduates are working, and we can compare the distribution of graduates from different subject areas. The breakdown of first degree completions by SIC code is outlined in Figure 4.3.

Figure 4.3: Destinations of First Degree Holders by Standard Industrial Classification (SIC) 6 Months After Study



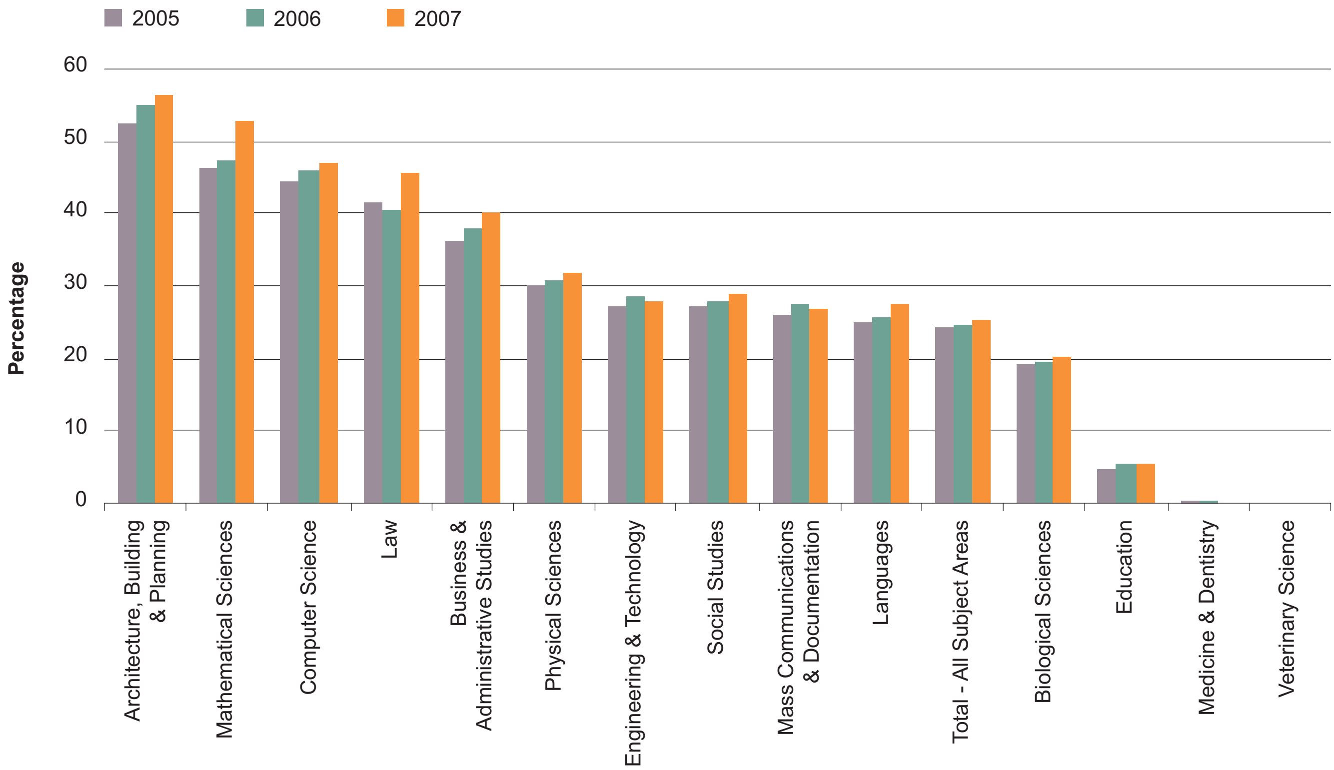
Source: HESA (2007)

The destinations breakdown for SET shows a diverse picture across the subjects. The largest proportion of Engineering and Technology graduates by SIC code can be seen working in the Finance and Business (30%), with the second largest group working in Manufacturing (24%). This compares with Computer Science where 46% of graduates work in Finance and Business. Physical Science weighs in with 31% in the same part of the economy and Mathematical Sciences with over 50%.

The high percentage of SET undergraduates entering SIC group Finance and Business (SIC 2003 Code Sections J and K) is a major feature of our analysis of the Destination of Leavers from Higher Education survey, although this does include employers involved in, for example, architectural engineering and technical consultancies, engineering R&D and computer hardware consultancy. Figure 4.4 overleaf looks at the proportion of students going into finance and business from various subject groupings over the last 3 years. Architecture, Building and Planning have the highest ratio of graduates working in Finance and Business with 57%. This is followed by Mathematical Sciences at 53% and Computer Science with 47%, as has been the case for three consecutive years.

There is a long standing view that there has been a drain on SET graduates towards Finance and Business – perhaps reflecting the fact that such firms value the analytical and mathematical competencies inherent in SET graduates. This assertion is supported by the fact that a large proportion of Mathematics and Computer Science graduates go into Finance and Business occupations. However, a much lower, but still substantial, percentage of graduates from Physical Sciences (32%) and Engineering and Technology (28%) go into Finance and Business. This is in the mid range of graduates entering Finance and Business, with the average for all subjects being at just over 25%. It should be noted that the Finance and Business sector employs people from *all* subject areas and this has been increasing since 2003. Engineering and Technology sees 28% of its graduates entering the field, it is similar to that for Social Studies students (29%) and Mass Communication and Documentation students (27%): so the drain to Finance and Business is not a phenomenon peculiar to Engineering and Technology.

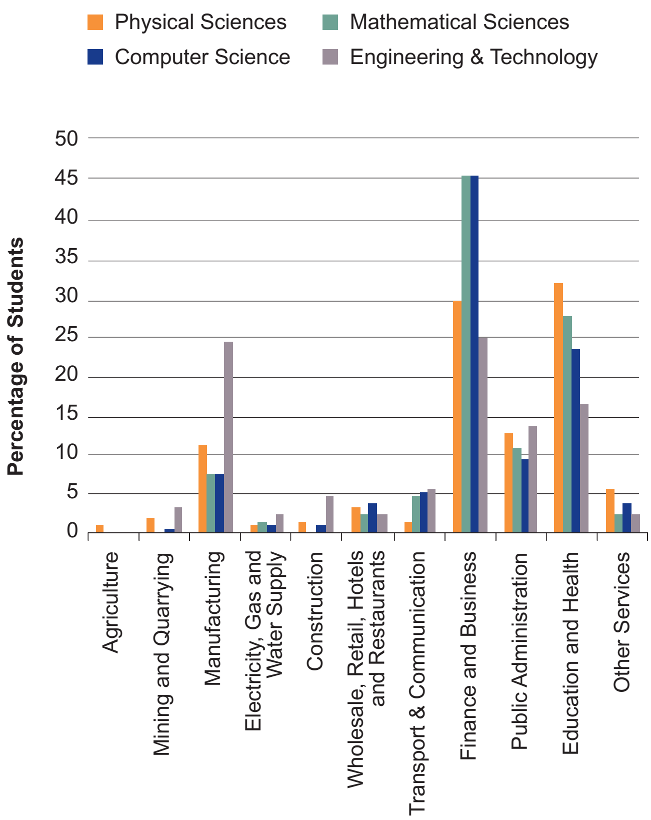
Figure 4.4: Percentage of All Students Going Into Finance and Business by University Subject 6 Months After Study



Source: HESA (2007)

Analysis of postgraduate destinations after completion provides a similar story for Engineering and Technology, and is demonstrated in Figure 4.5. A quarter of Engineering and Technology postgraduates going onto work in Finance and Business with 24% are working in Manufacturing, a situation not wholly dissimilar to that seen at undergraduate level.

Figure 4.5: Destinations of Postgraduate Degree Holders by Standard Industrial Classification (SIC) 6 Months After Study

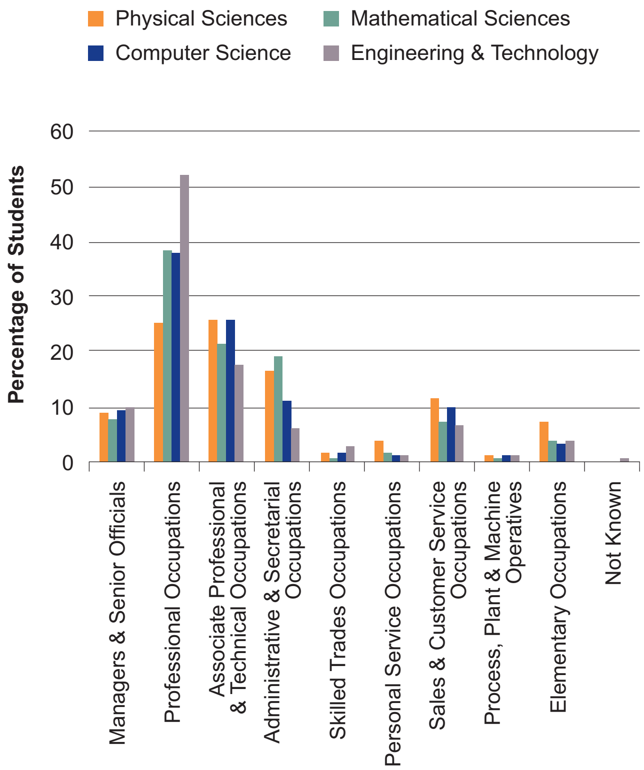


Source: HESA (2007)

It should be noted however that the situation is slightly different at postgraduate level for Physical Science and Mathematical Sciences. In both these cases there is a heavier bias towards work in Finance and Business (Physical Science at 29% and Mathematical Sciences at 45%), but with a large percentage of postgraduates staying on in academia. This is reflected in the figures for Education and Health of 31% for Physical Sciences and 27% for Mathematical Sciences.

Our analysis of destinations data can be put into a more detailed context than that offered solely by SIC codes. This is an issue because the SIC 2003 codes, whilst informing us of what type of industrial sector an employer may be categorised as, tell us little about the type of role the individual plays within that industry. There may be, for example, engineers working in parts of the economy not readily associated with engineering – SIC code analysis would always classify an engineer working at a retailer as working in retail. Further analysis through the use of Standard Occupational (SOC) Codes, allows us to re-examine the same data from an occupational perspective. This permits an analysis of the extent to which graduates are employed as engineers. The SOC breakdown for first degree SET students is outlined in Figure 4.6 overleaf.

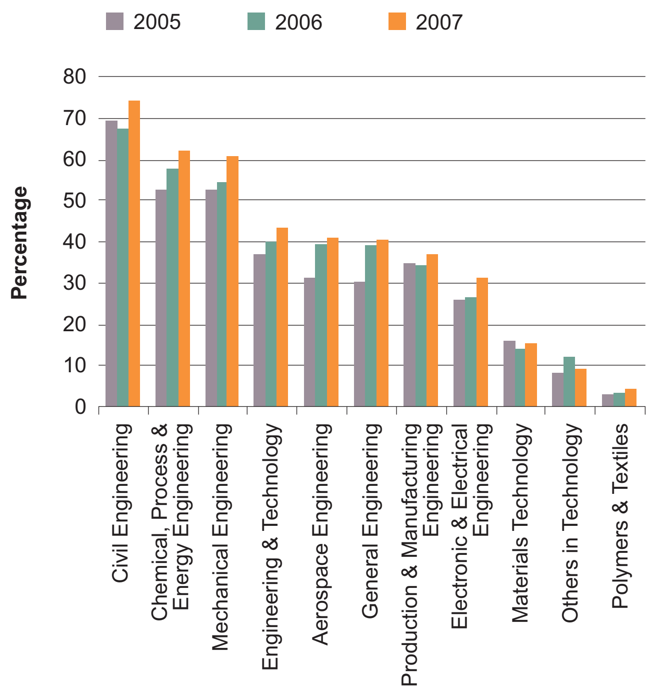
Figure 4.6: Destinations of First Degree Holders by Standard Occupational Classification (SOC) 6 Months After Study



Source: HESA (2007)

It is obvious from the SOC code analysis that professional occupations are the primary destination for SET students – it is not surprising to see that Engineering and Technology has over 53% of its students going into professional occupations. Computer Science and Mathematical Sciences also have a heavy bias into the professions with both registering around 38%. It is interesting that Physical Science has a three way split between professional, associate and administrative occupations. Further analysis of SOC codes for Engineering and Technology can tell us about differences in the separate branches of engineering. This is displayed in Figure 4.7, which outlines the percentage of students from each branch of engineering who go on to become professional engineers.

Figure 4.7: Percentage of Engineering Graduates Who Move Into Professional Engineering by Discipline 6 Months After Study



Source: HESA (2007)

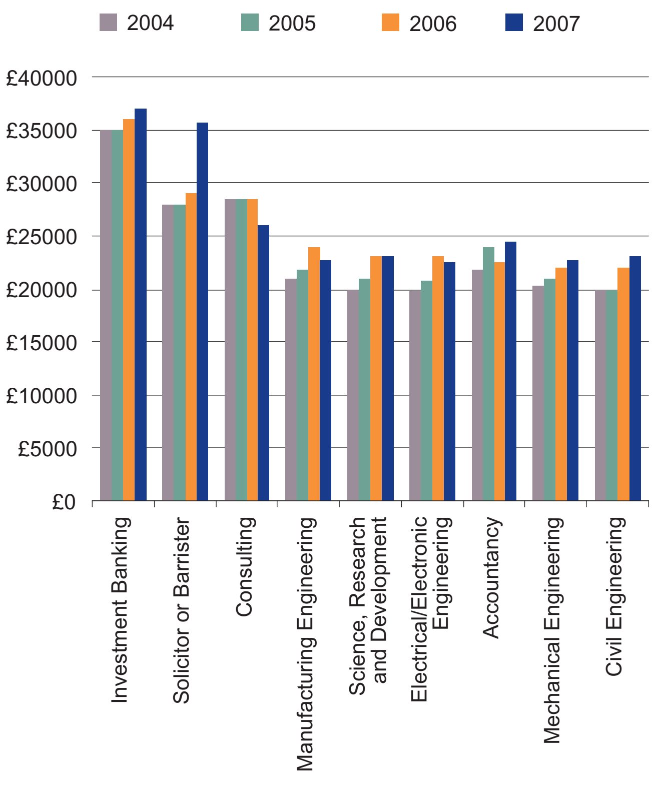
The propensity of graduates to enter professional engineering differs across the engineering world. Civil Engineering for instance has an extremely high rate of career progression with over 74% of Civil Engineering graduates working as professional engineers 6 months after graduation in 2007. Chemical Engineering (62%) and Mechanical Engineering (60%) have enjoyed a year on year increase of graduates going into the profession. It is a concern that Electronic and Electrical Engineering sees only a third of its graduates moving on to professional engineering careers, however, the data suggests that this percentage is growing year on year. The interaction of graduates and the demand of industry require further work, as the level of progression from graduate to professional engineer is dependant upon the demand of industry to employ graduates. It is likely that the low percentage of Electronic and Electrical Engineers who work as professional engineers is a function of low demand for graduates from electronics firms. All engineering disciplines experienced an increase of graduates moving into professional engineering in 2007 and there appears to be an upward trend emerging.

4.3 Graduate Starting Salaries

One of the main drivers behind graduate recruitment trends relates to initial starting salaries.

Data published by the Association of Graduate Recruiters is useful in that is gives us an indication of the starting salaries of different professions within larger graduate employers. This is outlined in Figure 4.8.

Figure 4.8: Median Graduate Starting Salaries

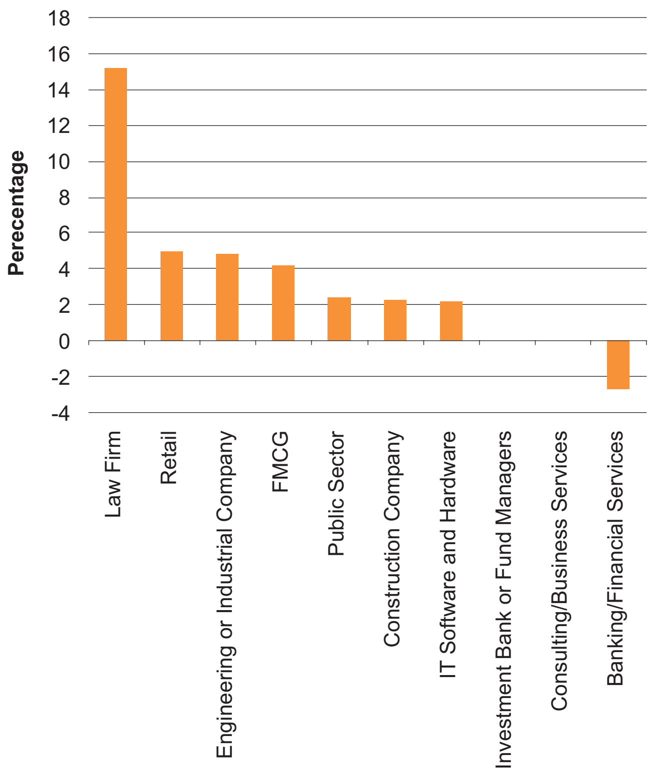


Source: Association of Graduate Recruiters 2007

In 2007 Civil Engineering has led the engineering disciplines with salaries at £23,000 after increases over the past three years, but this is well below the starting salaries of investment banking and solicitors at £36,000 or consulting salaries at £29,000. In fact the lowest salaries offered by engineering firms are for Electrical/Electronic Engineering graduates, earning an average of £22,500, though clearly there is not a lot of variation between starting salaries for individual disciplines. All engineering starting salaries appeared to be increasing annually, however 2007 has seen a drop for Electrical/Electronic Engineering and Manufacturing Engineering.

When comparing Engineering firms with other organisation types, the picture is a positive one. As illustrated in Figure 4.9, graduate salaries within Engineering companies have increased by 5% in 2007, this places them third highest compared to the other organisation types. Salary increases in Law firms greatly exceed other organisation types at just over 15%, Retail (5%) and FMCG (4%) have similar increases to Engineering, Public Sector, Construction and IT have all seen increases of 2% whereas Investment Banks and Consultancy Firms have seen no change in salary levels. Salaries in Banking actually experienced a 2% fall in 2007.

Figure 4.9: Changes to Salaries in 2007, by Organisation Type



Source: Association of Graduate Recruiters 2007

4.4 Summary and Conclusions

- The propensity of graduates to enter careers in professional engineering differs across the engineering disciplines with Civil Engineering as the highest and Polymers and Textiles as the lowest.
- The destinations data for SET shows a diverse picture across the subjects. Engineering and Technology sees the largest percentage of graduates working in finance and business (29%), with the second largest group working in the Manufacturing sector (24%).
- Whilst Engineering and Technology sees 29% of its graduates entering the finance and business field, it is similar for Social Studies graduates (29%) and Mass Communication and Documentation graduates (27%). The drain to Finance and Business is not a phenomenon peculiar to Engineering and Technology.
- Graduate starting salaries for engineering are close to the overall median of £23,500.

4.5 Comment

Although many SET graduates find careers in other sectors, including Finance and Business, this picture is not unique to the sector and reflects the interest other sectors have in the competencies, qualities, attitudes and motivations of SET graduates that are attractive to a wide range of employers.

The relatively high unemployment rates found in Engineering and Technology graduates (nearly 2% higher than the average) – with the exception of those studying Civil Engineering – suggests that the shortage of graduate engineers may be exaggerated. It will be very important to gain a thorough understanding of why this is happening if the drivers are to be addressed and the sector made more appealing as a place to work.

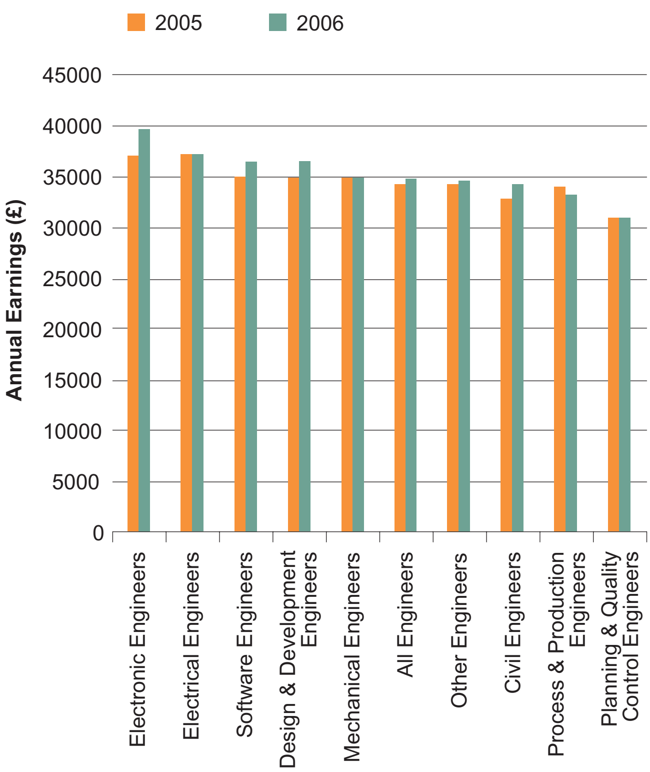
5. Engineering Salary Levels

Salary levels are a significant indicator of the relative supply and demand for engineers and impact not only the engineering profession, but also potential engineers. The subject is the cause of much debate within the profession; with a widely held perception that engineers are underpaid. This section attempts to assess the extent to which this is the case by the presentation and analysis of engineering salary data.

5.1 New Earnings Survey

A key source of information on the earnings of the UK workforce in the UK is the New Earnings Survey, published by the Office for National Statistics in 2006. The findings are illustrated in Figure 5.1 and Figure 5.2.

Figure 5.1: Engineering Salaries (mean)

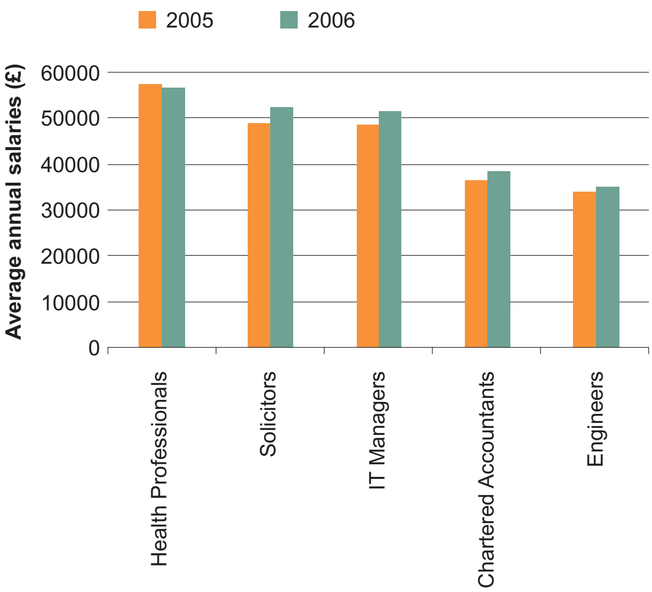


Source: New Earning Survey, ONS (2006)

According to the data presented in Figure 5.1 the mean annual gross earnings of professional engineers was £35,286 at the end of 2006 an increase of about £800 (+2.3%) from the previous year. In this context the data collected focused on the salaries of professional engineers, defined in the survey as graduates working with (academic) skills they have acquired whilst at university.

It is worth noting the variation in the earnings of engineers from the highest; electronic engineers (£39,592) to the lowest; Planning & Quality Control Engineers (£31,014). Essentially, most of the occupations have enjoyed an increase in the mean annual earnings from the previous year, apart from the Process & Production Engineers and the Planning & Quality Control Engineers. Figure 5.2 compares the mean salary for all professional engineers against a number of other professions. Again, for the third year running, Health Professionals head the list with mean salaries of £57,067, Solicitors come in with £51,463 and Chartered Accountants £38,406. In comparison the mean engineering salary is £35,286.

Figure 5.2: New Earnings Survey – Comparison of Salaries of Main Professions



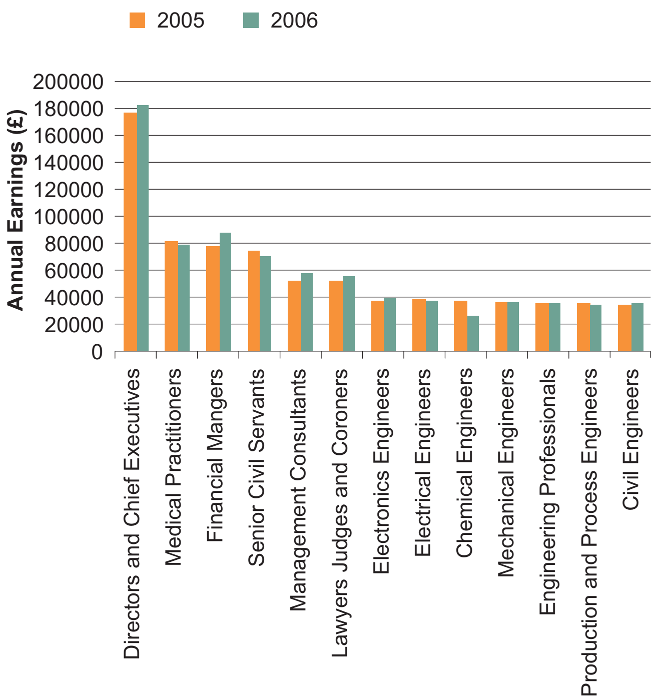
Source: New Earning Survey, ONS (2006)

5.2 New Earnings Survey – Comparison of Salaries of Main Professions

More recent data on salaries published by ONS in 2006 supports the data from the New Earnings Survey and provides a snapshot of salary levels across the UK economy. The data suggest that salary levels for professional engineers are lower than those of other professions. The mean professional engineer's salary only increased 1% from 2005 to 2006 according to the ONS data.

Figure 5.3 details the median annual earnings of the main branches of engineering in comparison with the main professions.

Figure 5.3: Median Annual Earnings of Main Professions



Source: ETB analysis of ONS (2006)

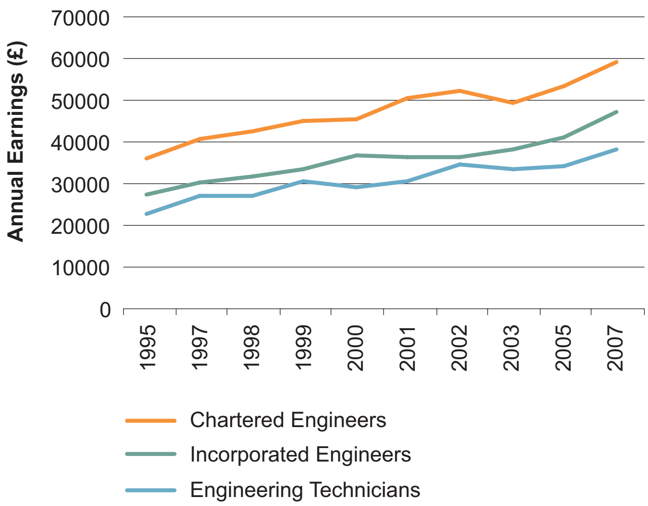
The data illustrate the fact that engineering salaries lag behind the other main professions. As one would expect, Directors and Chief Executives stand ahead from the other professions with median salaries of nearly £181,500. Medical Practitioners earn median salaries of £79,000, Financial Managers at £87,280 and Management Consultants at £57,244. Engineering in comparison has much lower salaries with Electronics Engineers featuring at £38,000, Chemical Engineers at £36,000 and Mechanical Engineers at £39,776. Civil Engineers rank as the lowest paid engineering profession with median salaries in 2006 of £35,338.

5.3 The ETB Survey of Registered Engineers

The engineering salary level of £35,286 outlined in the NES does not present the most positive picture of salary levels for professional engineers. The more recent data published by ONS goes some of the way to better understand current salary levels. However, both ONS pieces of data contrast with that presented in the ETB's 2005 Survey of EC^{UK} Registered Engineers, which put the mean annual gross earnings for registered Chartered Engineers in 2007 at £54,181 (this has been raised from £53,067 for 2005). This difference between the New Earnings Survey national data and the survey response from the profession could stem from a number of causes. One primary cause could relate to the age profile and professional status of those surveyed – newly academically qualified engineers require work experience and professional development before they are able to demonstrate the competencies necessary for registration at a later stage in their career. The data contained in the NES includes newly qualified engineers who are years away from professional registration; thus erroneously classifying them as professional engineers (unlike the other professions used in the NES and ONS comparisons). However, it is clear that, whatever the cause, registered engineers earn on average considerably more than the national average for the engineering profession.

The headline salary figures for mean and median earnings of registered engineers and technicians, over the period 1997-2007 are shown graphically in Figures 5.4 and 5.5. The average (mean) Chartered Engineer salary was £54,181 (up just 2% from £53,067 in 2005), while for Incorporated Engineers it was £43,759 up 8% from £40,500 in 2005. Engineering Technicians' average salary is now £34,392, a 2% increase from the 2005 figure of £33,800.

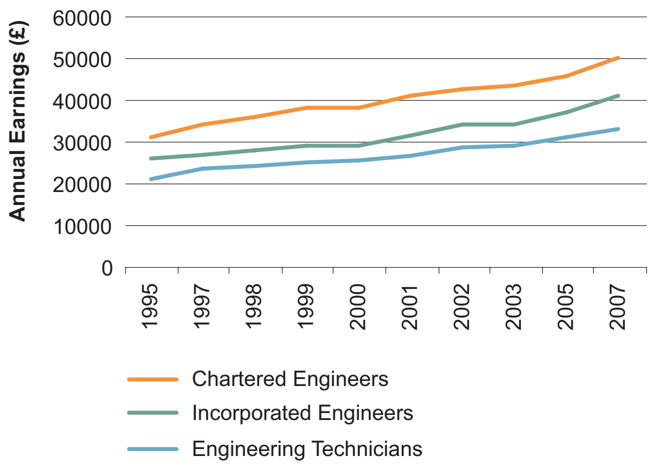
Figure 5.4: Mean Annual Earnings of Registered Engineers and Technicians



Source: Engineering and Technology Board (2007)

The figure for 2007 for Chartered Engineer salaries shows that the salaries have increased swiftly since 2003, evidently showing that professional engineers are becoming more valued. Median salary levels are included in Figure 5.5. As such they provide a better measure on salary levels as they are not subject to salary increases at the extremes of the salary scales.

Figure 5.5: Median annual earnings of Registered Engineers and Technicians



Source: Engineering and Technology Board (2007)

The median Chartered Engineer salary in 2006 was £50,000 (up from £45,500 in 2005), while for Incorporated Engineers it was £41,000 up from £37,000 in 2005. Engineering Technicians' salaries are now £33,000, an increase from the 2005 figure of £31,000.

Salary figures published in the 2007 survey of registered engineers compare favourably with some other professions such as architecture. Figures published by the Royal Institute of British Architects (RIBA) show that over the year to April 2005, its members had median earnings of £37,000. This compares directly to the Chartered Engineer median salary of £45,500 for the same time period.

5.4 Summary and Conclusions

- According to ONS data the average annual gross earnings of professional engineers was £35,286 at the end of 2006.
- More recent ONS salary data shows that Engineering professionals are paid significantly lower salaries than some other professions, such as Health, IT or Law.
- The negative salary situation contrasts to data presented in the ETB's 2007 Survey of Registered Engineers, which put the average annual gross earnings for registered Chartered Engineers in 2007 at £54,000.
- The median Chartered Engineer salary in 2007 was £48,000 (up from £45,500 in 2005), Incorporated Engineers' median salary was £41,000 (up from £37,000 in 2005) and Engineering Technicians' salary was £33,000 (up from £31,000 in 2005).
- Figures published by the Royal Institute of British Architects (RIBA) show that over the year to April 2005, its members had median earnings of £37,000. This compares directly to the Chartered Engineer median salary of £45,500 for the same time period.

5.5 Comment

The ONS data do not paint a positive picture for salary levels in the engineering profession. Compared to their contemporaries in Health, IT or Law, for example, the average engineering salaries lag behind. A possible reason for this may be premature classification of employees as professional engineers before they have achieved the work place competencies to join the professional register (unlike the other professions used in the NES and ONS comparisons).

The ETB's 2007 Survey of EC^{UK} Registered Chartered Engineers, however, found their average salaries to be considerably higher than those for professional engineers indicated by ONS data. Another positive feature of the data is the continuous upward trend experienced by all levels of registered engineer since 1995.

Chartered Engineers salaries show signs of stratifying into lower level (£30-40k), and higher level (£50k and above). More research is required to find out if this is true and if so, whether age, discipline or region are factors.

6. Professional Registration

Professional registration enables practising engineers to gain a widely recognised designation accrediting world class competence in engineering.

Engineers are able to register with the Engineering Council UK (EC^{UK}) as a Chartered Engineer, Incorporated Engineer or Engineering Technician. Registration enables employers to identify the competencies that they value and indicates their commitment to professional practice, all of which have been assessed by other engineering professionals. This section looks at trends in the uptake of professional registration. The material is sourced from the EC^{UK} register of professional engineers and Engineering Technicians.

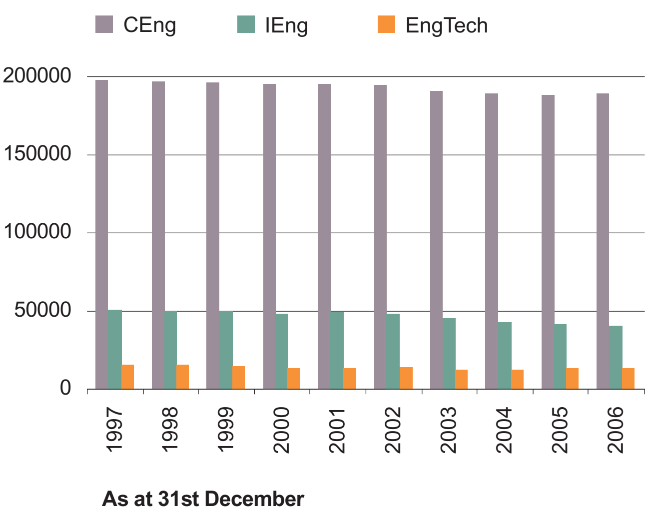
6.1 The EC^{UK} Register of Engineers and Technicians

EC^{UK} maintains the UK national register of professional engineers and technicians. As at 31 December 2006 there were 35 professional engineering institutions licensed by EC^{UK} to submit for registration those of their members who met the UK Standard for Professional Engineering Competence (UK-SPEC). To gain registration, individuals must demonstrate competence underwritten by education, training and responsible experience, as set out in UK-SPEC. Subject to licence, institution members can be entered in one of three categories on the register: Chartered Engineers (CEng), Incorporated Engineers (IEng) or Engineering Technicians (EngTech).

6.2 Registered Engineers

The total number of engineers and technicians registered at the end of each of the last ten years is outlined in Figure 6.1. The total number of registrants has declined from 263,999 in 1997 to 242,530 in 2006, representing a fall of 8% over the decade. The largest category of registered engineers is that of Chartered Engineers accounting for 78% of the total in 2006.

Figure 6.1: Total Registrations of Registered Engineers



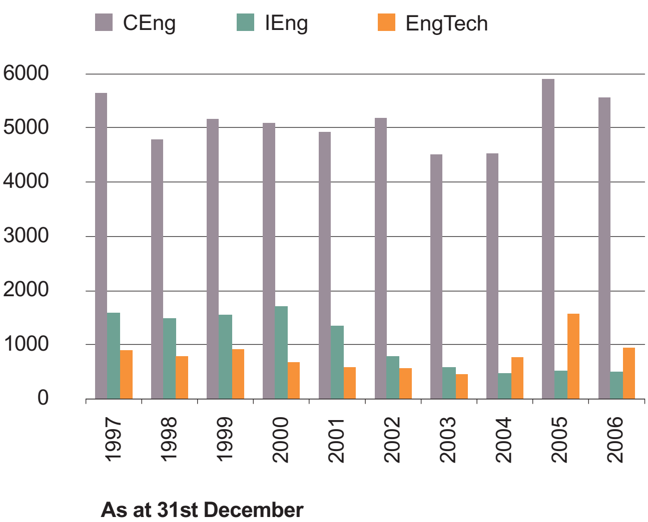
Source: EC[UK]

Meanwhile, Incorporated Engineers now account for just under 17% and Engineering Technicians for 5.5% of the total.

Of the three categories, the largest proportionate fall in numbers over this period has been in Incorporated Engineers, down 21% from 51,109 to just over 40,466, whilst the smallest decline has been in Chartered Engineers, dropping 4% from 197,414 to 188,701. There are signs of a stabilisation in the volumes of registered Chartered Engineers and Engineering Technicians with both experiencing slight rises in 2006 compared to 2005 of 334 and 256 respectively.

In Figure 6.2 we explore volumes of new registrations by category of registrant. As can be seen below, these figures fluctuate somewhat from year to year, although Chartered Engineers are once again clearly the largest group averaging about 5,100 new registrants each year over the last decade. The volume of new Incorporated Engineers peaked in 1987 at just over 3,000 and declined to an annual mean of about 1,500 between 1994 and 2001. Since then there has been a further stepped decline to just over 500 a year over the last four years. Volumes of new Engineering Technicians have fluctuated widely with 2005 experiencing the highest ever recorded figure of 1,580.

Figure 6.2: New Final/Stage Three Registrants

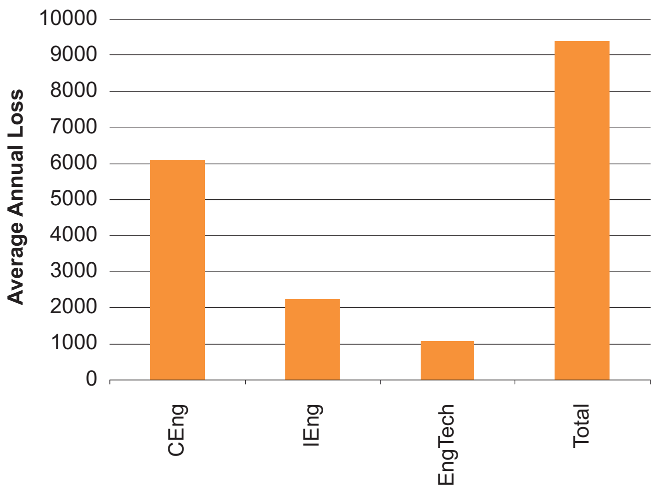


Source: EC[UK]

It is notable that the volume of new Engineering Technicians has exceeded that of Incorporated Engineers for the last three years following increasing efforts by Professional Engineering Institutions (PEI's) to engage with this group.

New registration volumes are tempered by annual losses that represent the other side of the change continuum. Volumes have fluctuated over the years but the relative proportions by grade are similar insofar as the ratios between CEng, IEng and EngTech are 6:2:1 as can be seen in Figure 6.3.

Figure 6.3: Mean Losses of Registered Engineers 1997-2006



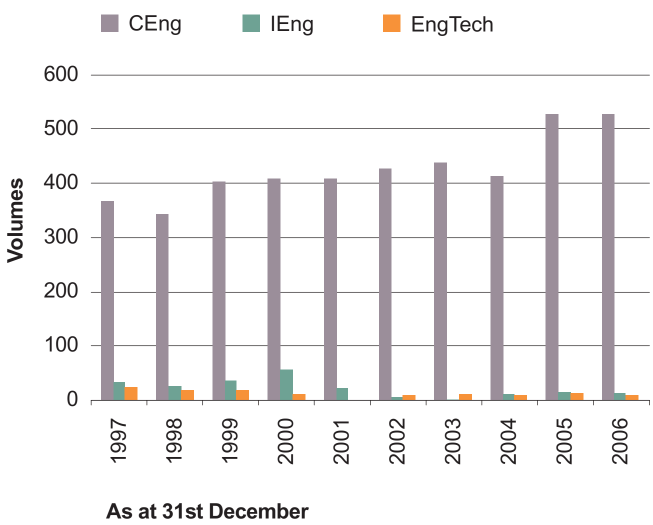
Source: EC[UK]

Examining the 2006 figure, one quarter of CEng losses were attributable to death, with the figures for IEng and EngTech being 9% and 3% respectively. The overall annual attrition rate is 3.8%.

6.3 Female Registrations

Figure 6.4 shows the percentage of female new registrants over the last decade, which shows an overall rise in their volumes at CEng level to 528 in 2006 compared to just 367 in 1997. However, these volumes are very small with a modest level of impact on the overall number of registered engineers.

Figure 6.4: New Female Registration Volumes



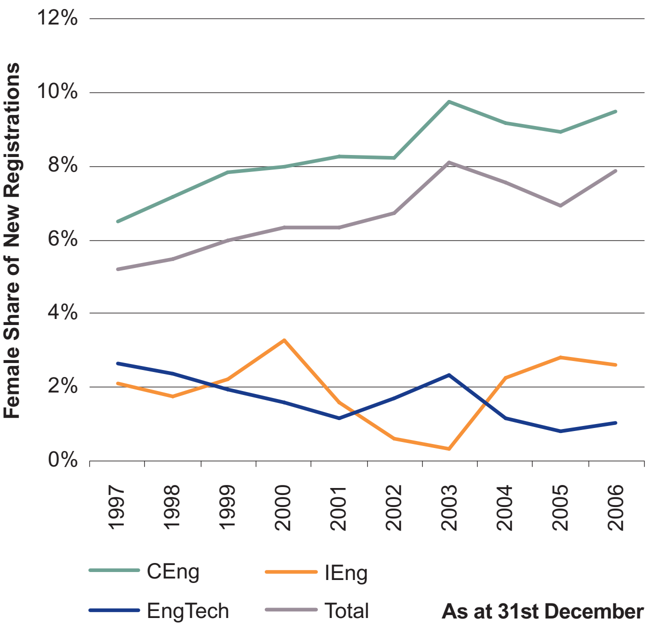
Source: EC[UK]

The volumes of female IEng and EngTech registrations are very low and show little sign of improvement over the period of the analysis.

Even when examining the share of new registrations that can apportioned to women (Figure 6.5), there can be seen an erratic increase in the proportion of CEng new registrations from 6.5% in 1997 to 9.5% in 2006. The data for the other grades show no significant sign of improvement.

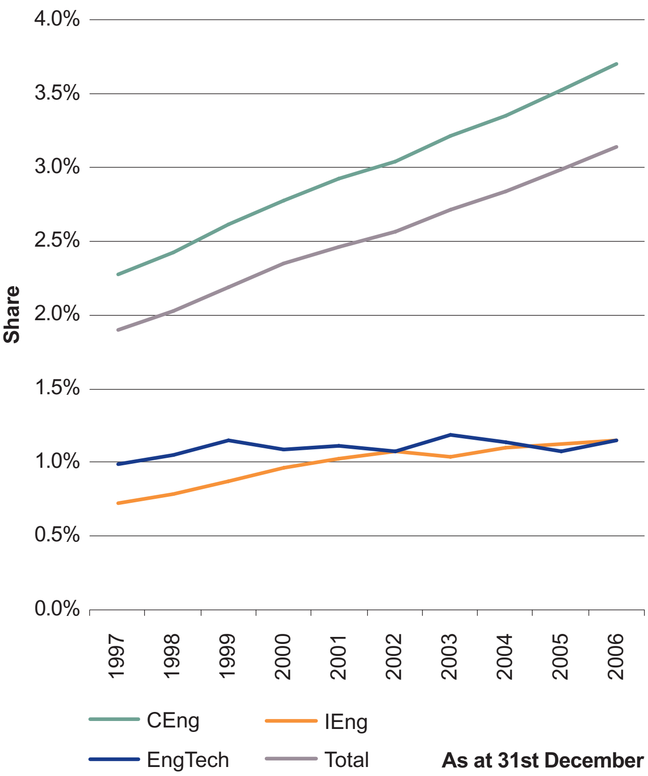
This degree of change is reflected in the female share of all registered engineers, which for the CEng grade has grown steadily from under 2.5% to over 3.5% between 1997 and 2006 (Figure 6.6). The share of IEng and EngTech registrants has shown little appreciable improvement over the last decade languishing at just over 1% in both cases.

Figure 6.5: Female Share of New Registrations



Source: ECUK

Figure 6.6: Female Proportion of Registered Engineers

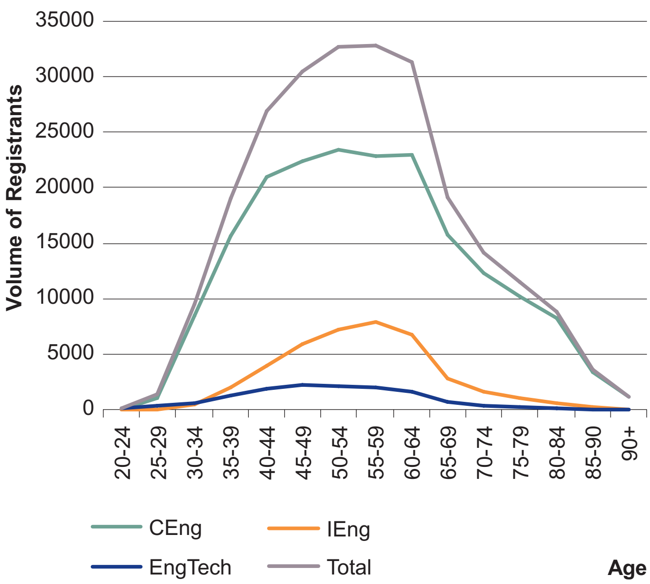


Source: ECUK

6.4 Age Profile

The age profile of those registered as engineers and technicians in 2006 is shown in Figure 6.7.

Figure 6.7: Registrants Age Profile 2006



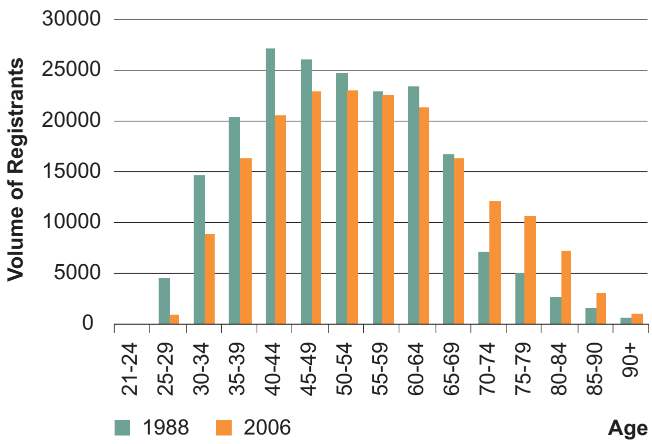
Source: ECUK

The mean age of CEng and IEng is 55, whilst the EngTech mean age is 50. Over a quarter (27%) of Chartered Engineers are aged over 65, whilst the proportion of Incorporated Engineers over 65 is 16% and Engineering Technicians over 65 is 9%.

Comparing the age profile of registered engineers in 2006 to that of 1988 provides a picture of the changing age profile over time. Age profiles for the three categories of registration are shown in Figures 6.8, 6.9 and 6.10.

These three age profiles clearly demonstrate that the average age of registered engineers is increasing. The mean age of a CEng in 2006 has risen 4.5 years from the 1988 level of 51.5 years of age. In the same period the mean age for IEng registrants has jumped a huge 9 years from 46 years of age in 1988.

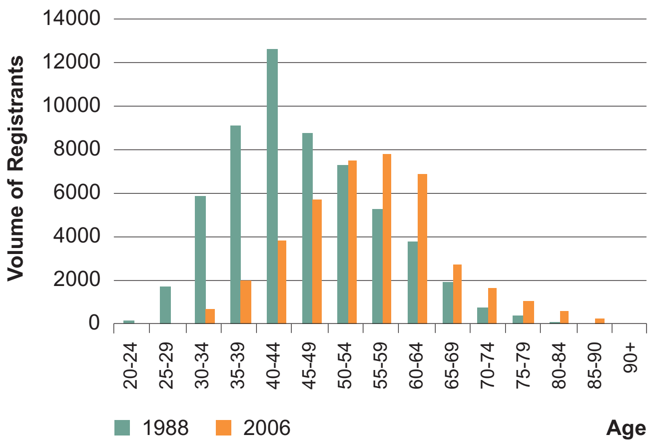
Figure 6.8: Chartered Engineer – Age Profile 1988/2006



Source: EC[UK]

There has been a significant decline in the volumes of registered CEng in all age groups under 55 totalling 25,700 between 1988 and 2006 equivalent to a 22% fall. To a large degree this reflects a substantially ageing profile of CEng registrants with over 17,000 more aged over 65 in 2006 than in 1988 – a rise of 50%.

Figure 6.9: Incorporated Engineer – Age Profile 1988/2006

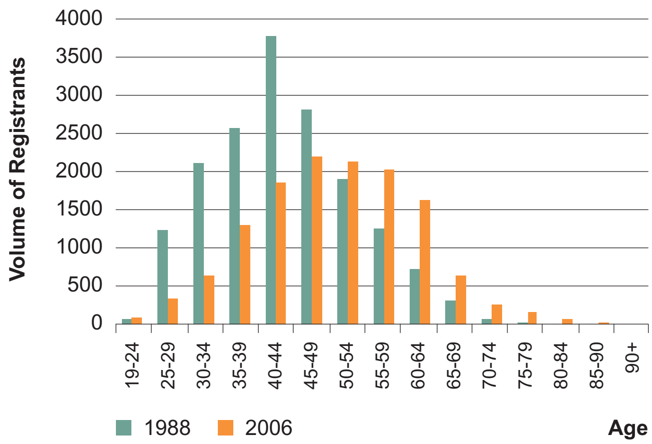


Source: EC[UK]

There has been an even more remarkable two-thirds decline in the volumes of registered IEng in all age groups under 50 totalling 37,000 between 1988 and 2006. To a lesser extent this reflects an ageing profile of IEng registrants with a doubling in volumes of those aged over 65 in the period.

The group aged 55-64 alone has risen 67% between 1998 and 2006. These 14,600 IEng registrants will all reach retirement age within the next 10 years, which highlights a potential slump in working age IEng registrants.

Figure 6.10: Engineering Technician – Age Profile 1988/2006



Source: EC[UK]

Among EngTech too there has been a 50% decline in the volumes of registered IEng in all age groups under 50 between 1988 and 2006. Once again this reflects to a lesser extent an ageing profile of registrants with a 60% increase in volumes of those aged over 50 in the period.

A similar demographic time bomb can be seen amongst the group aged 55-64 where volumes have risen 82% between 1998 and 2006. These 3,600 EngTech registrants will all also reach retirement age within the next 10 years.

6.5 Attitudes and Motivations

If there is to be a significant rise in the number of registered engineers it is important to better understand the attitudes and motivations of those in the sector who register.

The Survey of Registered Engineers 2007 clearly shows that those who are already registered did so primarily because they felt it would:

> Be helpful in career development

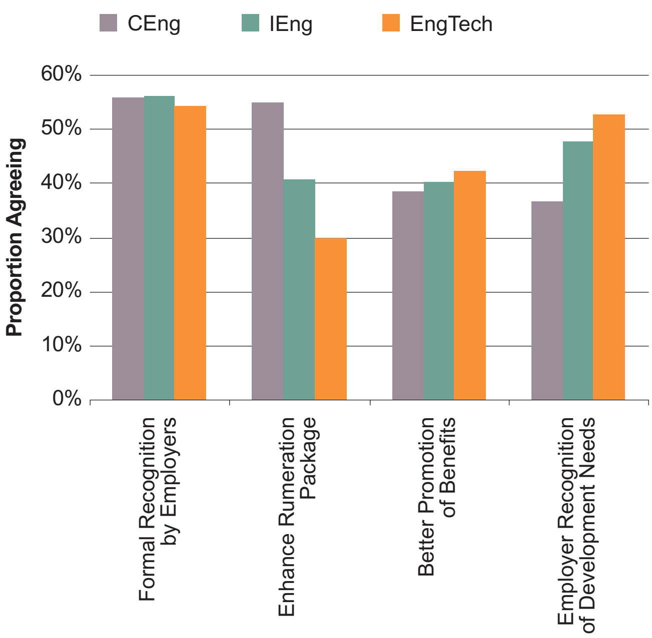
> Provide greater professional status

> Provide recognition of professional skills and experience

The respondents suggested that registration may have positive impacts on employment opportunities, enabling them to become more valued and have more influence. However, a significant minority of respondents felt registration had not had any impact; 37% of both CEng and IEng and 47% of EngTech registrants stated this.

Figure 6.11 shows the responses when respondents were questioned about what would encourage a greater level of registration.

Figure 6.11: Factors that would Encourage Registration



Source: ETB/EC[UK] Survey of Registered Engineers

A majority of all respondent registration grades see the formal recognition of registration by employers as being the most important factor in encouraging registration. The data also show that enhanced remuneration is important to a higher proportion, indeed a majority of CEng registrants, whereas the relative position is reversed for employer recognition of development needs. A significant minority of all grades considered that better promotional prospects would be a further encouragement.

6.6 Summary and Conclusions

> The total number of registrations continues to decline having fallen 8.1% or 21,500 over the last decade.

> The category of IEng has experienced the most significant decline, but both CEng and EngTech categories have experienced some stabilisation in numbers.

> Despite a decline in volume the category of CEng remains the largest and its share has grown three percentage points from 1997 to 2006.

> The increase in the proportion of female new registrants over the decade has been slow, even from a very low base.

> An ageing profile may store up some problems in the next ten years unless there is a significant rise in new registrations.

> The average age of registered engineers continues to increase.

6.7 Comment

The research featured in this section clearly shows that there is work to do to increase the appreciation of the benefits of registration for engineers and for employers as well. These benefits need to be articulated more widely and in a more targeted way to address the attitudes and motivations, both of those who do register and those who do not. This activity needs to focus on those exerting influence as well.

In this way it should be possible to increase the number of registered engineers by being as relevant and salient as possible through targeted promotional activity delivering clear messages. This is an urgent requirement given the extent to which the population of registered engineers is ageing. An upturn in registrations needs to be sustained over time if it is to make a significant impact on total numbers. The targeting of female engineers and, more broadly, all those engineers aged under 40 must be seen as being singular opportunities to achieve this and widen the inclusiveness of the sector.

The ETB believes it is vital to encourage professional membership and subsequent registration from as early a point in the engineer's career as possible.

The ETB and the EC^{UK} are currently working with all stakeholders across the sector to achieve these goals.

7. Engineers in the Economy

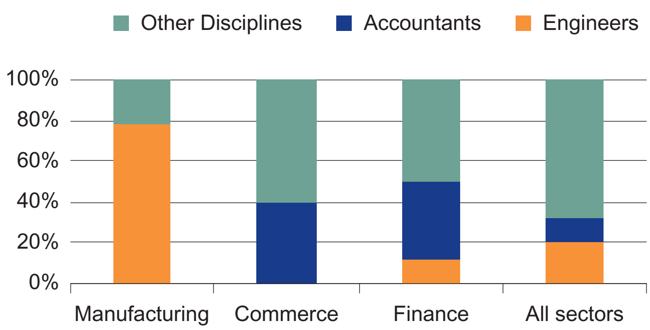
Engineers are employed across a wide spread of sectors and contribute immensely to UK industry and the UK economy. This chapter examines the role of engineers in the economy, their position at senior management level in large companies, their distribution amongst UK industry and the impact of engineering on the UK economy.

7.1 Engineers as Directors in FTSE 100 Companies

Research jointly commissioned by the EC[UK] and the Royal Academy of Engineering (RAEng) in 2007 examined the academic and professional qualifications of the directors and top executives (CEO, Executive Chairman or equivalent) of those companies listed on the FTSE 100 at 31 July 2007. The findings indicated that three-out-of-ten directors of a representative sample of FTSE 100 companies, with a first degree, had studied engineering.

There was a far higher proportion of qualified engineers than those who had studied science subjects or economics. When professional qualifications were considered, professionally qualified engineers outnumbered professionally qualified accountants 3:2 in the sample, though within the SET sector organisations four-out-of-five directorships were held by engineers compared with only two-in-five by accountants. This data is presented graphically in Figure 7.1.

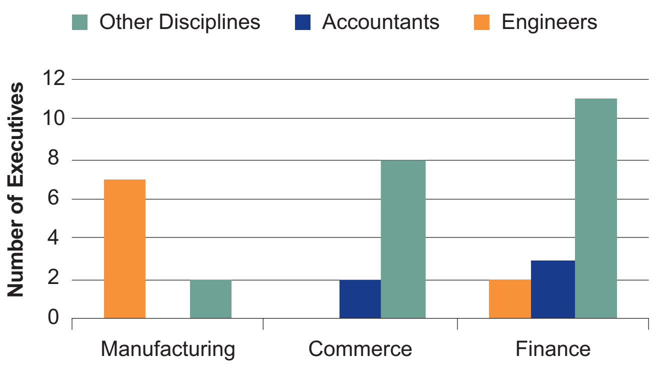
Figure 7.1: Directorships of FTSE 100 Companies Qualification



Source: Engineering Council UK / Royal Academy of Engineering (2007) IER: Engineers in Top Management

Looking specifically at the most senior executives, qualified engineers still outnumbered qualified accountants. Of the ten top executives in each of the FTSE 100 companies sampled, nine held engineering qualifications, as opposed to ten with accountancy qualifications. Within the manufacturing sector, the proportion of the top executives who were qualified engineers was as high as two-in-three people and no accountants were on the list. Within the finance sector, only two top executives were engineers, in contrast to eight accountants (see Figure 7.2 for further details).

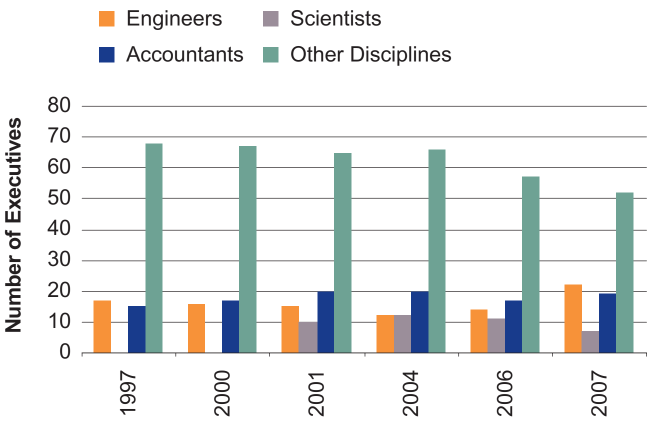
Figure 7.2: Top Executives of FTSE 100 Companies by Discipline



Source: Engineering Council/Royal Academy of Engineers/IER 2007

EC[UK] and the ETB up-dated the FTSE 100 top executive study in 2000, 2001, 2004, 2006 and 2007. The results of these studies are included in Figure 7.3. The trend suggests a rising number of top executives with engineering qualifications, from seventeen in 1997 to twenty two in 2007. In comparison the number of accountants has increased over the same period from fifteen to nineteen.

Figure 7.3: Top Executives from 10 Companies Across FTSE 100 Sectors



Source: Engineering Council/Royal Academy of Engineers/IER 2007, 2000, Engineering Council UK 2001, Engineering and Technology Board 2004, 2006

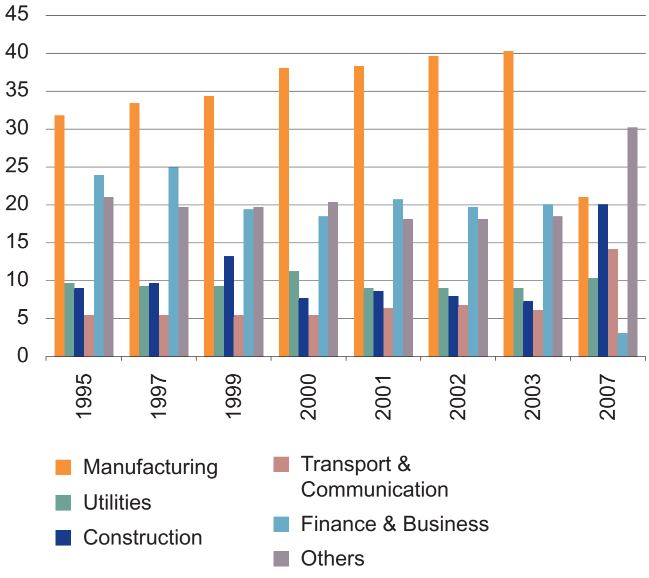
It must be stressed that this analysis was based on the full-time education qualifications of the companies' top executives – many of whom undertook careers in occupations not necessarily aligned to their qualification subject areas. For example, many of those with non-accountancy degree qualifications may well have followed the accountancy route after entering the workforce as part of their company's training programmes. Conversely it is unlikely that non-engineering graduates would move into the management of technical engineering disciplines.

7.2 Distribution of Engineers throughout the Economy

Gratifying as it is to find engineers and scientists reasonably well-represented at the top of the business world, it is still true to say that, until recently, it is in manufacturing companies that engineers are most likely to have achieved a top position. By contrast the overall employment of engineering professionals differs markedly from this pattern. The employment by industrial sector of those professional engineers who are registered with the EC^{UK} was collected as part of the EC^{UK} Surveys of Professional Engineers and Technicians and the ETB Survey of Registered Engineers, carried out between 1995 and 2007. This data is summarised in Figure 7.4.

Figure 7.4: Professional Engineers by Industrial Sector

Source: Engineering Council and Engineering and Technology Board (1995-2007)



The most striking feature from the surveys is the slump in numbers which contrasts with time series starting from 1995 to 2003 which has been fairly consistent. However, other sectors appear to dominate the employment of registered engineers. The spread of employment in other sectors has increased with ranges from 20% in 1997 to 30% of employment in 2007. For 2007 the remaining 70% are spread throughout all other sectors of the economy. Notably, Construction services accounts for the employment of 20% of registered engineers, a figure which has dramatically increased since 1995. Figure 7.4 clearly demonstrates the influence of the engineering profession on all aspects of our daily life, and, indeed, its importance in the development of our future.

7.3 National Statistics and The Engineering Profession

Formal professional registration of all appropriately qualified engineers, which is voluntary in the UK, will remain an objective for the professions but looks unlikely to be achieved in the current policy environment. For example, registered CEng and IEng may only represent about one third of those likely to be eligible. This estimate is based on a calculation of all the professional engineers found in the Labour Force Survey in 2007; a net total of 280,817.

7.4 Size and Scope

The total number of UK based CEng and IEng working and registered with the EC^{UK} in the UK as of January 2007 was 242,530. Of these, 188,701 were CEng, 40,466 IEng and 13,363 EngTech.

The ETB, the EC^{UK} and the Professional Engineering Institutions are working to promote registration and increase the number of registered engineers in the UK. In 2007, the EC^{UK} obtained a large matrix of data analysing specific jobs by the Standard Occupation Classification (SOC) codes and by Standard Industrial Classification (SIC) codes. This data was provided by the Office of National Statistics' (ONS) Labour Force Survey (LFS).

Based on these figures, it is estimated that there are approximately 800,000 engineers in the sector. SEMTA, the Sector Skills Council for manufacturing and engineering, estimates the total workforce in SET-related activities is around two million with LFS-based estimates totalling one and three quarter million. However, the EC^{UK} notes that "There are no reliable figures to estimate the numbers of people whose title does not include engineering but who practice engineering in the course of their work, such as scientists, technologists, metallurgists, computer programmers, and many more".

Table 7.1: Estimations of Employment Levels within SEMTA Footprint

Source	Warwick IER	Labour Force Survey (LFS)	Annual Business Inquiry (ABI)	SEMTA Estimate
Employment	1,443,000	1,746,039	1,325,473	2,000,000

Source: SSDA Matrix 2007

An analysis of the LFS data, using an expanded list of roles based on the SOC codes, may permit future LFS data to reflect the full universe of engineering roles.

7.5 Summary and Conclusions

- The number of top business executives with engineering qualifications in the 10 companies from FTSE 100 increased from 17 in 1997 to 22 in 2007.
- The manufacturing sector leads the employment of registered engineers with construction sector just falling behind. Even though the proportion of employment in manufacturing fell from 32% in 1995 to 21% of employment in 2007. In 2007 the remaining 79% is found throughout all other sectors of the economy.
- The CEng qualification remains the largest category for engineering professionals with 188,701, IEng 40,466 and EngTech 13,363 registrants.

7.6 Comment

The prevalence of SET-educated, if not SET-employed, senior management in FTSE 100 companies suggests a recognition among Britain's most successful firms that qualified engineers make excellent business managers.

The challenge for SET employers is to offer attractive careers for qualified engineers, thereby encouraging and enabling them to remain within SET professions and establishments, whilst enjoying career development and progression.

8. Public Perceptions of Engineering

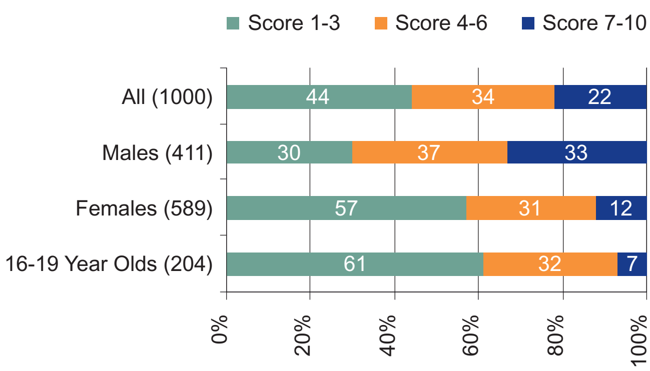
This chapter of Engineering UK 2007 looks at the perceptions the public holds about engineering and engineers covering their awareness and understanding of, attitudes to and associations with it, and how the sector can engage with the public in a more relevant and accessible way.

The image and reputation of science, engineering and technology plays a critical role in its perceived importance to society as well as its attractiveness as a place to work. This chapter looks at the public's perceptions of engineering based on research designed to explore attitudes and perceptions of engineering and engineers. It was jointly commissioned by the ETB and the RAEng and was conducted by BMRB Social Research and sister company BMRB Stakeholder.

8.1 Awareness and Understanding

General awareness and knowledge of engineering appears to be low amongst a large swathe of the public (Figure 8.1). For example, when respondents were asked to rate their knowledge of engineering as a profession on a scale of 1 (very little) to 10 (a lot), nearly half of all adults knew little about engineering as a profession and it became clear that women and 16-19 year olds in particular had little knowledge.

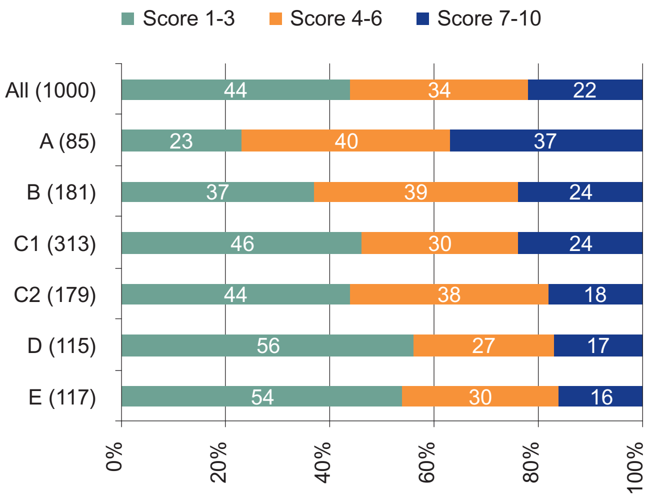
Figure 8.1: Amount Known about Engineering as a Profession on a Scale of 1 (Very Little) to 10 (A Lot)



Source: ETB/RAEng

There appears to be a strong correlation between social grade and the amount known about engineering as a profession. Using a 10-point scale (Figure 8.2 overleaf) the higher the social grade, the more knowledge is claimed about engineering.

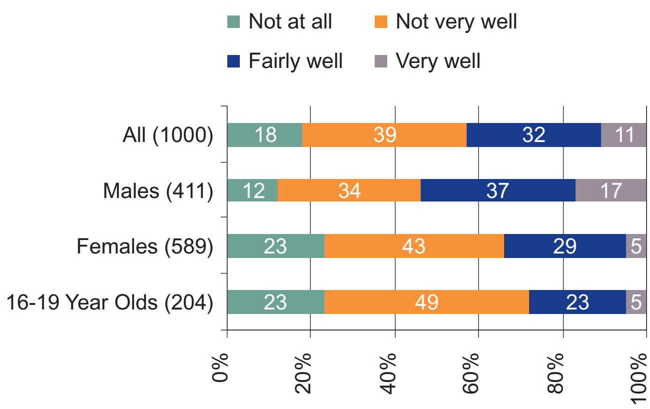
Figure 8.2: Amount Known about Engineering as a Profession on a Scale of 1 to 10 (Social Grade)



Source: ETB/RAEng

The extent to which the public feels well informed about the work of engineers shows an even lower level of understanding than that for engineering as a discipline. Just one-in-twenty women and the same proportion of 16-19 year olds considered themselves to be very well informed. Even amongst men, only one-in-six claim to be very well informed.

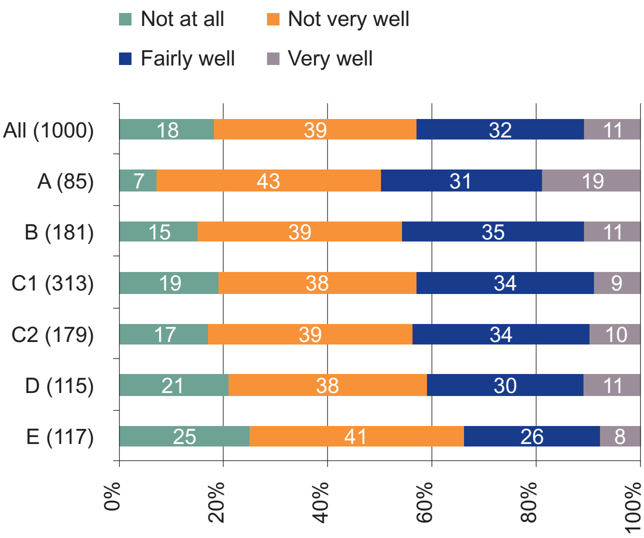
Figure 8.3: Extent to which Respondents Feel Informed about the Work of Engineers



Source: ETB/RAEng

The degree to which respondents in different social grades felt informed about the work of engineers followed a similar pattern insofar as the higher the social grade the greater the claimed understanding.

Figure 8.4: Extent to Which Feel Informed About the Work of Engineers (Social Grade)



Source: ETB/RAEng

When discussing in more detail doubts regarding the accuracy of their knowledge, participants tended to agree that engineering was a broad and vague term that was difficult to define.

Some comments elicited in the qualitative research indicated respondents tended to agree that the term ‘engineer’ has been hijacked by more lowly trades or activities seeking to appear more professional and/or worthy; eg ‘heating engineer’ rather than ‘plumber’. This has seemingly lead to greater confusion amongst the public as to what engineering actually is.

8.2 Attitudes and Associations

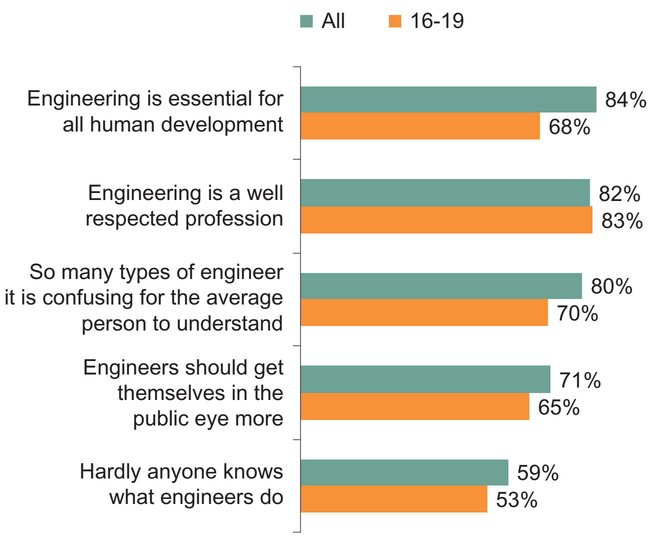
Understanding attitudes to engineering is an important component in building a picture of its status and stature, which in turn will influence the relative position of engineering in the labour market and help to inform the sector on what issues need to be addressed and in what way.

Figure 8.5 shows the proportion of respondents agreeing with a selection of statements about engineering. From these responses it is clear that most people think hardly anyone knows what engineers do and around two-thirds believe that engineers should raise their profile in the public eye.

The perceived lack of understanding is supported by the four-fifths who agreed that there are so many types of engineers it is confusing for the average person to understand, yet a higher proportion of all ages felt that engineering as a profession is well respected.

Five-out-of-six adults agreed that engineering is essential for all human development, but this proportion was 16% lower amongst those aged 16-19.

Figure 8.5: Attitudes to Engineering – Proportions Agreeing with Statement



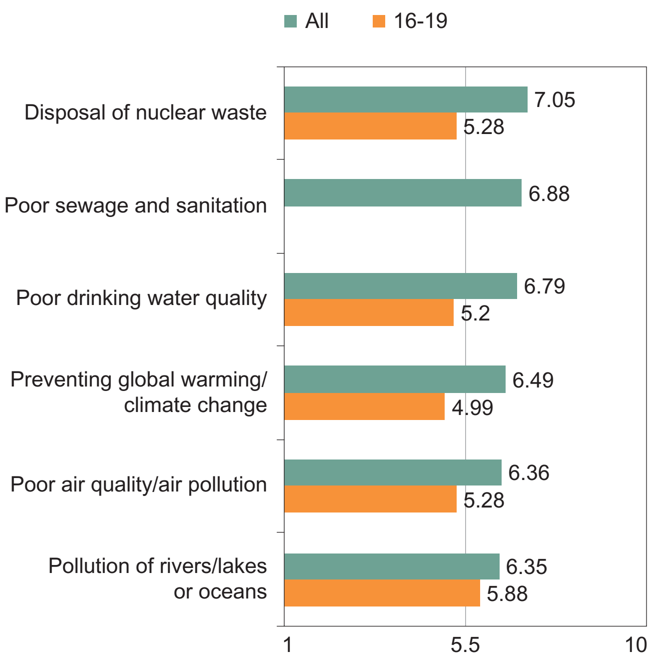
Source: ETB/RAEng

Adults were asked to rate how much contribution engineering and engineers had made towards the resolution of a number of world issues on a scale of 1 to 10, where 1 meant little or no involvement and 10 meant a lot of involvement.

Engineering is now, to some degree, associated with the problems faced in the world (eg pollution), where once the association with 'progress' may have been more positive.

This probably reflects long-term socio-cultural change and also presents an opportunity for engineering to be part of the solution: as can be seen from Figure 8.6 resolving issues of pollution and climate change are areas in which engineering is perceived as having much to contribute.

Figure 8.6: Contribution of Engineers to Resolving Issues. (Mean score)



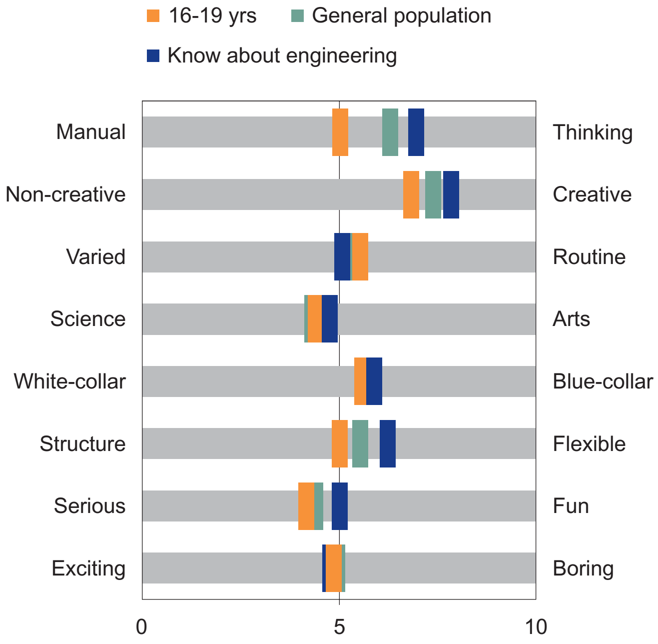
Source: ETB/RAEng

The data for those aged 16-19 are less positive and lie on or around the mean. Clearly there is scope for improving their perceptions of the contribution engineering can make to solve these problems.

When considering attributes of engineering, adults were read a series of descriptors and asked to state which ones were most closely associated with engineering on a series of bi-polar scales (Figure 8.7).

Those who were more knowledgeable about engineering were more inclined to perceive it as being more 'thinking', 'creative' and 'flexible'. On the other hand 16-19 year olds were more likely to see engineering as being more 'manual', 'structured' and 'serious'.

Figure 8.7: Where Engineering Falls on a Bi-polar Scale of 1 to 10



Source: ETB/RAEng

This has clear implications for increasing the awareness and understanding of what an engineer is and what engineers do in order to bring about more positive associations – especially for those aged under 19.

In the qualitative workshop, 'guided dreams'[6] were used in order to gain insight into participants' understanding of engineers and the work they undertake. When respondents described the mental image they had of an engineer as part of the guided dream, they described both manual and non-manual occupations and this very much impacted on the type of demographic characteristics (such as gender or social grade) they perceived the engineer to have. Few qualifications were felt to be needed for engineering associated with manual work, which was also regarded as more 'working class'. In contrast, the non-manual engineering was regarded as relatively 'upper class' and requiring a degree level qualification.

At its simplest level this can be seen as a dichotomy with the late Dr Fred Dibnah MBE at one end and Sir James Dyson at the other. In reality this may be over simplistic, but is nevertheless a reflection of the overall perception of the public at large.

6 'Guided dreams' are a qualitative technique used to explore perceptions. Respondents are asked to imagine and describe their perception. For this study guided dreams were used to explore perceptions of engineers and the environment they work in.

8.3 Public Engagement

The research highlighted the overall broad association of building, making, or repairing goods, products or infrastructure with engineering. It also illustrated the positive impact greater awareness and knowledge of engineering has on its image and reputation. This is particularly true where engineering has the ability to positively impact society as a whole for the common good.

If the sector and its constituent professional and trade bodies and employers are to communicate better with the public, their messages must be more engaging with the public, and such messages are most likely to do so if they are:

- Unexpected, yet particularly relevant to the audience's interests and concerns
- Uncomplicated, and focused on solving problems
- Focusing on benefits for the greater good of society and mankind

Such an approach is essential if the sector is to make significant improvements in perceptions of the sector as a career and a place to work.

8.4 Summary and Conclusions

- More than twice as many people know little about engineering as a profession (44%) as those that know a lot (22%). Women and the young (16-19 year olds) are particularly unaware.

- Well over half of the public think they are either not very well informed or not at all informed about the work of engineers (57%). Just 5% of women and the same proportion of 16-19 year olds consider themselves to be very well informed about the work of engineers.

- Overall, the lower the social grade of the respondent, the less likely it was that they would know anything about engineering as a profession or the work of engineers.

- Similarly, more than half of respondents agreed with the statement that 'hardly anyone knows what engineers do', and four-in-five adults agree that there are 'so many types of engineer, it is confusing for the average person to understand'.

- Around five-out-of-six adults agreed with the statement that 'engineering is essential for all human development' and that 'engineering is a well-respected profession'. However, a far lower proportion of 16-19 year olds agreed with the former (68%), which suggests that the contribution of engineering to human development is not as widely recognised among the young.

> The lower recognition by 16-19 year olds of the contribution engineers make to solving key issues facing mankind is clear. However, a high proportion of all adults do recognise this contribution, particularly in the disposal of nuclear waste, improving sewage and sanitation and drinking water quality and issues around pollution and climate change.

> Communication with the public to generate a more positive image and reputation for the sector, as well as increasing awareness and knowledge, will need to be:

- Relevant to their interests and concerns
- Straightforward and focused on the benefits of solving problems

8.5 Comment

The evidence from the research suggests that there is opportunity to improve the public perceptions of engineering and its contribution to people's lives as well as a worth while place in which to work and build a career.

Matters of great concern to the public, such as pollution and global warming, present themselves as opportunities for engineers to devise and implement innovative solutions.

The engineering sector as a whole needs to take a co-ordinated approach to communication with the public in order to deliver consistent, relevant, straightforward messages that focus on the benefits engineering can bring through problem solving and the positive impact the sector can have on the lives of ordinary people.

The ETB will be taking account of these findings in its own future marketing, communications, and campaigning activities, and will be benchmarking its success in promoting engineering against this public perception baseline in future years.

9. Skills and the Lisbon Agenda

This chapter comments on the scope and scale of the skills challenge for the UK if it is to compete successfully in a technologically driven global market place. This chapter also discusses the implications of the Lisbon Agenda.

9.1 Introduction

The relatively low levels of productivity in the UK compared to many other economically developed nations is cited in the Leitch report[7] as being due in part to a significant skills deficit. This key role of skills needs be better understood as a key driver, alongside capital investment, innovation and enterprise, in raising participation in employment and raising productivity. Significantly, there is an enormous opportunity to expand Gross Domestic Product (GDP)[8] by increasing the productivity levels. If the UK could increase productivity levels to the level seen of, for example, Ireland, we would add nearly £200bn to our annual GDP. Matching even average EU productivity would add £80bn to UK GDP. This is a prize worth winning and is also a measure of the current economic costs of low productivity in the UK.

7 *Leitch review of skills: Prosperity for all in the global economy – world class skills* – HM Treasury – December 2006.

8 GDP = Gross Domestic Product: The total value of a country's annual output of goods and services; ie private consumption + investment + public spending + the change in inventories + (exports – imports).

9 *Skills, the big issue* – Penny Tamkin, The Work Foundation.

10 Gross Value Added (GVA) = the difference between output and intermediate consumption for any given sector/industry. That is the difference between the value of goods and services produced and the cost of raw materials and other inputs which are used up in production.

9.2 Productivity

A key underlying factor accounting for the UK's low productivity is the relatively poor skills level in the UK which acts as a significant obstacle to the growth of productivity. According to the OECD, UK labour productivity lags behind much of the rest of Europe and the US. This is in the context of the UK recently being overtaken by China and dropping from fourth to fifth place amongst the largest economies in the world, but ranking only ninth for economic growth, thirteenth on the global competitiveness index (Lopez-Carlos et al 2005) and only eighteenth for GDP per head.

The Work Foundation has noted[9] the UK's economic decline relative to our major economic competitors combined with a persistent internal regional and sectoral difference in productivity – SMEs in particular are seen to underperform. If the UK is a high employment, relatively low productivity economy then the primary aim for UK economic strategy should be to maintain and enhance high employment levels but also to increase our productivity levels to a level similar to that of our major competitors. A number of economies have achieved this with high employment and productivity levels including the US, Denmark and the Netherlands.

Much of the difference in productivity between the UK and competitors such as the US, France and Germany, can be explained by physical capital and total factor productivity (TFP) as well as skills, the latter seemingly playing a lesser part in the differential. In order to gain an understanding of the impact of skills it is useful to look at levels of qualifications as a proxy.

Table 9.1 outlines the sharp reduction in the proportion of the working age population that do not have any qualifications. These improvements are associated with increases in the levels of qualifications held by young people and with older, less qualified members of the workforce reaching retirement age.

Table 9.1: Qualifications in UK Working Age Population, 1994-2004

	1994	1997	2000	2002	2004
No Qualifications	21%	18%	16%	15%	14%
Below Level 2	22%	22%	20%	19%	19%
Level 2	21%	22%	22%	22%	21%
Level 3	17%	18%	19%	20%	20%
Level 4	17%	18%	20%	20%	21%
Level 5	2%	2%	3%	4%	5%

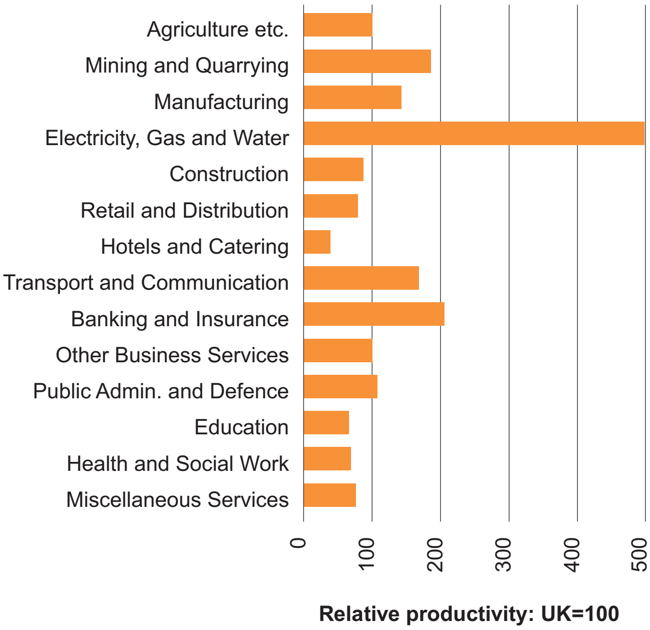
Source: Leitch (2006) chart 2.1, page 40.

Statistics developed by the Work Foundation (2007) show a significant positive statistical link between the proportion of employees receiving training and gross value added[10] (GVA) per head (log value). Dearden et al (2000) demonstrated a positive relationship between training levels and productivity in a number of sectors and Haskel and Hawkes (2003) attributed 8% of the productivity gap to skills gaps.

According to analysis by the Sector Skills Development Agency (SSDA) labour productivity differs far more between sectors than between countries and regions. This is partly a reflection of the nature of the goods and services produced by different sectors. For instance, the utilities sector stands out in having productivity five times the national average; and Banking and Insurance has productivity equal to twice the national average. By contrast, Hotels and Catering has productivity which is only 38% of the national average in 2002 (Figure 9.1).

Construction, Retail and Distribution, Education, Health and Social Work and Miscellaneous Services also have low labour productivity as shown in Figure 9.1. These sectors have a relatively high share of part-time employment, and this may serve to emphasise their low labour productivity since productivity is measured here as output per person in employment. Over time, the gap between the most productive and least productive sectors also appears to be widening.

Figure 9.1: Distribution of Relative Productivity by Sector, 2002

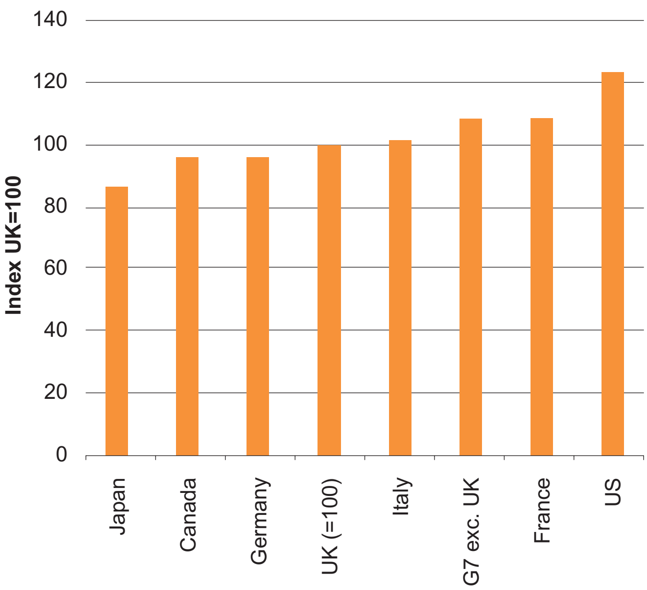


Source: Wilson et al (2003, 2004) and Green et al (2004)

Most significantly, international comparisons suggest productivity issues warrant further attention as there is a significant productivity gap between the UK and its counterparts abroad, which is as large as 40% as measured by value added per worker between the UK and the US. Previous work has suggested that Retail and Distribution, Banking and Insurance and part of Manufacturing, in the 14-sector classification used for this research, contributed significantly to the international productivity gap.

The productivity of the UK is compared to that of other G7 nations in Figure 9.2. The US leads on productivity but the UK has closed the gap from 40% in previous years to 23% in 2006, The importance of productivity in the creation of wealth through profitability cannot be underestimated.

Figure 9.2: International Productivity Estimates for 2006 – Index of GDP Per Worker



Source: Office for National Statistics (2007)

9.3 Globalisation

The emerging global economy makes it more difficult, and eventually unsustainable, for high wage economies to compete primarily on cost and price alone. This is forcing advanced economies to shift their skill bases to higher value-added products and services. These products and services require high levels of knowledge, creativity and innovation skills, which are not easily replicated by low wage economies. This may result in a polarised skills society made up of high level skills supporting the knowledge base/ innovation transfer economy and a low skilled service sector based cohort. This state of affairs would overlook the crucial intermediate skills slice of skills provision which acts as the means of progression for low skilled individuals and/ or as a parallel route to high skills and producer of professional technicians.

The primary example of this phenomenon is the rise of China, which will double its economic size over the next 10 years. Over the last 20 years, its share of the world economy has quadrupled. It is predicted that by 2015 its economy will be as large as that of the US and greater than that of the EU-25. Much of this growth has been achieved through leveraging low wage elements of its economy. In the future it is forecast that this rate of growth will be unsustainable over time and that they will have to concomitantly pursue higher level/ innovation skills.

This then puts the future UK's skills challenge into perspective. In the long term the UK must reduce its dependence on lower skills by increasing the proportion of people with intermediate and higher-level skills. Moreover, this will become a more important issue as the source of competitive advantage in products and services increasingly relies on information and knowledge content. This is evidenced by India's growth strategy - using demand led interventions – which includes targeting and encompassing high skills within innovation. India's recent declaration[11] of intent to set up 40 specialist HE institutions (including 5 institutes for science education and research), 30 universities; coupled with a push on vocational education through the creation of 1600 new industrial training institutes and polytechnics, 10,000 vocational schools and 50,000 skill development centres, serves to illuminate the scale of the challenge.

9.4 UK Skills Deficit

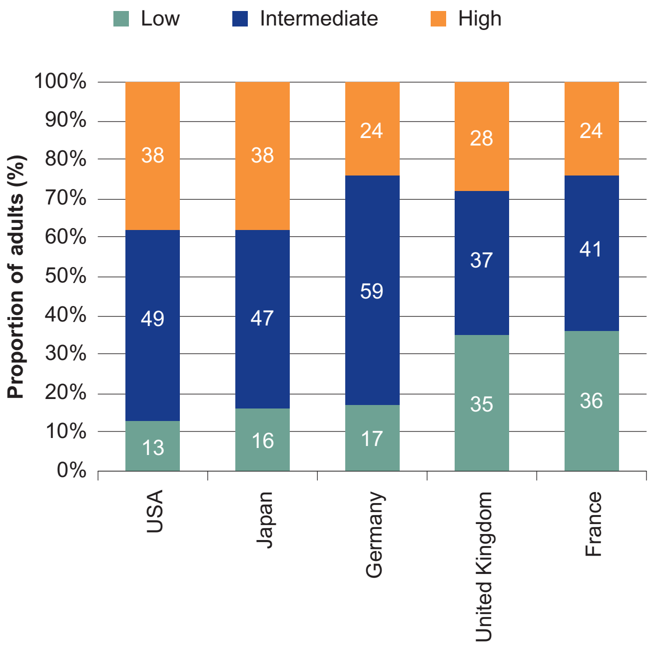
The ability of the UK to increase its productivity is interlinked with its ability to generate higher skill levels. Over the last decade the UK has been successful at generating higher levels of qualifications amongst its workforce as good as some of the EU nations. However, higher skills levels alone will not suffice in driving up productivity. SSDA evidence suggests that skills improvements will contribute positively to productivity performance over the long term if they are combined with new investments in other production inputs with which skills are complementary; for example new technologies, research and innovation.

The UK has substantial skills based problems in comparison to countries such as France and the US. Over five million people of working age still have no qualifications and only one in six adults have the literacy skills expected of an 11-year-old; and only half have the numeric skills expected of an 11-year-old (Leitch, 2006). Whilst it is increasingly recognised that qualifications do not equal skills; they will continue to be taken as a proxy for them, especially at basic levels. Regardless it is critical that individuals and Governments alike recognise that employers are looking for skills to enhance their businesses not qualifications per se, too high skills in the wrong jobs is not going to produce related productivity.

Skill levels of the UK labour force as a whole are comparatively low. Compared with other EU nations including Germany, the UK has a low proportion of workers with intermediate level skills as shown in Figure 9.3. According to data from the SSDA the skills gap accounts for a fifth of the productivity gap with Germany and an eighth of the gap with France.

11 Announcement by Prime Minister, M Manmohan Singh in August 2007

Figure 9.3: International Comparisons of Qualification Profiles – Adults 25-64



Source: OECD Education at a glance, 2005

The Organisation for Economic Cooperation and Development (OECD), provides a more detailed picture on the UK's skills deficit with its major competitors. Whilst the UK performs reasonably well with respect to higher level qualifications (11th place) we perform less well on intermediate skills, ranking at 20th out of the 30 OECD countries. In respect to low level qualifications we have a higher proportion than most of our major competitors. This over representation at low skills levels is a problem for the UK economy, especially as we move towards an increasingly knowledge-based global economy, which has different skills requirements to that previously required for industrialised nations.

Comparison of qualifications is presented in Figure 9.3. The UK and France have the highest proportion of low qualifications, but most significant is the UK's small (37%) cohort of intermediate level of qualifications. Germany on the other hand has the highest level of intermediate qualifications and are making concerted efforts to increase this[12] as they are rightly concerned about the future sources of professional technicians.

12 http://www.trainingvillage.gr/etv/Upload/Information_resources/Bookshop/466/8021_en.p

In our view, one obstacle is that whilst the relationship between spending on education and GDP is driven by short term political expedience, growth only exists in the long term; Governments are rarely, if ever, in office long enough to see the results of that spending on education filter through to the economy. Historically, this manifests itself in stop/start strategies that do not work their way through the education and skills systems. Leitch has appropriately recognised the longer planning cycle required to 'up skill' the UK through his 2020 targets. However, this is conditional upon successive UK Governments adhering to long term policies and actions that may outlive different elected Governments. Overseeing adherence to the pursuit of these targets should be a priority for the new Commission for Employment and Skills.

9.5 Importance of SET Sectors

The employment distribution of low-skilled workers across the economy (measured by the proportion that is not qualified to Level 2) is highly skewed. High and intermediate skills shortages have been prevalent in parts of manufacturing, construction, engineering and agriculture. This presents an opportunity for the UK to increase its productivity. Focusing upon greater skills production in these areas will result in a greater impact on the UK skills portfolio.

If the UK is to see increases in productivity then an investment priority must be in the SET sectors of the UK economy. The number of people working in SET occupations is key to economic competitiveness, because activity in these knowledge-intensive sectors creates the intellectual property necessary for technological advance and hence improvements in economic productivity, competitiveness and the standard of living. There is a strong hypothesis endorsed by Government via its Science and Innovation framework 2004 - 2014[13] that the number of people employed in SET industries, and the quantity and quality of research material, leads to increases in economic productivity.

Concurrently it would be folly not to continually address investment in skills in Information and Communications Technology (ICT) technologies; evidence shows that ICT is a key element of productivity growth and economic success (source: SSDA Sector Skills Almanac for the UK 2007). Nowhere has this been better illustrated than in the USA where the application of ICT technologies in the late 1980s and early 1990s resulted in a rise in the rate of USA productivity growth from the mid-1990s onwards.

9.6 The Lisbon Agenda

The Lisbon Agenda was both an economic action and development plan for the EU set out by the European Council in Lisbon in March 2000. The strategic intent was to address the low productivity and stagnation of economic growth across the EU through the implementation of policy initiatives which would be adopted by all EU member states.

The strategy was further developed at subsequent meetings of the European Council, from which three specific themes emerged. These were:

- Economic – to prepare the ground for the transition to a competitive, dynamic, knowledge-based economy. Emphasis was placed on the need to adapt constantly to changes in the information society and to boost research and development (R&D).
- Social – to modernise the European social model by investing in human resources and combating social exclusion. EU states were expected to invest in education and training and to conduct an active policy for employment in order to facilitate a move to a knowledge economy.
- Environmental – added in 2001, to highlight that economic growth must be decoupled from the use of natural resources.

The Lisbon Agenda was introduced at the height of the 'dot.com' boom, a period of rapid economic growth, when the prospects of achieving the ambitious targets in the strategy seemed possible. The main objective was to match the strong economic growth being seen in the USA.

13 http://www.hm-treasury.gov.uk/media/5/B/spend04_sciencedoc_1_090704.pdf

However, by 2005 a mid term review of the strategy indicated that the EU was failing to meet the targets set out in 2000. Instead of positive economic growth, in many EU countries the economic outlook had actually declined from 2000. Economic growth in the EU was only 1.6% in 2005, compared with 3.46% in the USA and over 10.2% in China. The main contributory factor to relatively low growth rates in Europe was the downturn in the world economy following the collapse of the dot.com bubble. Recovery from has been markedly slower in Europe than in the USA, and well behind the rapid growth levels seen in China. Additionally, Europe's problems have been further exacerbated with the issues of an aging population and increased competition from Asia.

In 2005 the European Commission declared that the social and environmental aspects of the Lisbon Agenda were no longer a priority and that instead the strategy would be revised to focus on the economic context only. The ambitious targets of the strategy were consequently reduced and focused on boosting jobs and economic growth. The only target that was retained was the 3% of GDP to be devoted to research and development by 2010.

The UK reduced its own target to what was thought to be a more realistic 2.5% of GDP. This should be viewed in the context of recent trends. Table 9.2 clearly shows that the UK has in fact seen a decline in its percentage of GDP spend on R&D, and that the spend is lower than the EU average, over the period 2000-2005. This is obviously well short of the 3% target set out by the Lisbon Agenda, and well below the 2.68% spend on R&D seen in the USA. Of increasing concern is the rapid increase in R&D expenditure seen in China over the same period.

Table 9.2: Investment in R&D as Proportion of GDP

	2000	2001	2002	2003	2004	2005
UK	1.86	1.83	1.83	1.79	1.78	n/a
EU – 25	1.87	1.88	1.89	1.88	1.85	1.85
USA	2.73	2.74	2.64	2.67	2.67	2.68
China	n/a	0.95	1.07	1.13	1.23	1.33

Source: OECD, Eurostat

The proportion of the R&D spend by business and industry, as opposed to Government is shown in Table 9.3 which highlights that the USA has a much higher proportion of business based R&D than both the EU and the UK. Well over 75% of the US' R&D is sourced from firms whereas less than 45% of the UK's R&D is from the commercial sector. This is a serious concern especially as the UK Government has viewed the private sector as the main focus for future economic growth. However, the GDP growth since 1997 has been driven by increases in employment and technological capital. In this regard it can been seen that the R&D spend by business and industry as a proportion of GDP shown in Figure 9.3 highlights that the USA has a much higher proportion of business based R&D than both the EU and the UK. Consequently, appropriate skills provision within the R&D technological innovation fields needs to be a priority action for Government, education providers and employers alike.

Table 9.3: Investment in Business-based R&D as Proportion of GDP

	2000	2001	2002	2003	2004	2005
UK	48.3	45.6	43.6	42.3	44.2	n/a
EU – 25	56.3	55.9	54.6	54.2	54.9	54.5
USA	72.4	73	73.9	74.5	75.7	76.1

Source: OECD, Eurostat

9.7 Perspective – The Scale of the Problem

On face value, the targets previously discussed seem straightforward. However, the actual implications for the UK need to be put into context. In 2004 UK GDP was just over £1184bn. Based on these ONS figures, the UK current percentage spend on R&D in 2004 was 1.78% of GDP or £21bn. Putting this into perspective – of the £21bn only £9.3bn is attributed to business based R&D. To illustrate the magnitude of the challenge; if the UK were to have hit its target of 2.5% in 2004 it would have had to invest a total of £29.6bn in R&D, £8.6bn more than was actually spent, a 40% increase in overall R&D spending, and a near doubling of business R&D investment.

9.8 The Skills Issue

As discussed earlier, the adequate supply of skilled people is an EU-wide challenge. A recent report (Gago 2004) estimated that to achieve the level of R&D activity envisaged in the 3% target, an extra 500,000 graduate researchers would need to be produced across the EU. This is a tall order by any standards, and emphasises the seriousness of the issue, especially in light of the data presented in Table 9.4, which shows that the EU-25 had 1.2m graduate researchers in 2005. A further 500,000 represents an over 40% increase in graduate researcher numbers.

Table 9.4: Total Researchers 2005

	2005
UK	157,662
EU – 25	1,209,077
USA	1,334,628
China	926,252

Source: OECD

On a brighter note from a national point of view, according to statistics published by the EU, the UK is well ahead of other EU countries in its science and engineering skills base. In 2004 just under one fifth of 20-29 years olds in the UK had some form of SET qualification, well ahead of the EU average of just over 12% and even further ahead of the US figure of 10% – see Table 9.5. This suggests that the UK has a skills-base (at least in numbers) for employers to source. However, whist the skills base may be healthy in terms of numbers, if there is to be a 40% increase in the number of graduate researchers, difficult decisions will need to be made by Higher Education Post Graduate funding agencies as to which areas of the skills base will have to be sacrificed to make way for this growth in SET graduate researchers.

Table 9.5: Tertiary Graduates in Science and Technology per 100 of Population aged 20-29

	2000	2001	2002	2003	2004
UK	18.5	20.0	20.3	21.0	18.1
EU – 25	10.4	11.0	11.4	12.3	12.6
USA	9.7	9.9	10.0	10.9	10.2

Source: Eurostat

9.9 Technology Strategy Board

The main thrust of the UK Government's attempt to achieve its Lisbon target has been through the funding of its Research Councils (the primary supporters of academic research) and the recently formed Technology Strategy Board (TSB). The TSB's role is to encourage developing R&D activity within the private sector. The TSB aims to promote and support research, development and the exploitation of science, technology and new ideas to benefit business, increase economic growth and improve the quality of life in the UK. It will be responsible for delivering Government support to encourage business investment in technology and innovation across all sectors of the UK economy. It will deliver this in a range of ways, including Collaborative R&D, Knowledge Transfer Networks, Innovation Platforms and Knowledge Transfer Partnerships. Over the period 2005-2008, the TSB will spend £190m per year of the Department for Business, Enterprise and Regulatory Reform (BERR) funds to businesses to support research and development in technology areas identified by the TSB.

9.10 Summary and Conclusions

> The role of skills needs be greater understood as a key driver, alongside capital investment, innovation and enterprise, in raising participation in employment and raising productivity.

> Whilst qualifications are a useful indicator/tool/proxy for employers' recruitment strategies, it is skills at the appropriate level for the job that will contribute to a businesses bottom line.

> The major challenge in the UK has been the low levels of productivity in contrast to other economically developed countries.

> Recent international growth rates in skills coupled with future national ambitions particularly of China and India, demonstrates that the UK needs to accelerate its own rates of upskilling in order to ensure higher levels of productivity and a stronger global economic presence. Within the SET disciplines this is even more pronounced and urgent.

> If the UK could increase productivity levels to match the average EU productivity it would add £80bn to UK GDP.

> The initial targets set out in the Lisbon Agenda were far too ambitious. With the relatively poor performance of the world economy since 2000 it seems most unlikely that the UK will achieve anywhere near its 2.5% target of R&D spend of GDP by 2010.

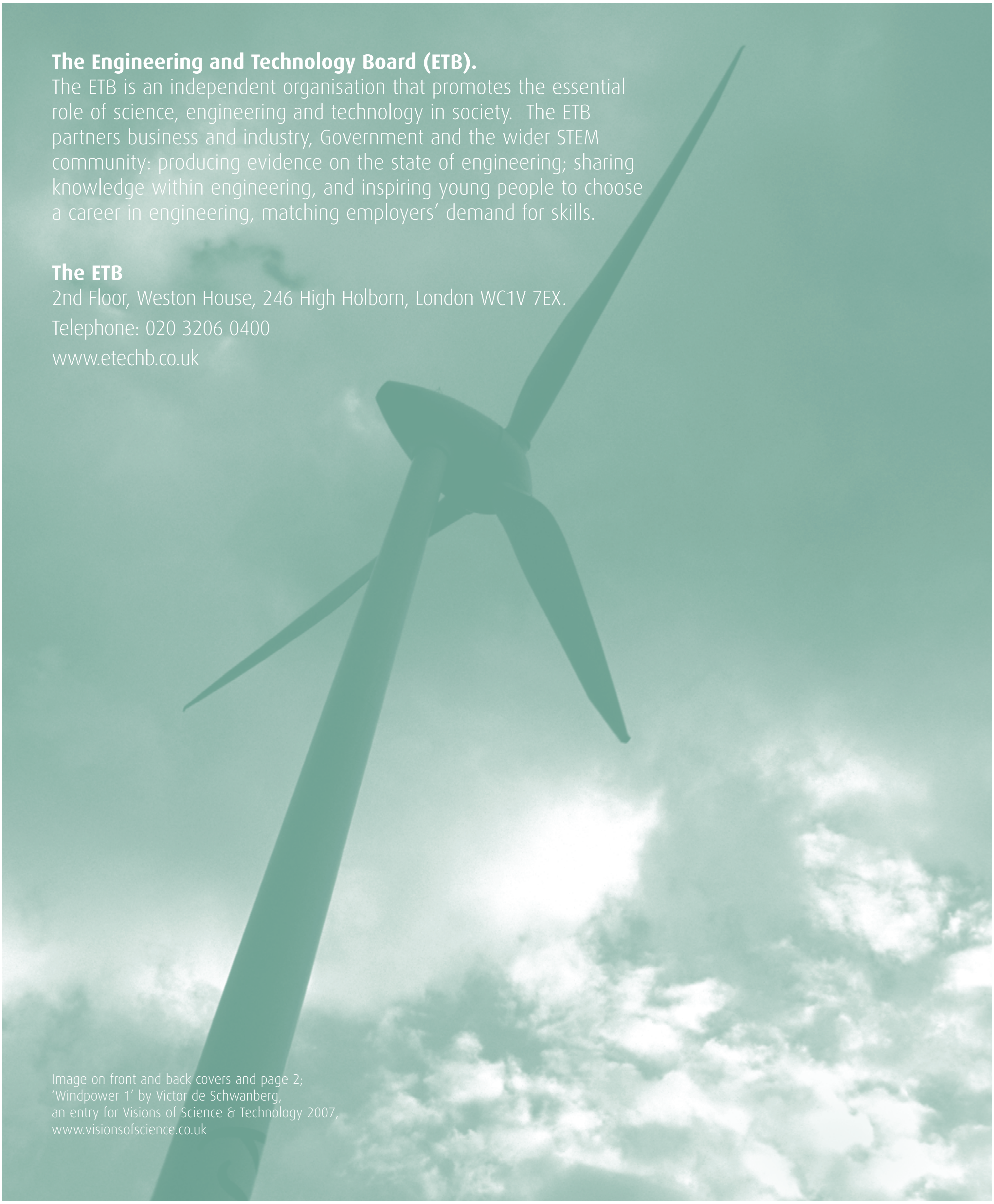
9.11 Comment

Skills constitute an important element of the productivity gap between the UK and its competitors and if the UK is to be become the kind of high-skills economy that can compete in the twenty-first century, more must be done to raise skills levels across a wide range of occupations and positions.

The key to success lies with management and leadership skills. Without high quality, high calibre, highly qualified management able to deliver both the formal process-oriented aspects of management and the informal motivational and attitudinal aspects of leadership, the delivery of upskilling elsewhere in business and the economy will be severely hampered.

What is needed is both insight and imagination to truly develop the UK's engineering workforce in ways that will enable innovation and creativity to flourish and deliver ultimate success through added value and improved profitability.

Progress through partnerships



The Engineering and Technology Board (ETB).
The ETB is an independent organisation that promotes the essential role of science, engineering and technology in society. The ETB partners business and industry, Government and the wider STEM community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

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Image on front and back covers and page 2;
'Windpower 1' by Victor de Schwanberg,
an entry for Visions of Science & Technology 2007,
www.visionsofscience.co.uk