Research Report
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etb
Progress through partnerships

Engineering UK 2005

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

produced in association with ec uk

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> Foreword

Welcome to our new annual publication "Engineering UK". This builds upon and extends previous editions of the "Digest of Engineering Statistics" published over the past eight years, and has been renamed "Engineering UK" to reflect a new, broader scope.

While the title of this publication focuses attention on engineering, in reality the route to engineering, particularly in schools, is via science and mathematics. One should therefore think not of science, engineering and technology as discreet entities but of a continuum from science to engineering.

The strategic importance of science, engineering and technology (SET) to the future development of the UK economy is not in doubt; the work presented in this edition reinforces the view that professional engineers, scientists and technicians will play a major role in the future growth of the UK economy. It is, therefore, vital that the UK is able to attract enough of today's talented, creative and innovative young people to pursue a career in SET. This edition provides data and information which will inform policy makers, industry and careers advisors about the realities of careers in SET and the engineering profession in particular.

However, the supply and demand of SET skills is not a simple issue – it involves the subtle interaction of a number of interrelated socio-economic factors. The complex interaction of supply and demand labour processes makes work in this area difficult. Nonetheless we at the etb see research into supply and demand issues and the charting of the subsequent trends as crucial to our overall mission of promoting the engineering profession.

"Engineering UK" has a special focus on long term skills issues – examining the educational 'supply chain' which provides the future cohorts of young people to meet the demand for SET skills in the work-place; be that in businesses, academia, in Government and in the many other organisations that rely on SET skills for their success. We see this report as useful for Government policy makers, administrators and academics within the Further Education and Higher Education sectors, other SET promotional organisations, but also to UK companies whose future prosperity is dependent on the sufficient supply of engineers and scientists.

Dr John Morton
Chief Executive,
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> Introduction

This is the eighth in a series of annual statistical digests published by the Engineering and Technology Board (etb). It is intended as a valuable resource for everyone interested in labour supply and demand issues within the science, engineering and technology (SET) community.

This year's report has built on the work presented in previous editions and includes a large amount of new material and analysis. This edition also focuses more on the provision of summary data which highlights the main statistical trends within the world of SET. The majority of the material focuses on the engineering profession and includes information which is relevant to the wider SET community – particularly in relation to schools and Further and Higher Education.

The material is structured around the career timeline of a typical engineer. It begins with a review of statistics relating to mathematics and science within UK schools – this looks at both GCSE and A-level examination performance (section 1). The discussion then moves onto vocational routes for engineering in Further Education and Work Based Learning (WBL); this section includes a large amount of new material with particular data on participation and drop out rates for WBL (section 2). The world of Higher Education is then reviewed; trends for undergraduate and postgraduate courses are presented for all areas in SET (section 3).

Work on graduate destinations six months after university is outlined in section 4, and sheds light on the realities of the 'drain' of qualified engineering graduates to non-engineering careers. Work on engineering salaries and the employment conditions of engineers is reviewed in section 5 including new data from the etb's 2005 survey of registered engineers. Trends associated with professional registration are reviewed in section 6 and provide data directly from the Engineering Council UK (EC[UK]) register of professional engineers. The position of engineers in the economy is reviewed in section 7. The final two sections examine public perceptions of SET (section 8) and careers related issues (section 9); both sections present new research material undertaken by the etb in 2005.

This annual programme of research is funded by the etb. We would like to acknowledge the support of our colleagues at EC[UK] in the creation of this report.

A copy of this publication together with the detailed statistical and reference material on which it is based appears on our web site: www.etechb.co.uk.

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> Summary

1. Secondary Education

As the primary supply mechanism for the Higher Education and vocational pathways, the state of science and mathematics education within UK secondary schools is a key input into our understanding of the supply and demand of science, engineering and technology (SET) skills.

- The demographic data suggests that the 16 and 18 year old populations are going to be at a relatively stable level over the next five years with the 16 year old population settling at around 780,000 and the 18 year old population at just under 820,000 by 2010.
- The increased numbers of students taking GCSE mathematics and science is in most part attributable to the demographic increase in the size of the 16 year old cohort over the last decade.
- The data indicates that there has been an upward trend, affecting all GCSE mathematics and science subjects, in the percentage of students reaching a grade C or above.
- Since 1995 there has been a 24% decline in A-level mathematics students.
- A-level students who achieve grades A-C have seen an encouraging trend over the last decade. Mathematics is contributing a similar number of A-level grades A-C in 2004 than seen in 1994 (in fact there has been a 2% increase in student numbers over the last decade). Biology has seen an encouraging increase of 31% in grades A-C; chemistry has seen an increase of 20% and physics has a 6% increase. While the overall student numbers for SET subjects is at best static, average grades within subjects are on the increase.

2. Further Education, Vocational Education and Training

The supply of technician level skills is an area overlooked in previous analysis. This section looks at the state of engineering and technology within the Further Education and vocational sectors.

- In 2004 just over one tenth of the workforce held no qualifications; nearly one fifth were qualified up to Level 1 and Level 3. A slightly higher proportion of the population held Level 2 and Level 4 qualifications, with Level 4 the highest at 23%. Just under 6% of the population held Level 5 qualifications.
- Research indicates that engineering technicians make up a substantial part of the UK workforce – nearly 2m jobs – or just over 7% of the total workforce.
- 16% of technicians work in manufacturing and 8% work in construction. It is also worth noting that, many technicians work in non-engineering sectors.
- DfES data suggests that the success rate for engineering and technology Level 3 courses appears to be rising from 57% in 2001/02 to 62% in 2003/04.
- However the picture on drop out rates is not straightforward; Learning and Skills Council (LSC) published data suggests that success rates on all types of vocational programmes have been improving from 42% in 2001/02 to 49% in 2002/03. Although this improvement is encouraging, the fact that only half of those on vocational courses actually complete them seems at odds with the more positive picture painted by the DfES data.

3. Higher Education

The training of the majority of graduate level engineers takes place within Higher Education (HE). This section looks at trends within HE and their implications for the SET sector as a whole.

- The UK has witnessed a rapid expansion of participation in Higher Education over the last 10 years; the number of undergraduate programme entrants has risen by nearly 40%.
- The number of UK students accepted onto physical sciences courses has declined from 15,000 in 1994 to just under 14,000 in 2004.
- Engineering and technology has remained relatively static with UK acceptances remaining at around 16,500.
- Over the last decade the number of students (UK and foreign) completing undergraduate programmes in engineering and technology has remained relatively steady at around 20,000. During the same period the number of students completing programmes in biological sciences has grown by nearly 120%, with computer science courses also up by 159%.
- At the doctorate level the number of completions in science, engineering and technology has increased with the greatest growth commencing in 1999/2000.
- The UK currently has a strong relative position with over 10% of 24 year olds holding a SET degree. Only South Korea and France perform at a higher level, with the UK doing much better than traditionally strong SET countries such as the United States and Germany.
- The UK has seen a fourfold growth in the percentage of first SET degree holders between 1975 and 2000.

4. Graduate Recruitment

This section looks at what happens to engineering graduates after they leave Higher Education and enter the workforce. The analysis looks at where the graduates work and what salaries they are likely to earn.

- The destinations breakdown for SET shows a diverse picture across the subjects. Engineering and technology see the largest percentage of graduates working in the manufacturing sector (26%), with the second largest group working in finance and business (25%).
- Whilst engineering and technology sees 25% of its graduates enter the finance and business sector, it is similar for history graduates (24%) and language graduates (24%):- the drain to finance and business is therefore not a phenomenon peculiar to engineering and technology.
- The propensity of graduates to enter careers in professional engineering differs across the engineering disciplines.
- A striking feature of the data is the fact that 6 out of the top 12 graduate starting salaries are attributed to engineering disciplines, with chemical engineering leading the way in third place with an average salary of just over £20,000.
- However, analysis of graduate starting salaries from the Association of Graduate Recruiters (AGR) shows that engineering does not perform as well as other graduate professions, amongst the membership of the AGR.

5. Engineering Salary Levels

Salary levels are a subject popular with all members of the engineering profession. Traditionally there has been a view that engineers are underpaid. This section attempts to assess whether this is the case through the presentation of engineering salary data.

- According to Office of National Statistics (ONS) data the average annual gross earnings of professional engineers was £33,300 at the end of 2002.
- This contrasts to data presented in the Engineering and Technology Board 2005 Survey of Registered Engineers, which put the average annual gross earnings for registered Chartered Engineers in 2005 at £53,000. Whilst the median Chartered Engineer salary in 2005 was £45,500 (up from £43,500 in 2003).
- Figures published by the Royal Institute of British Architects (RIBA) show that over the year to April 2003, its members had median earnings of £35,000. This compares directly to the Chartered Engineer median salary of £43,500 for the same time period.

6. Professional Registration

Trends in the uptake of professional registration are dealt with in this section. The material is sourced from the Engineering Council UK (EC^{UK}) register of professional engineers.

- The total number of registrations has declined from just over 267,200 in 1994 to just under 244,900 in 2004, representing a fall of 8.3% over the decade.
- New registrations fell over the last decade amongst all three categories of registration. However, 2004 saw an increase in new registrations, a reversal in the trend for the first time since 1999.
- The overall age profile of registered engineers in 2004 has a median age of over 50.
- The average age of registered engineers is increasing.

7. Engineering in the Economy

This section looks at the role of engineers in the economy, their role as senior management in large companies, their distribution alongside UK industry and the impact of engineering on the UK economy.

- The number of top business executives with engineering qualifications in FTSE 100 companies fell from 17 in 1997 to 12 in 2004.
- The manufacturing sector still dominates the employment of registered engineers. The proportion of employment in manufacturing rose from 32% in 1995 to 40% of employment in 2003. In 2003 the remaining 60% are found throughout all other sectors of the economy.
- Estimates suggest that only 39% of UK professional engineers are registered with the Engineering Council UK (EC^{UK}).
- Science, engineering and technology intensive sectors of the economy accounted for over 27% of UK GDP in 2003.

8. Perceptions of SET

This section reviews the findings of a number of studies which have looked at the public's perceptions of science, engineering and technology (SET).

- Adult perceptions of SET are positive – the majority of the adult population feel that science and engineering have a positive impact to make on the UK economy. However when prompted the population have an out dated view of science and engineering.
- The public have a more accurate understanding of the role of science and scientists than of engineering and engineers.
- The United States public appear to have a more favourable view of engineering than their European counterparts.
- Teachers were unclear about pathways open to their pupils to enter engineering careers, and what qualifications were best suited to this. Teachers also saw engineering as a dirty, old-fashioned and predominately male orientated career.
- It would appear that pupils have a more up to date view of the engineering profession. Research indicates that the majority of young people feel that engineering is important to day-to-day life and recognised that it was particularly associated with transport, new technology and computing.

9. Career Advice and Perceptions of Engineering

This section reviews some of the research into the sources of career advice used by young people and the influences they rely upon in making career decisions.

- Research suggests that the main reason for choosing engineering as a career is that young people were interested in engineering, and that they had a role model, typically a father, who was already working as an engineer. Role models were therefore identified as an important influence on the decision to enter into a career in engineering.
- Individuals appear to be influenced by a variety of "significant others", i.e. parents, siblings, relations, friends, teachers and careers advisers.
- Decisions about jobs are made at an early age, at least by Key Stage 3 (Age 11 to 14).
- Information and guidance is complicated by the breadth and complexity of choice beyond 16, and by the continuing tension between the need for young people to be informed and advised, and the needs of institutions to compete for young people's choices in the education and training market place.
- Given that early perceptions and subject choices can serve to block whole areas of science, engineering and technology (SET), it is argued that careers advice should challenge assumptions and give early guidance, rather than simply alerting young people to what is available.
- Parents reported that their children use a wide range of sources of information to keep themselves informed about a broad range of topics and that these factors collectively influence them.
- That there is a large group of young people who would welcome more information about SET careers and the wide range of opportunities in that area, to help them decide which, if any, is the right one for them.

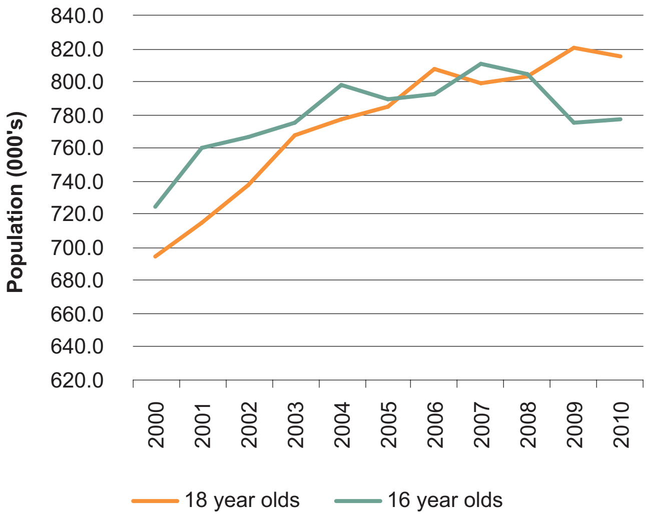
1. Secondary Education

As the primary supply mechanism for the Higher Education and vocational sectors, the state of science and mathematics education within UK secondary schools is a key input in our understanding of the supply and demand of science, engineering and technology (SET) skills. This section reviews the numbers and characteristics of the population taking secondary-level qualifications which prepare the way for further and higher level qualifications in the various SET disciplines.

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

Population estimates for the numbers of 16 and 18 year olds living in the UK are shown in Chart 1.1. The period from 2000 has seen the populations of both cohorts recover after a relative decline in the mid 1990s. Government estimates suggest that the population has increased in recent years, with both age cohorts approaching or exceeding 800,000 by 2006.

Chart 1.1: 16 and 18 year old population of the UK



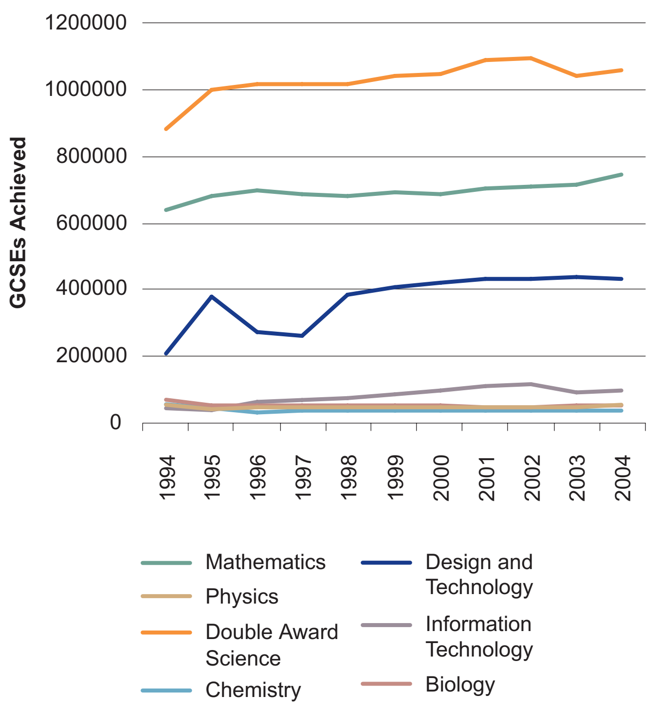
Source: ONS & Government Actuaries Department Populations Estimates, Projections 2001 Census.

The actual population estimates for 2005 are 785,000 for the 16 year old population and 789,000 for the 18 year old population. The demographic data suggests that the 16 and 18 year old populations are going to be in a relatively stable position over the next five years with the 16 year old population settling around the 780,000 level by 2010 and the 18 year old population to just under the 820,000 level in 2010. It is worth noting that there will be a slight decline in the 16 year old cohort between 2007 and 2010, from 810,000 to just under 780,000.

1.2 GCSE

Against this background of population trends for the 16 year old cohort, Chart 1.2 shows the GCSE awards made over the ten year period to 2004 in mathematics and selected science subjects. The mid-1990s onwards saw a gentle rise in total GCSE mathematics awards from 641,000 in 1994 to with over a half now marked at grades A, B and C. This increase in mathematics students is in most part down to the demographic increase in the size of the 16 year old cohort mentioned in section 1.1. The cohort size for 16 year olds in 2004 was just over 790,000, with some 641,000 students passing any grades at GCSE mathematics; this suggests that over 81% of the cohort passed a GCSE in mathematics.

Chart 1.2: GCSEs achieved in mathematics and selected science subjects (all grades, all boards, UK candidates)



Source: Joint Council, AQA

The demographic increases affecting mathematics awards also seem to have impacted the double science awards; increasing from 879,000 in 1994 to 1,056,000 in 2004. It is worth noting that because the GCSE science award is a double award the figure for achieved grades outlined in Chart 1.2 is double the actual number of pupils taking the exam i.e. 528,000 pupils took the exam in 2004.

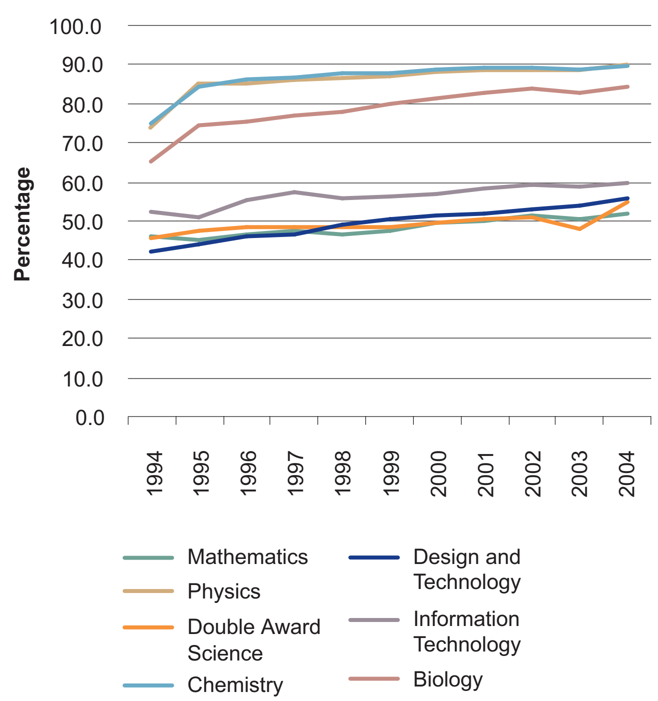
Chart 1.2 also highlights the relatively small number of pupils studying physics as a single GCSE; this is reflected in the number of physics awards which fell from 53,500 in 1994 to 50,500 in 2004. The low uptake of GCSE physics can be attributed to a trend away from individual science subjects towards the Science: Double Award GCSEs. In 2004 just over 90% of physics candidates achieved a grade C or higher, reflecting the tendency for more able pupils to be put forward for individual science subjects. It is not surprising that both chemistry and biology both have relatively low numbers of students taking the exams (49,000 taking chemistry in 2004, 59,000 taking biology) with their low uptake being affected by the same factors as those seen by physics.

Design and technology was one of the seven subjects in the National Curriculum in England and Wales at Key Stage 4 (14 to 16 years) until 2003. However in the mid-1990's there were two years, 1996 and 1997, when design and technology became optional and then mandatory again and this largely explains the drop in GCSE design and technology awards from 376,000 in 1995 to 261,000 in 1997. Since 1997 the number of GCSE design and technology awards has risen from 261,000 in 1997 to 433,000 in 2004 an increase of 65.9%. Despite the increase in students taking GCSE design and technology there remains a degree of non-compliance occurring at a proportion of schools, with OFSTED predicting that 20% of schools do not ensure their pupils take GCSE design and technology.

The number of GCSE computing and information technology awards has been expanding rapidly in recent years, rising from 50,000 in 1994 to a peak of 117,000 in 2002. This represents an expansion over this period of 133%. However it must be noted that the number of awards in this subject fell in 2004 to just over 99,000. This is in part a result of the rapid increase since 2002 in the number of people sitting the GNVQ Intermediate Full Awards in Information Technology.

The relative grade breakdown of pupils achieving grade C or better for both GCSE mathematics and selected sciences is outlined in Chart 1.3.

Chart 1.3: Percentage of GCSE candidates achieving a grade A-C in mathematics and selected sciences



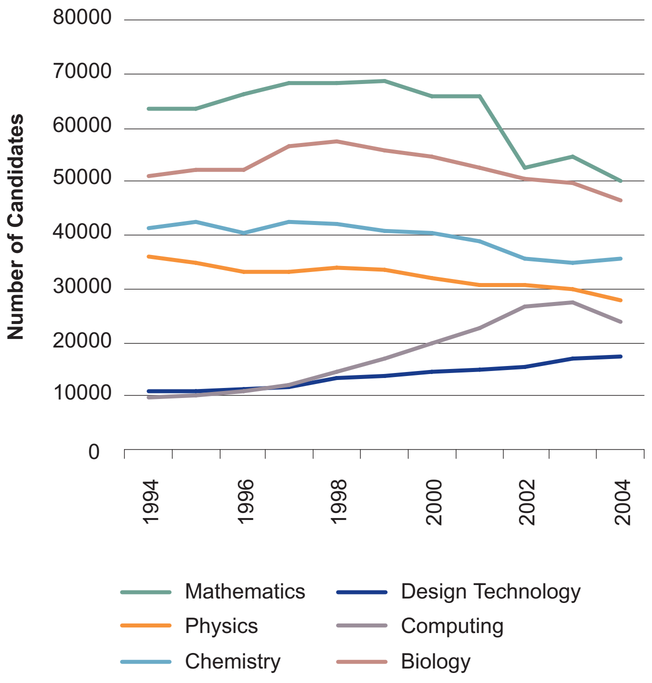
Source: Joint Council, AQA

The data indicates that there has been an upward trend, affecting all subjects, in the percentage of students reaching a grade C or above, with GCSE mathematics increasing from 46.6% in 1994 to 52% in 2004. This compares to GCSE science which also saw an increase from 45.7% to 55.2%. This upward trend is important as the entry indicator for A-levels in science and mathematics is a grade C or higher at GCSE. Coupled with the increase in cohort population outlined in Chart 1.1, the higher percentage of students achieving grade C and above in mathematics and science is encouraging. Chart 1.3 also confirms the fact that the single science subjects of physics, chemistry and biology have a higher A-C ratio than the GCSE double science award. This is largely due to the tendency of higher achieving pupils to be put forward for individual science GCSEs; this is particularly the case in the independent school sector.

1.3 A-levels

As the subjects often required by Admissions Tutors for science and engineering undergraduate degrees, mathematics and physics A-level are of particular interest to the engineering profession. Chart 1.4 shows the trend in A-levels taken in mathematics and selected science subjects in the UK over the period 1994-2004.

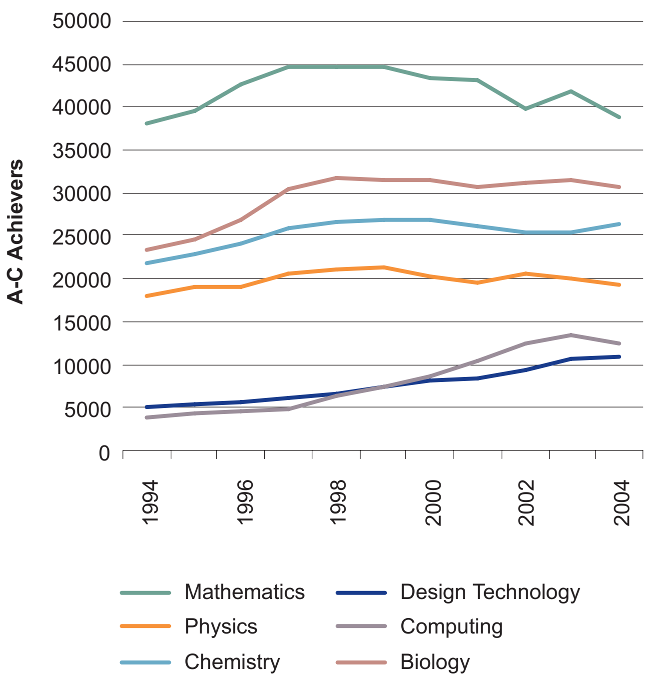
Chart 1.4: A-level candidates in mathematics and selected sciences



Source: Joint Council, AQA

From 1995 there has been a modest rise in A-level mathematics awards until 2001. However, in 2002 there was a sharp decline in student numbers. These have fallen from 66,000 in 2001 to 50,000 in 2004; representing a 24% decline in student numbers. The decline in numbers taking A-levels can be attributed to the problems resulting from the introduction of Curriculum 2000 for mathematics. At the time this was widely seen as a one-off event but the recent data suggests that student numbers have not recovered and in fact continue to decline. The decline in A-level student numbers between 1994 and 2004 seen in mathematics has also been seen in biology (9% decline), chemistry (14% decline) and physics (23% decline). Whilst the decline in number is of concern there have been increases in the number of students taking design and technology (55% increase) and computing, which has seen a 149% increase in students numbers, from under 10,000 to nearly 24,000 over the last decade. However, the decline in overall student numbers in many SET subjects is only half the story. For the majority of university science and engineering departments, students require a grade A-C in their A-level attainment to be offered a place at university. Chart 1.5 looks at the mathematics and science A-levels achieved at grade A-C.

Chart 1.5: A-levels at grade A-C in mathematics and selected sciences



Source: Joint Council, AQA

The picture here is much more encouraging than seen for total numbers of A-level students. Mathematics is contributing a similar number of A-level grades A-C in 2004 than seen in 1994 (in fact there has been a 2% increase in student numbers over the last decade). Biology has seen a encouraging increase of 31% in grades A-C; chemistry has seen an increase of 20% and physics a 6% increase. Not surprisingly the increase in overall student numbers in design and technology and computing has been matched in the increases in grades A-C achieved, with design and technology seeing an increase of 118%, and computing seeing a massive rise in grades A-C of 227%. The key point to take from the analysis of A-level student numbers is that, despite a decline in actual numbers of students taking mathematics and sciences, the numbers achieving grades A-C (the usual requirement for university) has in fact remained relatively steady and in many cases shown a healthy increase. It is particularly encouraging to see the increases of students taking design and technology and computing which have both seen positive growth over the last ten years.

1.4 Women taking A-level Mathematics, Physics, Chemistry, Technology and Computing

In 2004, women represented 39% of the A-level mathematics entrants, 22% of those taking physics, 50% of those taking chemistry, 38% of design and technology, 27% of those taking computing and 60% of those taking biology. One point of concern is the fact that in 2002 and in 2003, despite 50% in GCSE mathematics awards achieved by female pupils only 40% of those attaining an award in GCSE physics were female. These proportions dropped quite sharply to just 37% and 23% respectively at A-level. This has an impact on the numbers going into engineering departments which require skills in mathematics and physics. The experience of chemistry is worth highlighting where 41% of the GCSE awards are obtained by female pupils and this proportion rises to about 51.5% at the A-level stage, a more diverse make up of A-level students. This may reflect the attraction of medicine for female students where A-level chemistry is usually a pre-requisite.

1.5 Summary and Conclusions

- The demographic data suggests that the 16 and 18 year old populations are going to be in a relatively stable position over the next five years with the 16 year old population settling at around 780,000 and the 18 year old population at just under 820,000 by 2010.
- The increased numbers of students taking GCSE mathematics and science is in most part down to the demographic increase in the size of the 16 year old cohort over the last decade.
- The data indicates that there has been an upward trend, affecting all GCSE mathematics and science subjects, in the percentage of students reaching a grade C or above.
- Since 1995 there has been a 24% decline in A-level mathematics students.
- The number of A-level students who achieved grades A-C has seen an encouraging trend over the last decade. Mathematics is contributing a similar number of A-level grades A-C in 2004 than seen in 1994 (in fact there has been a 2% increase in student numbers over the last decade). Biology has seen an encouraging increase of 31% in grades A-C; chemistry has seen an increase of 20% and physics a 6% increase. While the overall student numbers for SET subjects is at best static, average grades within subjects are on the increase.

2. Further Education, Vocational Education and Training

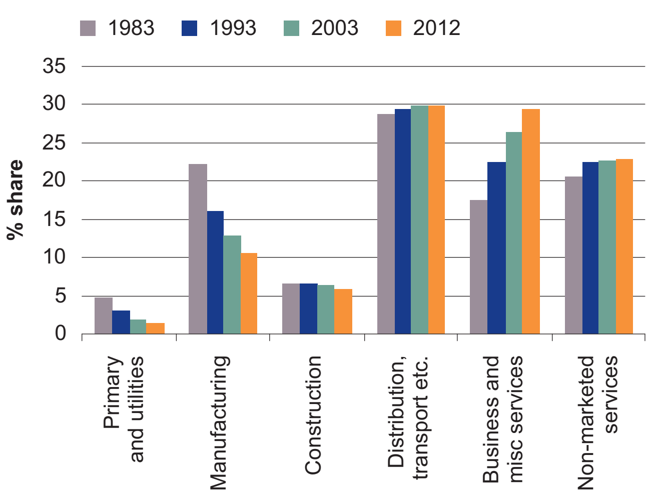
Skills at technician level underpin the entire fabric of UK engineering. The supply of technician level skills is an area often overlooked in previous analysis. This section looks at the state of engineering and technology within the Further Education and vocational sectors; the main supply route for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

2.1 Changing Skill Requirements

Demand for skills in the UK economy is changing. Engineering is not immune to these changes. Manufacturing has seen the largest fall in employment of all the major sectors in the engineering economy. Chart 2.1 describes the changing employment patterns across the economy between 1983 and 2012. Of interest are the large reductions in employment being seen by the manufacturing sector – a fall from 22% of employment in 1983 to just over 10% in 2012. Whilst not all areas of manufacturing require engineering skills, contraction of employment in this traditionally engineering intensive part of the economy reflects the on going transition from unskilled and semi-skilled mass employment, towards the mechanised, high-tech, high skill economy of the future. Nevertheless, manufacturing alone will still provide nearly 3 million jobs to the UK economy in 2012.

At the same time there is still a large demand for engineering skills in other engineering dependent sectors of the economy such as distribution and transport, and business and miscellaneous services. This is reflected in future predictions of employment (see Chart 2.1).

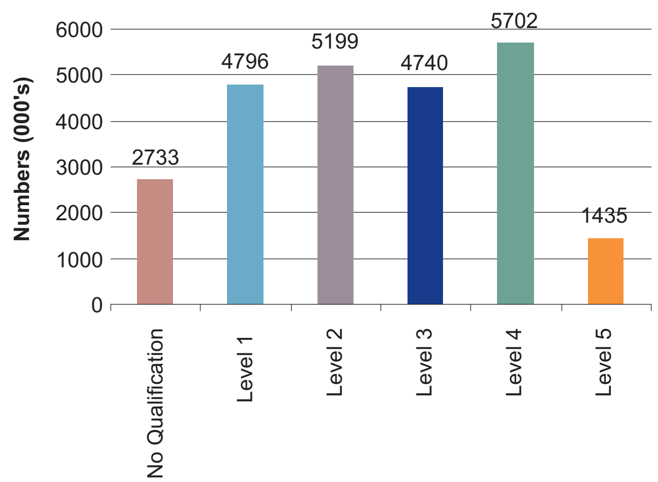
Chart 2.1: Percentage share of employment in England 1983-2012



Source: LSC 2005

In the absence of detailed data about the numbers of holders of Level 1 to 3 engineering qualifications, we use national data from the Learning and Skills Council. Chart 2.2 shows the totals of those in the workforce who hold qualifications at Levels 1 to 5. Level 4 is equated to first degree, and Level 5 to higher degree or professional qualification, so, for this section, we are largely interested in Levels 1 to 3. It is worth noting that the use of Levels in this data context is not to be confused with the use of Levels to describe the difficulty of National Vocational Qualifications (NVQ) which will be referred to later in this section. Successive surveys have demonstrated the relatively small numbers in the workforce who hold qualifications at Level 3, compared to competitor nations such as France or Germany, and have drawn the inference that their greater productivity is, at least in part, attributable to this (Department of Trade and Industry DTI, 2005).

Chart 2.2: Qualifications held by workforce, England 2004

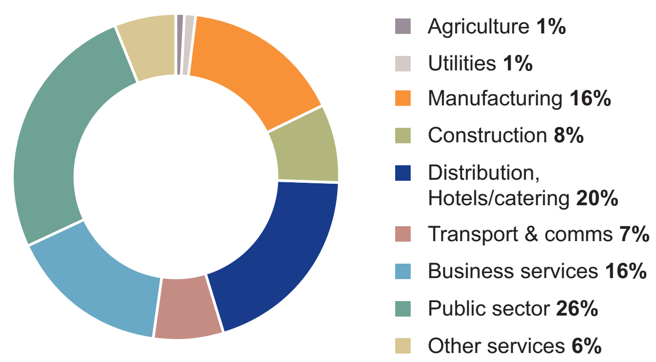


Source: LSC 2004 / Labour Force Survey 2004

In 2004 just over one tenth of the workforce held no qualifications, nearly one fifth were qualified up to Level 1 and Level 3, respectively. A slightly higher proportion of the population held Level 2 and Level 4 qualifications, with Level 4 the highest at 23%. Just under 6% of the population held Level 5 qualifications.

In engineering, Level 3 broadly equates to 'Technician'. A recent sector skills agreement draft report (SEMTA, 2005) indicated that one area of future skills shortage is at Level 3. Chart 2.3 highlights employment in 'Technician' related occupations. The sectoral split highlighted in the chart shows where engineering technicians work in the economy. Additional work carried out by the 2002 Labour Force Survey also suggests that engineering technicians make up a substantial part of the UK workforce – nearly 2m jobs – or just over 7% of the total workforce.

Chart 2.3: Technicians by sector, all UK



Source: LFS (Averaged Quarterly Estimates, December 2001/November 2002)

Whilst it is no surprise that 16% of technicians work in manufacturing and that 8% work in construction it is worth noting that, as Chart 2.3 indicates, many technicians work outside the traditional sectors – as many as one fifth work in distribution, hotels and catering, whilst over a quarter of engineering technicians work in the public sector. The main supply mechanism for technician related qualifications is the Further Education (FE) sector which offers vocational courses and Work Based Learning (WBL).

2.2 Overview of Vocational and Work Based Learning in Further Education (FE)

For engineering, the importance of Work Based Learning (WBL) cannot be over emphasised. Without exposure to engineering workplace equipment, workflows and disciplines, qualification-holders are often found to be inadequately equipped with the skills engineering employers seek.

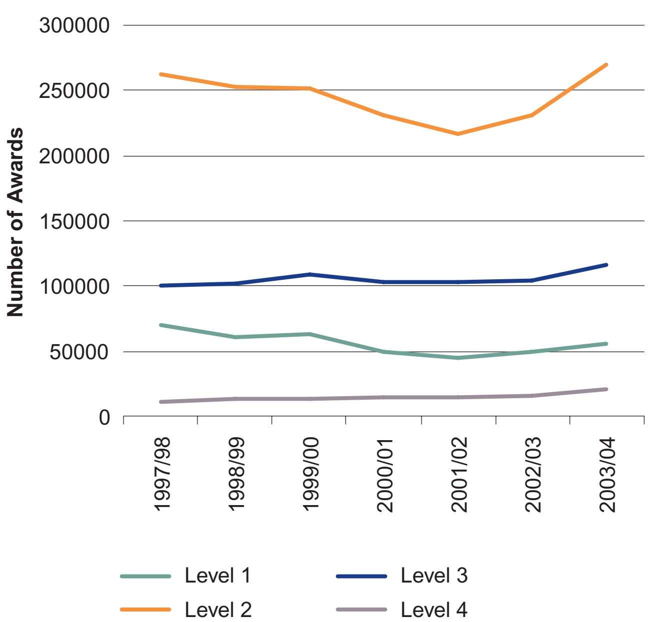
Data on the uptake of full time FE, WBL and those not in education and training is published by the UK government's Department for Education and Skills (DfES), and provides details of the distribution of learners on WBL schemes over the period 2000-2004. The picture here is one of falling numbers on advanced apprenticeships – which lead directly to the Level 3 qualifications employers seek (down nearly 30,000 over the period 1994-2004), and an expansion of (non-advanced) apprenticeships (up from 90,000 in 1994 to 164,000 in 2004).

Further data published by the Learning and Skills Council (LSC) provides a more detailed picture of the number of learners on Learning and Skills Council funded FE provision between the last two academic years, and allows us to examine the breakdown of this vocational training amongst the five different Levels of qualifications. As of October 2004 there were an estimated 2.26 million learners in LSC funded Further Education. This represented a decrease of 1% on the figure for October 2003. However the number of learners aged under 19 increased by 3% between 2003 and 2004 from 615,000 to 632,000. Decreases were seen in the number of adults aged over 19 (3%) and adults over 60 (7%). Amongst the under 19s the actual number of learners has increased by 2.6%, with Level 3 seeing a 2.4% increase on the previous year. Of concern in the post-19 age group is that the number on Level 3 training fell by over 3%. In the case of WBL, there was a nearly 5% fall in student numbers on Level 3 training amongst the under 19 age group and a nearly 2% fall in WBL Level 3 training amongst the over 19 age group. The picture being painted is of an expanding FE and WBL sector as a whole, but contracting numbers of learners on Level 3 WBL – a major concern in efforts to solve the long term skills shortage for Level 3 engineering skills.

DfES published data from 2004 details the situation for engineering, technology and manufacturing within FE and WBL in October 2003 and 2004. This consists of student numbers at the commencement of the learning programme – as such it does not take into account the effect of drop out rates, a point which we will discuss later. Neither is there indication of learning levels. Turning first to FE, the number of learners in engineering, technology and manufacturing rose from 86,000 to 89,000 – an increase of over 4% on the previous year. This is in contrast to the whole of FE which saw a 1.4% decline in student numbers, down by over 30,000 at a national level. WBL showed a 3.3% increase in learners over the period. This figure is significant, since engineering, technology and manufacturing accounts for nearly a quarter (23.5%) of the WBL starts.

Chart 2.4 highlights the awards of NVQs from 1997/98 to 2003/04, broken down by qualification level.

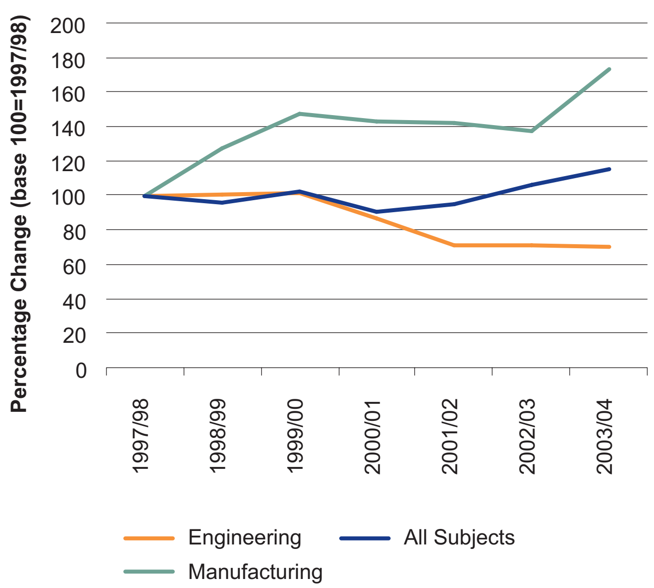
Chart 2.4: Awards of NVQs by academic year 1997/98-2003/04, all UK



Source: QCA

The trend is a contracting one for Level 1 awards (a fall of over 20% over the period). Level 2 awards have remained around 263,000 in 1994 to 270,000 in 2004, a rise of just under 3%. However, Level 3 awards are up by nearly 16% over the period, with Level 4 awards nearly doubling. The trend for engineering and manufacturing NVQ awards is outlined in Chart 2.5.

Chart 2.5: Awards of engineering and manufacturing NVQs 1997/98-2003/04, all UK



Source: QCA

Overall, NVQ awards (at all 5 Levels) are down for engineering from some 45,700 to 32,000, a fall of just under 30%. However the situation is much more positive for manufacturing which has witnessed a 74% increase in NVQ awards. Unfortunately there are, at present, no published data on the breakdown in different NVQ levels for engineering and manufacturing. The lack of breakdown into specific levels is important as it limits our analysis of trends in FE; this is particularly the case as we are unable to pinpoint where there are shortfalls in the numbers of learners. Another possible factor affecting engineering NVQ uptake, is that perhaps engineering learners are not taking NVQs because there are increasingly more appropriate (or attractive) learning options available to them than perhaps there are to those taking NVQ in manufacturing.

One issue touched on earlier is that of drop out rates on vocational training. The data presented to date in this section has relied on published material from the DfES and the LSC. The DfES material focuses on the number of learners who start vocational courses in FE and WBL – this data is inadequate to forecast supply of skills without details of the significant number who fail to complete their training. Data on this is less readily available. Tables 3.1 and 3.2 summarise DfES data on the success rates of courses in FE institutions.

Table 3.1: Success rates in FE institutions by qualification type 2001-2004

	2001/2002		2002/2003		2003/2004	
	Success Rate	Starts (000's)	Success Rate	Starts (000's)	Success Rate	Starts (000's)
Level 1 (long)	51%	784	55%	904	59%	912
Level 2 (long)	51%	870	52%	825	56%	805
Level 3 (long)	62%	1150	65%	1156	67%	1120
Level 4, 5 and HE (long)	38%	29	43%	30	47%	29
All long	56%	3216	58%	3113	61%	3005
All short	75%	2697	78%	2819	81%	2900
All qualifications	65%	5913	67%	5932	71%	5905

Source: DFES 2004

The data shows that for example the success rate for Level 3 courses appears to be rising from 62% in 2001/02 to 67% in 2003/04.

Table 3.2: Success rates in engineering, manufacturing and technology at FE institutions

	2001/2002		2002/2003		2003/2004	
Area of Learning	Success Rate	Starts (000's)	Success Rate	Starts (000's)	Success Rate	Starts (000's)
Engineering, Technology and Manufacturing	57%	208	59%	179	62%	165
All subjects	65%	5913	67%	5932	71%	5905

Source: DFES 2004

The data highlighted in Table 3.2 looks specifically at engineering, technology and manufacturing courses in FE institutions (once again with no breakdown for Level); the success rate has risen from 57% in 2001/02 to 62% in 2003/04. Note, however that during this time the number of starts has fallen by just over 20%. The DfES data appears to paint a positive picture with a reduction in drop out rates. Taken together, the data illustrates a fall in successful completions because the improvement in success rate is affected by the larger fall in starts.

However the picture on drop out rates is not straightforward, as the FE data includes all courses run at FE colleges, not just those described as vocational. Data published by the LSC (Table 3.3) paints a slightly different picture of the drop out rates on vocational courses.

Table 3.3: Success rates for engineering, technology and manufacturing by programme type 2001/02-2002/03

	Advanced Modern Apprenticeships		Foundation Modern Apprenticeships		NVQ Training		All Frameworks	
	Success rate	Total Leavers	Success rate	Total Leavers	Success rate	Total Leavers	Success rate	Total Leavers
2001/2002	47%	13000	32%	6900	43%	8500	42%	28400
2002/2003	53%	15000	39%	7800	44%	7600	47%	30300
2003/2004	50%	14600	42%	9400	62%	4800	49%	28700

Source: LSC 2004

Overall the data, which looks at success and leaver rates, shows a much lower completion rate than the DfES data. Success rates on all types of vocational programmes have been improving from 42% in 2001/02 to 49% in 2002/03. Although this improvement is encouraging, the fact that only half of those on vocational courses actually complete them seems at odds with the more positive picture painted by the DfES data. Analysis of cohort data of 16/17 year olds provides us with more insight into the reason for the high drop out rates on vocational training. It is this analysis to which we shall now turn.

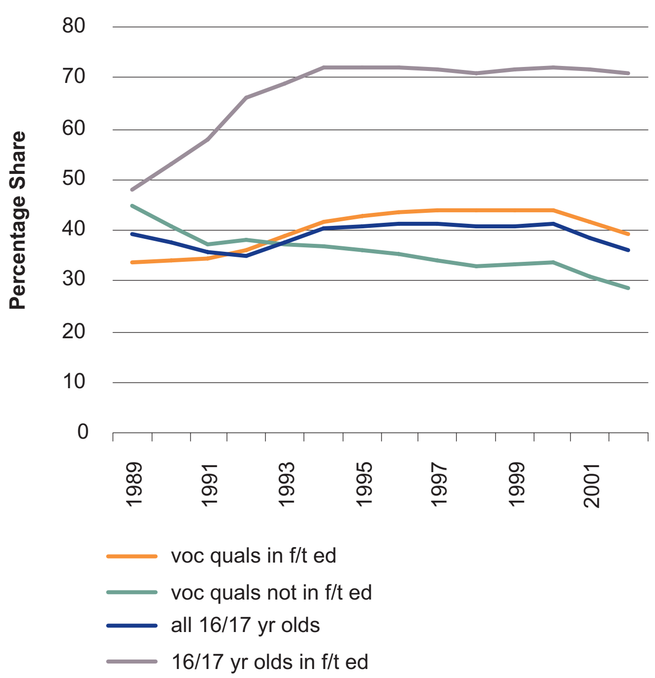
2.3 Cohort Analysis

Work carried out by Payne (2003) for the DfES provides additional insight into the dynamics of vocational training, examining the behaviour of individual year cohorts of 16/17 year olds over time. The main cohort presented in Payne (2003) were studied in Spring 2002; of those surveyed, around a third of 16/17 year olds were working for a vocational qualification, whilst two fifths were studying for academic qualifications. Of these vocational students three quarters were in full-time education, with most in FE colleges; an additional group of 18% of vocational students were also in Government-Supported Training (GST).

The young people's prior attainment as measured by GCSE results had a strong impact on whether young people took the vocational qualifications. The majority of 16/17 year olds in the top third of GCSE results had AS or old A-levels as their main study aim. Only one in ten in this top band chose vocational qualifications, usually Level 3, and only one in twenty was not studying for any qualifications at all. In the middle third of GCSE results, the proportion having vocational qualifications as their main study aim rose to nearly half. In the bottom third of GCSE results nearly half were not working for any qualifications. Nearly all of those who were working for qualifications were taking vocational courses, but very few were working for Level 3.

Using data from previous cohort studies, changes in the proportion of 16/17 year olds taking vocational qualifications can be plotted. After an initial fall in the 1990s, the proportion of 16/17 year olds taking vocational qualifications in full-time education grew. This growth was associated with increases in staying on rates after age 16. During the 1990s the overall proportion of 16/17 year olds working for a Level 3 vocational qualification grew, however there was also a slight fall between 2000 and 2002. It is perhaps surprising to see in Chart 2.6 that despite the growth of all NVQs and GNVQs, the proportion of the age group who were working for vocational qualifications was smaller in 2002 than in 1989. This was in most part due to the phasing out of GNVQs with vocational GCSEs and vocational A-levels in 2003.

Chart 2.6: Proportion of 16/17 year olds working for a vocational qualification, England and Wales



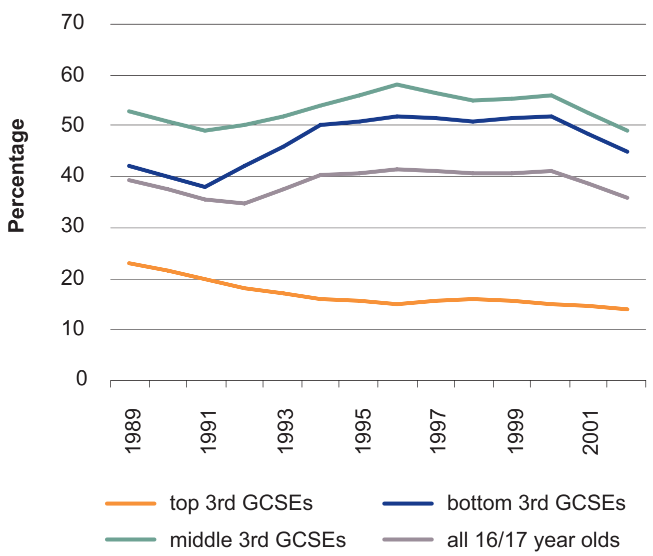
Source: Payne (2003)

The rapid increase in staying on rates in full-time education that took place between the late 1980s and mid-1990s was accompanied by a rise in the proportion of the age group taking vocational qualifications in full-time education.

The proportion of 16/17 year olds in full-time education who were working for vocational qualifications peaked in 2000, but by 2002 had dropped markedly. It seems likely that this was due to the Curriculum 2000 reforms, which may have increased the attractiveness of A-level courses relative to vocational alternatives for young people in the middle ability range who chose to stay on in full-time education. As was shown in the previous section the proportion of students achieving grades A*-C at GCSE rose over this period, providing more students with access to general and broader post 16 learning. Fewer 16/17 year olds were working for vocational qualifications in 2002 than in 1989.

Chart 2.7 shows trends in the proportions of young people in the top, middle and bottom thirds of GCSE results who were working for vocational qualifications.

Chart 2.7: Proportion of 16/17 year olds working for a vocational qualification by GCSE results 1989-2002, England and Wales



Source: Payne (2003)

The pattern in the top results band is very different from that in the lower two bands – the proportion of young people with good GCSE results taking vocational qualifications declined since 1989. While the proportion in the middle and bottom GCSE results bands who were taking vocational qualifications grew in the first half of the 1990s.

2.4 Implications for Policy

The cohort analysis tells us a lot about the behaviour of young people in relation to vocational training. Possibly the most important conclusion to take from the analysis is that learners who gain lower GCSE results are more likely to find themselves on vocational or occupational training paths post-16 rather than on broader, general education pathways. However, this stratification is not only about GCSE results, and GCSE results do not necessarily indicate 'ability'. Payne (2003) reported that "the probability of taking vocational rather than academic qualifications was increased by poor GCSE results, being female, being white, truancy, unfavourable attitudes to school, less well qualified or less skilled parents, living in social rented accommodation, and having attended in Year 11 a secondary modern school or a comprehensive with no sixth form." (Payne, 2003, pp. 43-44). The final report of the Equal Opportunities Commission (2005) investigation into job segregation, reports on construction, engineering, plumbing, ICT and child-care. The report noted that "the majority of young people from lower socio-economic groups rely upon vocational learning routes into the workplace that deliver, for women in particular, a limited range of opportunities with lower pay." (EOC, 2005, p. 5.)

Forsyth and Furlong (2003) note that young people from such families are more likely to leave education at the minimum age and follow vocational routes, and echo the EOC suggestion of long term impact on careers of those from the most disadvantaged families.

Some policy implications are therefore related to why some groups of learners do not achieve similar GCSE results to their contemporaries, why certain individuals (and not others) are encouraged onto vocational/occupational routes, how to keep all in learning and paid work for longer, and concern that the social equity gap is growing rather than diminishing (Kelly, 2005).

Furthermore, there is little current knowledge about the effectiveness of vocational learning (LSRC, 2004) whilst at the same time the modes of learning and qualifications that currently hold status may not include the sorts of learning which might be of particular value to a 'knowledge-based economy'.

It also seems hardly surprising that fewer learners with good GCSEs seek out a vocational or occupational route as longer-term 'earnings returns' substantially differ. Returns to an individual for general qualifications are around 26% for a first degree, 16% for 2 or more A-levels, and 28% for 5 or more grade C or above GCSEs (McIntosh, 2002). McIntosh also reports that there are smaller 'returns' on some vocational/occupational qualifications (for example, HNC/HND and ONC/OND qualifications return 14% and 11% respectively for men and 8% for each for women) but that "NVQ qualifications at Levels 1 and 2, however, are still not observed to have a positive effect on earnings" (McIntosh, 2002, p.4).

Lower tiers of GCSE achievers may not yet be able to cope with the demands of vocational qualifications (particularly at Level 3). This may be a reason behind the apparent high drop out rates seen on vocational/occupational engineering, technology and manufacturing courses. However, drop-out data rarely allows for those transferring to, for example, full-time paid work or to other courses. Some post-16 providers have already taken on board the need to make up for lack of earlier learning and, like their HE counterparts, are providing pre-entry courses and substantial support in Key Skills learning.

At the same time, as pressure to increase the number of learners entering Higher Education continues, the Government's skills strategy advocates the expansion of apprenticeship programmes (LSRC, 2004). High GCSE achievers have not been opting for apprenticeships (LSDA 2005). Strategies to remedy this in engineering are already in place with, for example, the introduction of Graduate Apprenticeships and the DfES Young Apprenticeship model which requires a minimum entry level in mathematics, English, and sciences at age 14.

Issues of how to encourage more (at any age), and higher level, occupationally specific and transferable learning will need to be addressed if the projected skills shortages outlined in Sector Skills Agreements are to be met. For engineering there is a particular need for those with sound mathematical ability as well a creative insight and there is an urgent need, particularly given the projected change in UK demographic working-population profile, to encourage more women and people with ethnic backgrounds into the field – and to retain them.

2.5 Summary and Conclusions

> In 2004 just over one tenth of the workforce held no qualifications, nearly one fifth were qualified up to Level 1 and Level 3, respectively. A slightly higher proportion of the population held Level 2 and Level 4 qualifications, with Level 4 the highest at 23%. Just under 6% of the population held Level 5 qualifications.

> Research indicates that engineering technicians make up a substantial part of the UK workforce – nearly 2m jobs – or just over 7% of the total workforce.

> 16% of technicians work in manufacturing and 8% work in construction. It is also worth noting that, many technicians work outside the traditional sectors.

> DfES data suggests that the success rate for engineering and technology Level 3 courses appears to be rising from 57% in 2001/02 to 62% in 2003/04. However, this is counterbalanced by a fall in starts.

> However the picture on drop out rates is not straightforward; LSC published data suggests that success rates on all types of vocational programmes have been improving from 42% in 2001/02 to 49% in 2002/03. Although this improvement is encouraging, the fact that only half of those on vocational courses actually complete them seems at odds with the more positive picture painted by the DfES data.

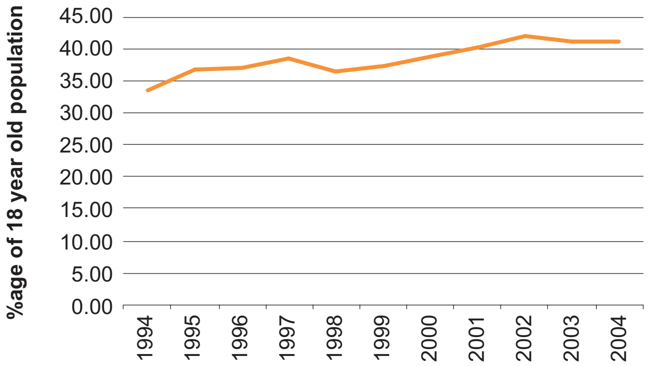
3. Higher Education

The training of graduate engineers takes place within the Higher Education sector. The UK's universities therefore have a vital role in supplying the next generation of the professional engineering workforce. This section looks at trends within Higher Education and their implications for science, engineering and technology as a whole.

3.1 Supply of Students into Higher Education

The UK has witnessed a rapid expansion of participation in Higher Education over the last 10 years; the number of undergraduate programme entrants has risen by nearly 40% from just under 230,000 in 1994 to 320,000 in 2004. This is at a time when the 18 year old population increased by only 16%, growing from just over 671,000 to 777,000. The ratio of home degree students to the total 18 year old population is detailed in Chart 3.1, and shows the number of UK degree entrants as a percentage of the 18 year old population.

Chart 3.1: Percentage of home degree entrants to total 18 year old population



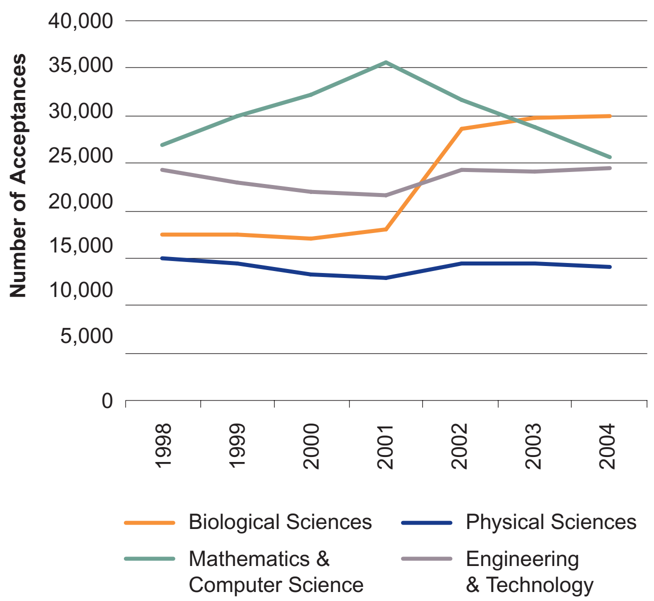
Sources: ONS Population Estimates; UCAS/UCCA/PCAS Annual Reports

The number of home students entering university has increased by over one fifth over the last decade. The introduction of student tuition fees in 1998 does not seem to have seriously influenced the number of young people entering Higher Education (HE). The UK government has set itself a target of achieving a 50% level of university participation of the 18 year old population; although the definition of the term participation has evolved since the target was first set, from traditional undergraduate education to include foundation degrees and other HE based provision in Further Education (FE).

3.2 Trends Within SET Subjects

Chart 3.2 outlines the trend for overall student acceptances onto science, engineering and technology (SET) subjects. It is worth noting that this data includes all acceptances, comprising all home and foreign students. For the purpose of this analysis the SET subjects have been split in line with the JCAS codes used by both UCAS and Higher Education Statistics Agency (HESA). This breaks SET into four areas. Biological sciences includes all the life sciences; physical sciences includes physics and chemistry; mathematics and computer science includes all the IT disciplines, and engineering and technology includes all the traditional engineering disciplines (expanded later in this section in Chart 3.4).

Chart 3.2: Total acceptances onto SET undergraduate courses

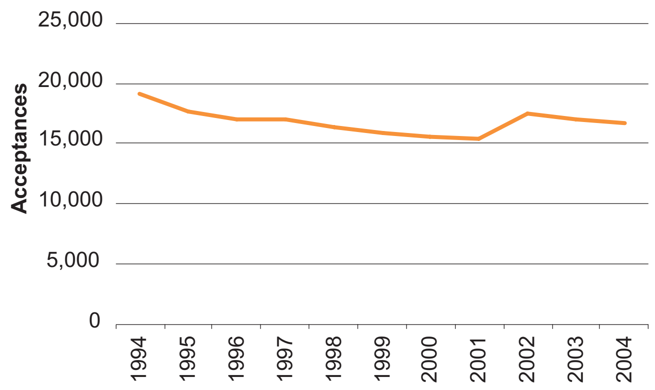


Source: UCAS

The situation facing the 4 main branches of SET has varied in the last decade. The number accepted onto physical sciences courses has declined from 15,000 in 1994 to just under 14,000 in 2004. Engineering and technology has also remained relatively static with acceptances remaining around 24,500. The situation facing biological sciences over the decade has been extremely positive, with increases from just under 17,500 in 1994 to just under 30,000 in 2004. Mathematics and computer science are in a different situation where they have only seen a minor decline from 27,000 in 1994 to 25,600 in 2004; this hides the massive increase seen in student numbers up to 2001 and the subsequent decline (possibly a result of the decline in the IT industry seen more widely in the global economy).

Chart 3.3 shows the trend in acceptances of home students to undergraduate degree courses in engineering and technology subjects. Numbers of acceptances to engineering and technology have fallen over the period 1994 to 2001, to a low of just under 15,500, but have since recovered to over 16,500. However, it is worth noting that 1994 was a peak year for acceptances. It is possible that the abolition of the "binary divide" which separated polytechnics from university status and the enhanced funding of engineering by the University Grants Committee played some part.

Chart 3.3: Home acceptances onto engineering and technology courses



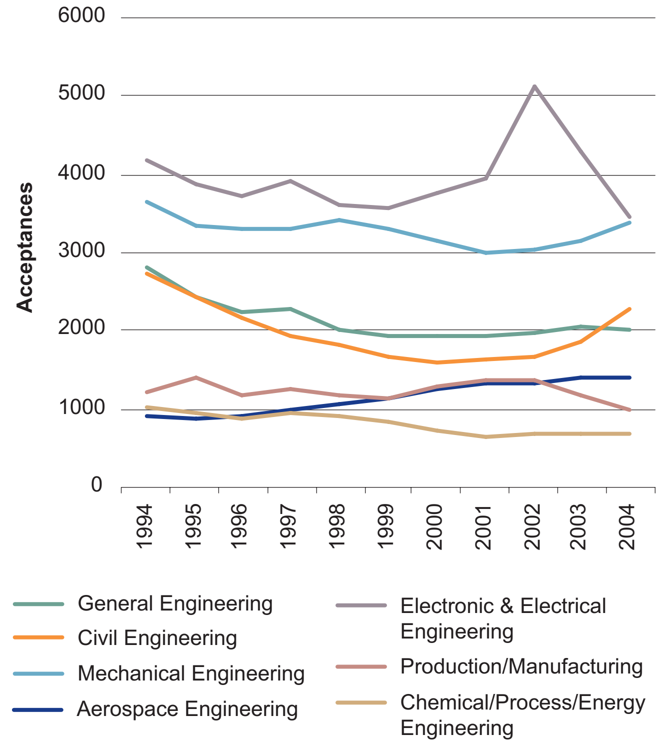
Source: UCAS

One important issue to note is that, because the majority of engineering and technology entrants hold A-levels in maths and physics, the numbers of undergraduates is probably constrained by the number of awards made. Since A-level at A-C is a good indicator of the level of mathematics skill demanded by undergraduate engineering degrees to be able to comfortably assimilate the mathematical demands of the first year, it is interesting to note that the total output of awards for A-level mathematics has oscillated at around 40,000 for the past 10 years (2004 = 38,800). Since A-level mathematics is a good grounding for degrees in many other SET subjects as well as for medicine and built environment subjects, it may be surmised that engineering is attracting more than its fair share of these award-holders.

3.3 Individual Engineering Disciplines

The numbers of students accepted through UCAS to engineering and technology degree courses by discipline over the last decade is described in Chart 3.4.

Chart 3.4: Home acceptances onto engineering courses



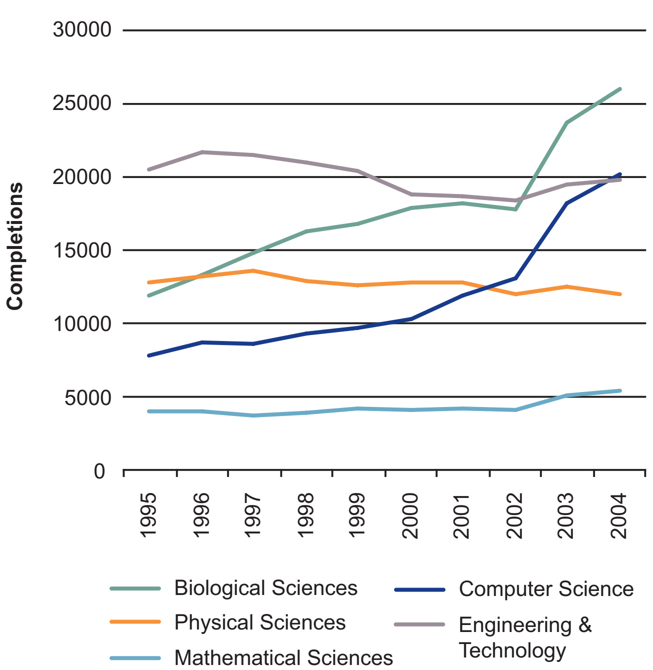
Source: UCAS

Interestingly, while some subjects show a recovering trend since 2000 as a response to a decline in the late 1990s in acceptances such for civil, general and mechanical engineering. Other subjects seem relatively unaffected by this pattern (aerospace, and production/manufacturing engineering). One of the most striking trends is that of electrical & electronic engineering which saw a dramatic increase in acceptances from 1998 to a peak in 2002. However, since then they have dropped back significantly with a 32% decline in applications in the last 2 years alone; 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 A-levels. More encouragingly both civil engineering and mechanical engineering both appear to have positive growth rates, with civil engineering seeing a 40% rise in applications since 2000 and a more modest 13% increase in mechanical engineering applications. It is worth highlighting that part of the recovery in overall acceptances onto engineering and technology since 2000 is attributed to increases in civil engineering and mechanical engineering. This raises the possibility that new students are picking their particular engineering specialism based on future job opportunities; undergraduates are therefore becoming more selective about the type of engineering they follow. The collapse of the dot com boom may have encouraged budding engineers to move away from electrical engineering and towards civil and mechanical engineering – areas with perceived benefits in terms of future employment and in line with the expansion in future skill requirements in those areas. If students are basing their engineering course selection as part of long term career decisions then it may be likely that the numbers of students following general engineering courses will increase as students keep their options open. If this is to happen then there should be an increase in acceptances onto general engineering degree courses – something which, according to the data, has yet to happen. General engineering degrees also become more popular if university departments found it easier to have these programmes accredited by the profession.

3.4 Completions at Undergraduate level

The data presented so far describes the supply of home students entering the Higher Education sector. However, it tells us little, about the output of Higher Education (HE) in the UK. Data published by the Higher Education Statistics Agency (HESA) does this by presenting the number of degree completions in undergraduate and postgraduate degrees across the UK HE sector. The number of completions in science engineering and technology (SET) undergraduate courses is detailed in Chart 3.5.

Chart 3.5: Undergraduate degree completions in SET



Source: HESA

Over the last decade the number of students completing undergraduate programmes in engineering and technology has remained relatively steady at just under 20,000 from 1995 to 2004 (with only 3.5% fewer completions in 2004 compared with 1995). During the same period the number of students completing programmes in biological sciences has grown by nearly 120%, with computer science courses also up by 159%. Both these subject areas have seen massive growth during the last decade, with both subject areas benefiting from widespread interest and exposure to biotechnology and information technology. It must be noted, however, that the expansion of computer science appears to have ended, perhaps reflecting the collapse of many IT intensive businesses in the late 1990s. It will be interesting in future years to see if this has any effect on the long term trend of completions within computer science. Completions in mathematics also increased – by 33% from 1995 to 2004. Physical sciences, however, have seen a 6.5% fall in the number of completions.

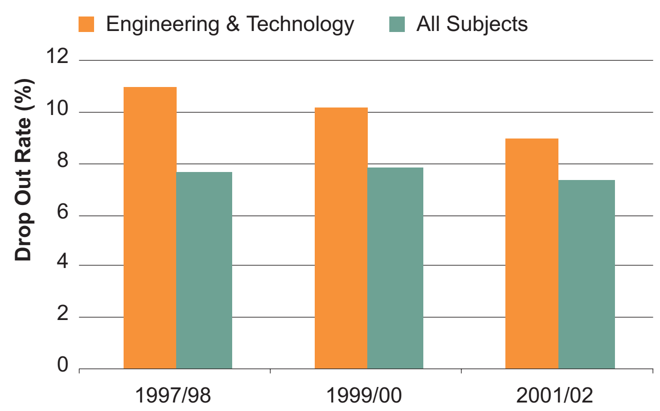
Nevertheless, recent engineering and technology completions are on the increase; in 2000 they were at 18,810 and have now increased to 19,780 in 2004, an increase of over 5%. This trend is encouraging especially in the light of the fact that acceptances over the same period were up by 8%. One would expect the increased trend in acceptances highlighted earlier in this section to contribute to a long-term increase in engineering and technology completions in the next few years, as accepted students complete their studies. Overall, the undergraduate population studying for qualifications in engineering and technology appears stable and likely to increase in the next few years.

This analysis of acceptances and completions of undergraduate programmes ignores the important – maybe vital – contribution to the economy and to the continuing health of the HE sector, of post graduate studies.

3.5 Drop-Out and Non-Continuation Rates

The drop-out data featured in this document is sourced from HE performance data published by HESA. Chart 3.6 outlines the 'non-continuation' rate – a measure which describes the percentage of first year students who leave an undergraduate course and fail to commence another undergraduate course in the following academic year.

Chart 3.6: Non continuation rates for engineering and technology compared to all subjects



Source: HESA

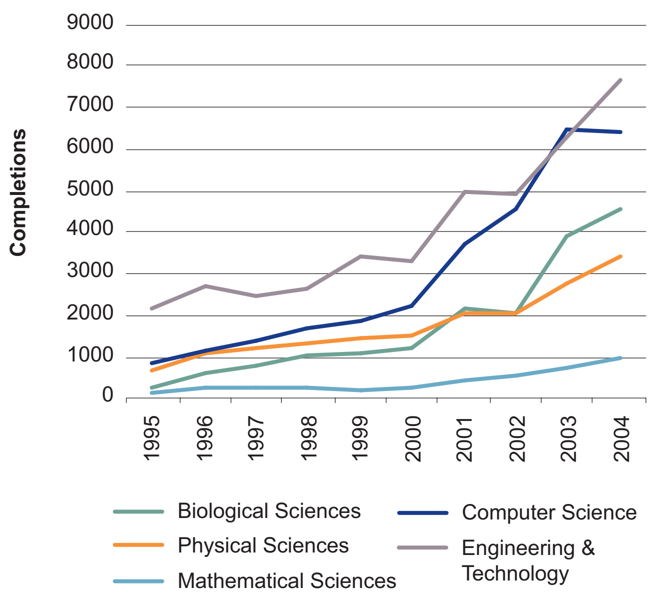
For those who entered engineering and technology courses in 1996-97 the non-continuation rate of 12% was higher than any of the other subject groupings listed. The corresponding figures for both 1997-98 and 1999/00 were 11% and 10% respectively. The most recent data for 2001/02 suggests a non-continuation rate of just under 9%. This significant reduction in the drop-out rate is encouraging, especially in the light of the fact that the drop-out rate of all subjects has remained static over the period between 7% and 8%.

Reasons for the higher drop-out rate are not clear, but must include the excessive demands placed on 1st year students by the gap between A-level knowledge and skills and those for the relatively short UK undergraduate programme. Most engineering undergraduate programmes now include intensive mathematics tuition and support during the first year. It is also worth noting that the drop-out rates for engineering and technology courses at undergraduate level are much lower than those seen in Further Education and Work Based Learning (described in the previous section).

3.6 Postgraduate Completions

Chart 3.7 highlights the number of postgraduate students achieving masters level degrees over the last decade. Whilst all areas of SET have seen increases in the number of completions, engineering and technology has seen a remarkable increase in completions, from around 2,200 in 1995 to nearly 7,700 in 2004, a rise of 250%. Much of this expansion has been through the wider adoption of four year long MEng degrees.

Chart 3.7: SET masters degree completions

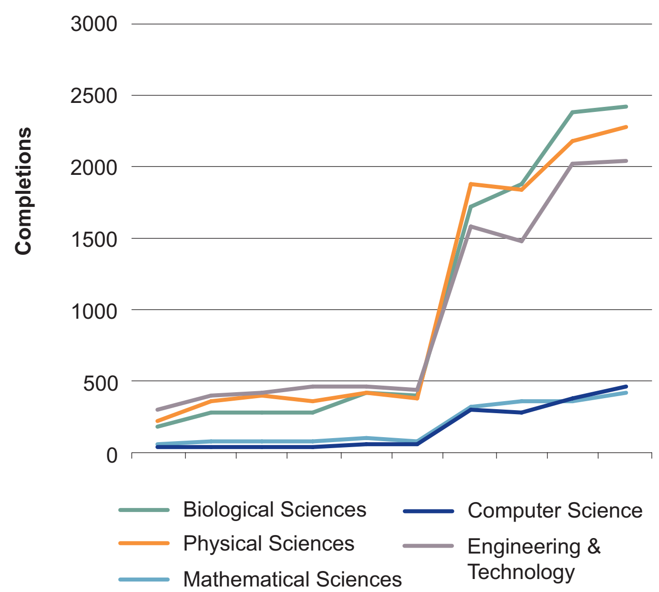


Source: HESA

Computer science also appears to perform well in the analysis of masters degrees; rising from fewer than 900 to over 6,300 over the decade. Note however, that much of this expansion has been through the expansion of IT conversion courses; introductory courses in IT for non specialists. It seems unlikely that these programmes meet the QAA descriptors for masters level programmes published in 2004. Overall, engineering and technology programmes are ahead of all other SET disciplines in expansion of masters level degree courses.

Chart 3.8 shows the number of completed doctorates in science, engineering and technology over the last decade. The picture is one of major expansion in biological sciences, physical sciences and engineering and technology with the greatest growth commencing in 1999/2000. All three subject areas saw a massive increase in completions during this academic year; physical sciences saw the biggest increase, with a 380% increase in completions in a single year. Engineering and technology followed up with an impressive 250% increase in completed doctorates over the same year (from 500-1800). These increases were due to changes in funding arrangements for doctorates which were introduced in the early/mid 1990s making doctoral studies in the UK more accessible to both UK and foreign students. It is interesting that these impressive increases in doctoral completions have not extended to all areas of SET – computer science and mathematical sciences saw only a few hundred more awards.

Chart 3.8: Completed SET doctorates



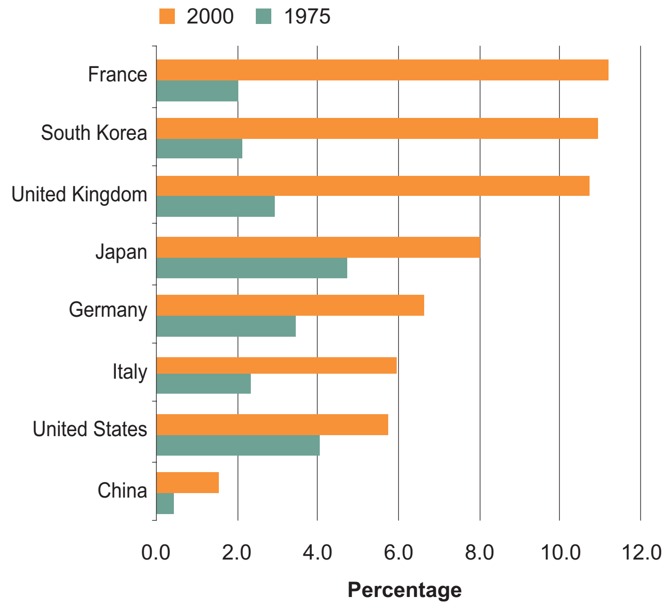
Source: HESA

However it is clear that many of the new post graduate students are from outside the UK (see chart 3.10). If they stay and work in the UK after they have completed their studies, they will contribute to the UK economy. Further work is necessary to determine how many do.

3.7 International Dimensions

In order for the UK to compete in products and services requiring technical innovation, it is crucial that the UK continues to produce high quality engineers and scientists in sufficient quantity to supply the needs of industry. Chart 3.9 is based on data published by the United States National Science Foundation and describes the relative position of the UK in terms of numbers of graduate engineers (and scientists) in 2000 expressed as a percentage of 24 year old population. This chart also compares the data to the situation in 1975.

Chart 3.9: Ratio of first university science and engineering degrees to 24 year old population



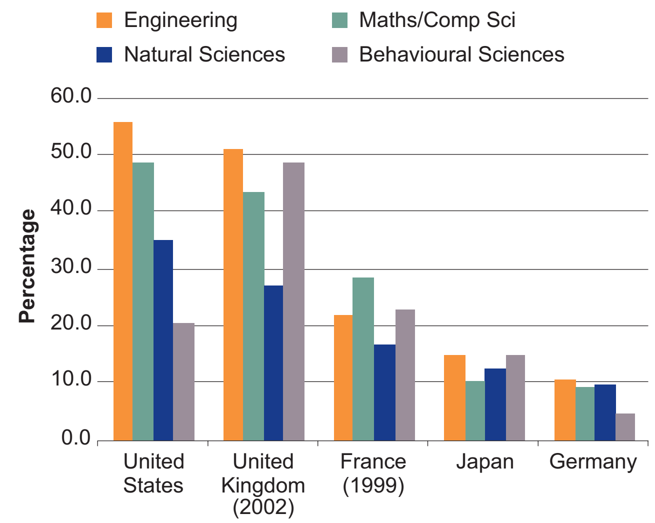
Source: NSF / OECD (2001)

In the period from 1975 to 2000 all the countries in the analysis saw an increase in the uptake of natural science and engineering undergraduate programmes. According to this data the UK currently has a strong relative position with over 10% of 24 year olds holding a SET degree. Only South Korea and France perform at a higher level, with the UK doing much better than traditionally strong SET countries such as the United States and Germany.

3.8 International Student Mobility

The 1990s witnessed a worldwide increase in the number of students going abroad for Higher Education study to the well established destinations of the United Kingdom, the United States, Australia, and France. However, other countries, including Japan, Canada, and Germany, also expanded their intake of foreign science and engineering postgraduate students (NSF, 2004). Chart 3.10 shows the proportion of foreign doctoral students across a number of subject areas.

Chart 3.10: Science and engineering doctoral degrees earned by foreign students in 2001 or most recent year



Source: NSF (2002)

It is interesting to note that over half of all engineering doctorates awarded in the USA and the UK are gained by foreign students.

3.9 Summary and Conclusions

- The UK has witnessed a rapid expansion of participation in higher education over the last 10 years; the number of undergraduate programme entrants has risen by nearly 40%.
- The number of UK students accepted onto physical sciences courses has declined from 15,000 in 1994 to just under 14,000 in 2004.
- Engineering and technology has also remained relatively static with UK acceptances remaining at around 16,500.
- Over the last decade the number of students (home and foreign) completing undergraduate programmes in engineering and technology has remained relatively steady at around 20,000 from 1995 to 2004. During the same period the number of students completing programmes in biological sciences has grown by nearly 120%, with computer science courses also up by 159%.
- At the doctorate level the number of completions in science, engineering and technology has increased with the greatest growth commencing in 1999/2000.
- The UK currently has a strong relative position with over 10% of 24 year olds holding a SET degree. Only South Korea and France perform at a higher level, with the UK doing much better than the traditionally strong SET countries such as the United States and Germany.
- The UK has seen a fourfold growth in the percentage of first SET degree holders between 1975 and 2000.

4. Graduate Recruitment

The interface between the supply and demand of graduate engineers takes place when graduates enter the workplace. This section examines trends relating to engineering graduates after they leave Higher Education 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

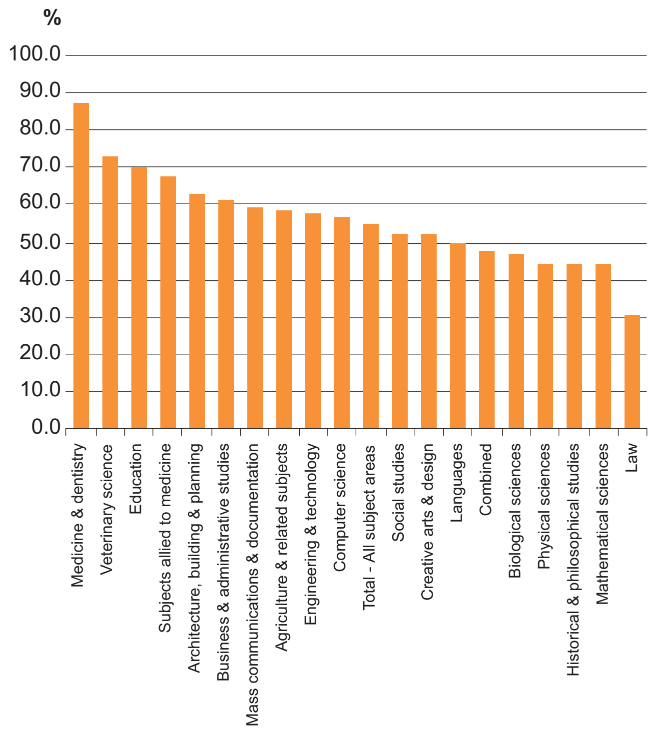
The rapid expansion in Higher Education (HE) during the last decade, together with a shift to a more open and diverse HE system has created a wide range of choice for potential students. It has also posed challenges to universities and colleges in their marketing and recruitment. Students are increasingly seen as customers with individual needs and preferences and there is consequently a competitive market for HE. Choice of a Higher Education institution to enhance future employment prospects is becoming a more important factor these days in applicants' minds, particularly as the perception of student debt increases. The employment prospects of science, engineering and technology (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.

This section 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 section begins by setting out some of the main findings from the latest version of the graduate first destinations survey, published annually by the Higher Education Statistics Agency (HESA). This looks in particular at where SET graduates work in the UK economy. The second half of the section examines some of the data published by HESA and the Association of Graduate Recruiters (AGR), on salaries and working conditions of SET graduates.

4.2 First Destinations Survey

HESA produce the First Destinations Survey 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 September 2004 the results from the 2002/03 cohort are presented; the study received over 240,000 responses from full time students. This represented a response rate of over 80% from full time postgraduate and undergraduate students. The full time employment rate of the undergraduates in January 2004 for the cohort of 2002/03 is detailed in Chart 4.1. The highest employment rates are seen in medicine and dentistry (87%) with veterinary science (74%) and education (71%) also seeing high levels of employment; this 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%, with historical and philosophical studies, mathematical sciences and physical sciences all with employment rates lower than 45%. It is worth noting that law is a special case in this analysis; many law graduates go directly onto low paid training contracts, or take part in legal practice courses, lowering the employment levels for law students.

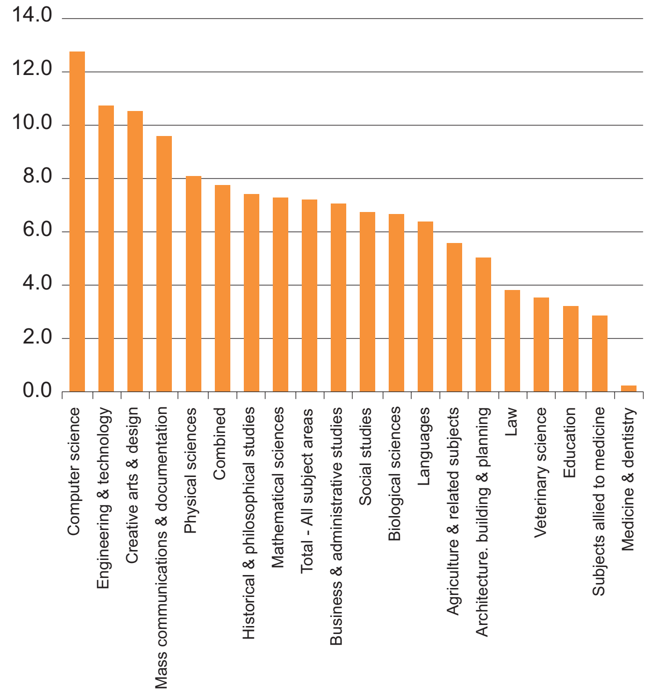
Chart 4.1: Percentage of students in full time employment by subject 6 months after study



Source: HESA (2004)

The situation for engineering and technology (58%) and computer science (57%) puts both these applied subjects above the total for all subjects of 55%. However it must be stressed that these figures for full time education per subject do not take into account the number of students carrying on into full time study and those in voluntary/unpaid work only. An alternative measure is to look at unemployment rates by subject. This is shown in Chart 4.2. Here the picture is less positive for computer science (13%) and engineering and technology (11%), with both subjects having the highest levels of unemployment. Physical sciences has an 8% level of unemployment.

Chart 4.2: Unemployment rate by subject 6 months after study

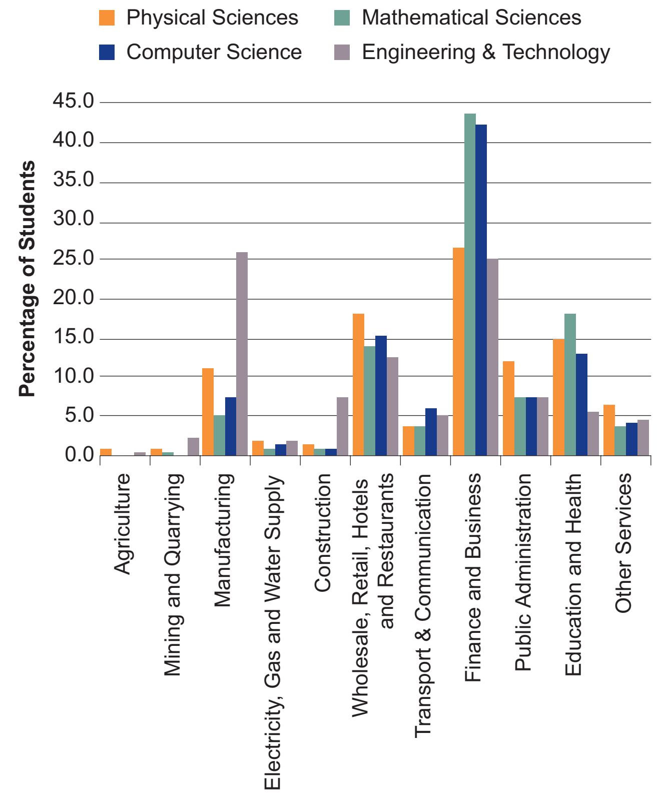


Source: HESA (2004)

At the other end of the spectrum, medicine and dentistry have an unemployment level of 0.2% with subjects allied to medicine having a unemployment rate of just under 3%. It is clear that the interaction between employment rates and unemployment rates requires further study, as one would expect the high employment rates and low unemployment rates seen by subjects like medicine, whereas the fact that engineering and technology and computer science has an above average employment rate but a high unemployment rate requires further investigation.

One type of analysis of the first destinations data is to examine graduate destinations by subject in line with the Standard Industrial Classification (SIC) codes. This allows analysis of where in the economy graduates are working, we can compare the distribution of graduates from different subject areas. The breakdown of first degree completions by SIC code is outlined in Chart 4.3.

Chart 4.3: Destinations of first degree holders by Standard Industrial Classification (SIC) 6 months after study

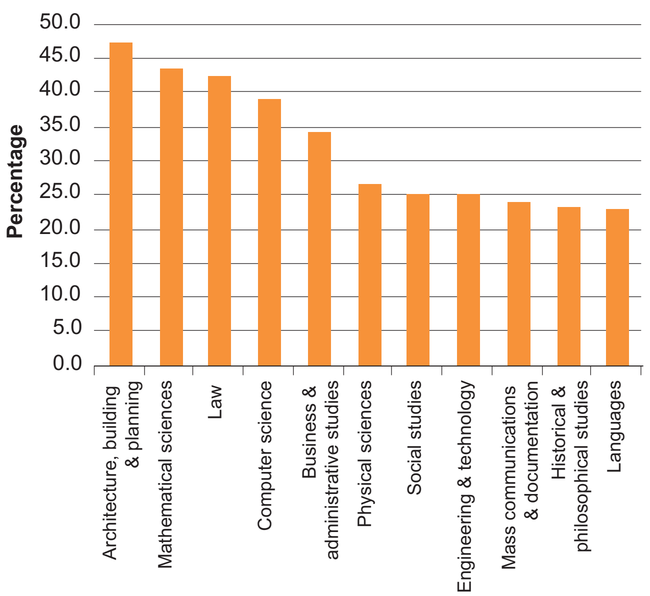


Source: HESA (2004)

The destinations breakdown for SET shows a diverse picture across the subjects. Engineering and technology see the largest percentage of graduates working in the manufacturing sector (26%), with the second largest group working in finance and business (25%). This compares to the situation for computer science where over 43% of graduates work in finance and business, physical sciences weigh in with 27% in the same part of the economy and mathematical sciences with nearly 44%.

The high percentage of SET undergraduates entering finance and business is a major feature of our SIC analysis of the first destinations survey and is an issue which requires more investigation. Chart 4.4 looks at the percentage of students going into finance and business from various subject groupings. Architecture, building and planning have the highest ratio of graduates working in finance and business with nearly 48%, this is followed by mathematical sciences at 44% and computer science with 43%. There has long been a view that there has been a drain on SET graduates towards finance and business – a feature of the fact that finance and business firms value the analytical and mathematical skills inherent in SET graduates. This trend is backed up by the fact that a large proportion of mathematics and computer science graduates go into finance and business occupations. However a much lower percentage of graduates from physical sciences (27%) and engineering and technology (25%) go into finance and business. This in the mid range of graduates entering finance and business, with the average for all subjects being at just under 23%. It should be noted that one feature of the uptake of work in finance and business is the fact that the sector employs people from all subject areas. Whilst engineering and technology sees 25% of its graduates entering the field, it is similar for history students (24%) and language students (24%):- the drain to finance and business is not a phenomenon peculiar to engineering and technology.

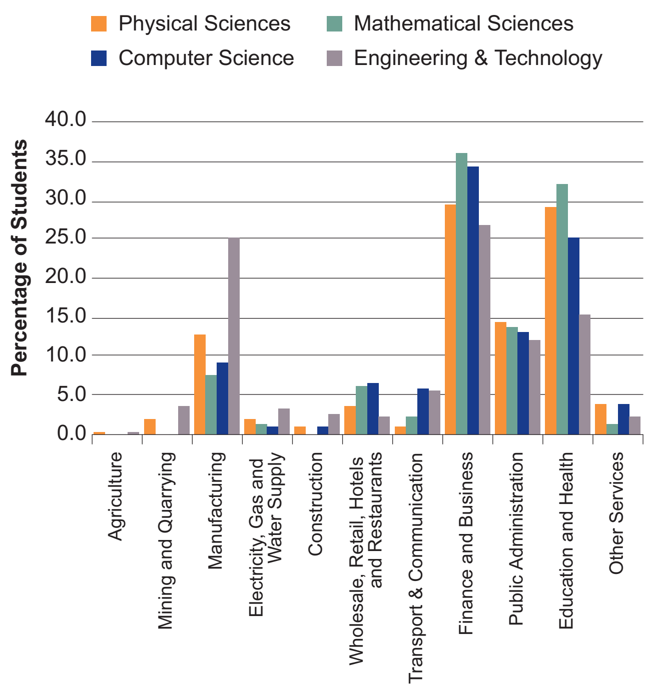
Chart 4.4: Percentage of all students going into finance and business by university subject 6 months after study



Source: HESA (2004)

Analysis of postgraduate destinations after graduation provide a similar story for engineering and technology, and is shown in Chart 4.5; with 27% of engineering and technology postgraduates going onto work in finance and business and 25% are working in manufacturing, a situation not wholly dissimilar to that seen at undergraduate level.

Chart 4.5: Destinations of postgraduate degree holders by Standard Industrial Classification (SIC) 6 months after study

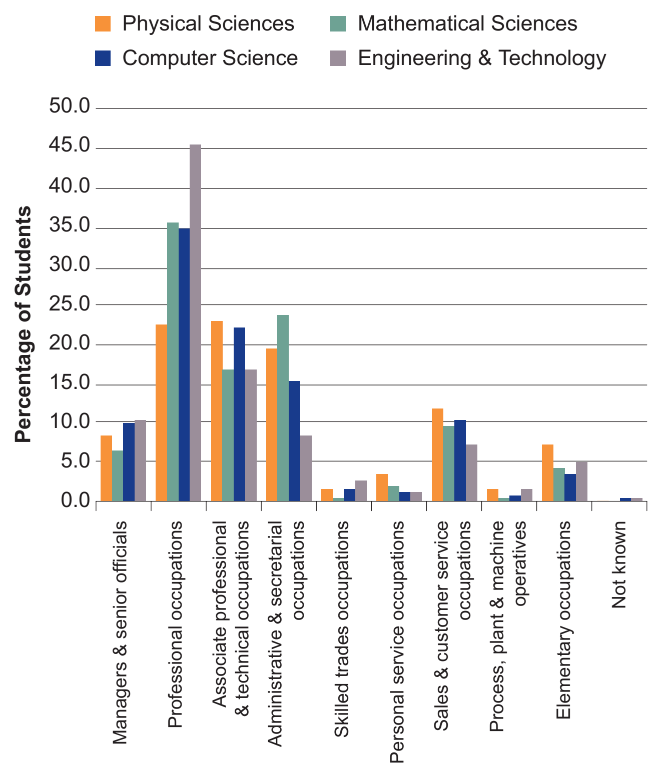


Source: HESA (2004)

It must be noted however that the situation is slightly different at postgraduate level for physical science and mathematical sciences. In both these cases there is still a heavy bias towards work in finance and business (physical science at 29% and mathematical sciences at 36%), but with a large percentage of postgraduates staying on in academia – this is reflected in the figures for education and health of 29% for physical sciences and 32% for mathematical sciences.

Our analysis of destinations data needs to be put into more detailed context than that offered solely by SIC codes. Whilst SIC codes inform us of what type of industry an individual is working in, they 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 Codes, allows us to look at 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 Chart 4.6.

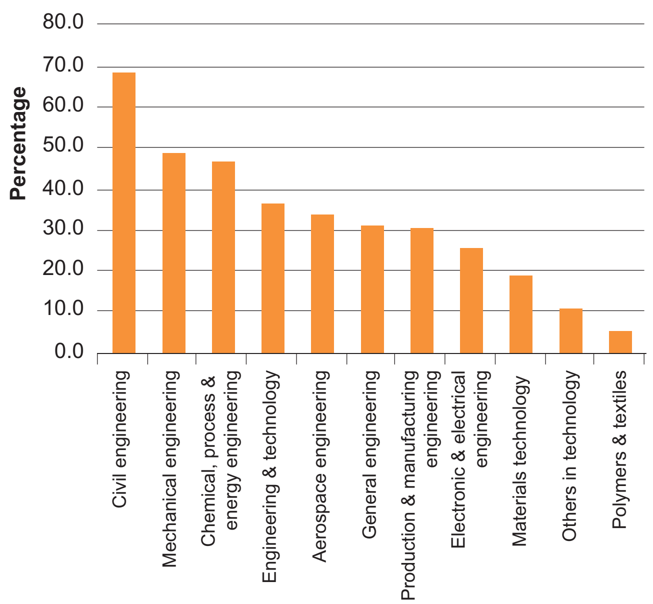
Chart 4.6: Destinations of first degree holders by Standard Occupational Classification (SOC) 6 months after study



Source: HESA (2004)

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 45% of its students going into professional occupations. Computer science and mathematical sciences also have a heavy bias into the professions with both registering around 35%. 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 Chart 4.7, which outlines the percentage of students from each branch of engineering who go on to become professional engineers.

Chart 4.7: Percentage of engineering graduates who move into professional engineering by discipline 6 months after study



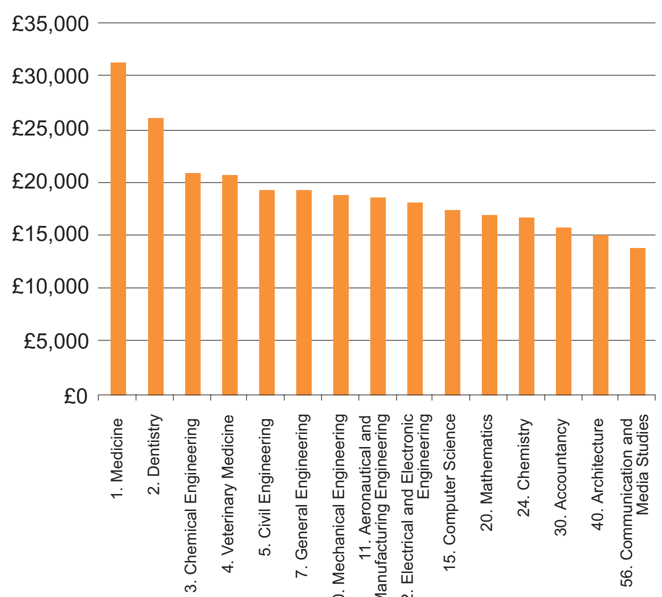
Source: HESA (2004)

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 nearly 70% of civil engineering graduates working as professional engineers 6 months after graduation. Mechanical engineering (50%) and chemical engineering (48%) also see a large proportion of their graduates going into the profession. It is a concern, however, that electronic and electrical engineering sees only a quarter of its graduates moving onto professional engineering careers. The interaction of graduates and the demand of industry requires 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.

4.3 Graduate Starting Salaries

One of the main drivers behind graduate recruitment trends relates to initial starting salaries. These differ between different degree subjects. Chart 4.8 outlines the starting salaries of graduates from different university courses. This data shows the salaries graduates are earning on average, regardless of where in the economy they are working.

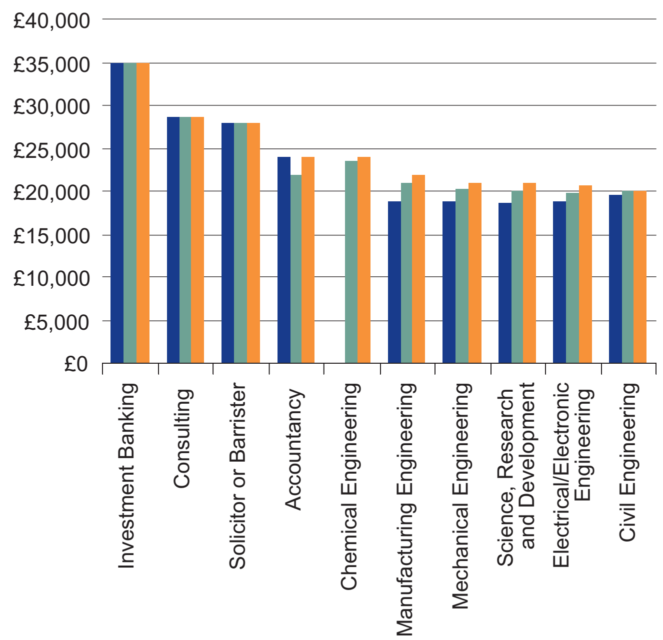
Chart 4.8: What do graduates earn? by subject 6 months after study



Source: HESA (2004)

A striking feature of the data is the fact that 6 out of the top 12 salaries are attributed to engineering courses, with chemical engineering leading the way in third place with a average salary of just over £20,000. This graphic contains data from all students who finished each degree – it may well be the case that some of the engineering graduates are working in other areas. Data published by the Association of Graduate Recruiters (AGR) is useful in that is gives us an indication of the starting salaries of different professions within larger graduate employers. This is outlined in Chart 4.9.

Chart 4.9: Median graduate starting salaries



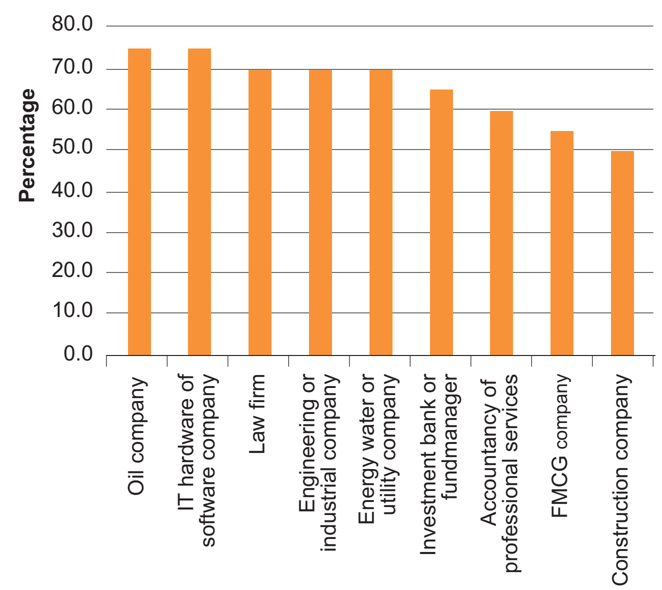
Source: Association of Graduate Recruiters

In the AGR analysis of graduate starting salaries engineering does not perform as well as in the HESA data. Chemical engineering once again leads the engineering disciplines with salaries at £24,000, but this is well below the starting salaries of investment banking at £35,000 and consulting or solicitors salaries at £28,000. In fact the lowest salaries offered by engineering firms are for civil engineering graduates, earning an average of £20,000.

4.4 Graduate Retention Rates

The AGR also look at the issue of graduate retention rates and salary levels five years after initial recruitment. These are outlined in Charts 4.10 and 4.11. The data on retention rates puts engineering at 70%, only slightly lower than the best levels of 75% retention seen in oil companies and IT/software firms. The lowest retention rates are within construction companies at 50% (it must be noted that the job market for construction graduates is particularly fluid, so it is not surprising that they have a low level of graduate retention).

Chart 4.10: Retention rates for graduates 5 years after recruitment

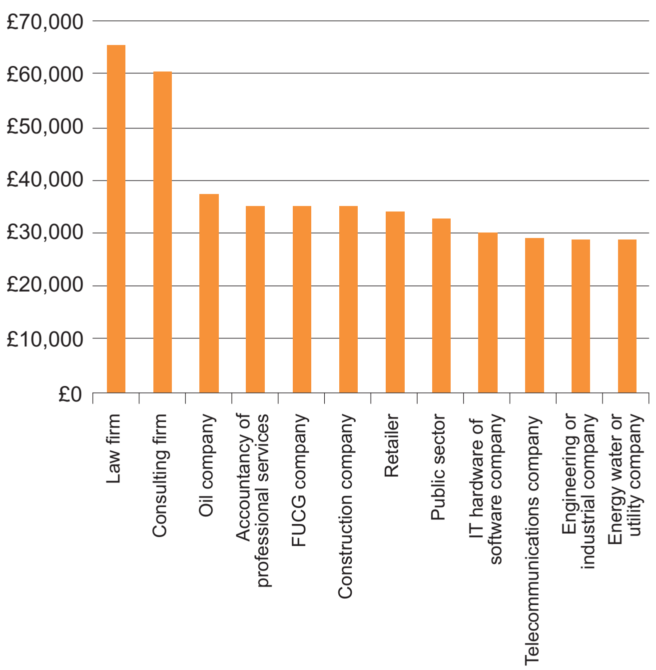


Source: Association of Graduate Recruiters

4.5 Long Term Graduate Salary Levels

The salary rates of those recruited five years previous do not appear to show engineering salaries to be catching up with other graduate salaries. Whilst engineering salaries have increased to an average of £28,500 this is well below those working in law firms and consulting firms (over £60,000) and below the £35,000 level seen by a number of salaries in the oil, professional services and construction sectors.

Chart 4.11: Current salaries paid to graduates employed 5 years ago



Source: Association of Graduate Recruiters

4.6 Summary and Conclusions

> The destinations breakdown for SET shows a diverse picture across the subjects. Engineering and technology see the largest percentage of graduates working in the manufacturing sector (26%), with the second largest group working in finance and business (25%).

> Whilst engineering and technology sees 25% of its graduates entering the field, it is similar for history graduates (24%) and language graduates (24%) – the drain to finance and business is not a phenomenon peculiar to engineering and technology.

> The propensity of graduates to enter careers in professional engineering differs across the engineering disciplines.

> A striking feature of the data is the fact that 6 out of the top 12 graduate salaries are attributed to engineering disciplines, with chemical engineering leading the way in third place with an average salary of just over £20,000.

> Analysis of graduate starting salaries from the AGR shows that engineering does not perform as well as other graduate professions, amongst the membership of the AGR.

5. Engineering Salary Levels

Salary levels are a subject close to the heart of all within the engineering profession. The subject is often the cause of much debate within the profession; traditionally there has been a view that engineers are underpaid. This section attempts to assess whether this is the case by the presentation of engineering salary data.

5.1 New Earnings Survey

Information on the earnings of the UK workforce is collected annually in the UK New Earnings Survey (NES), published by the Office for National Statistics. The published details from the January 2003 New Earnings Survey are given in Chart 5.1 and Chart 5.2.

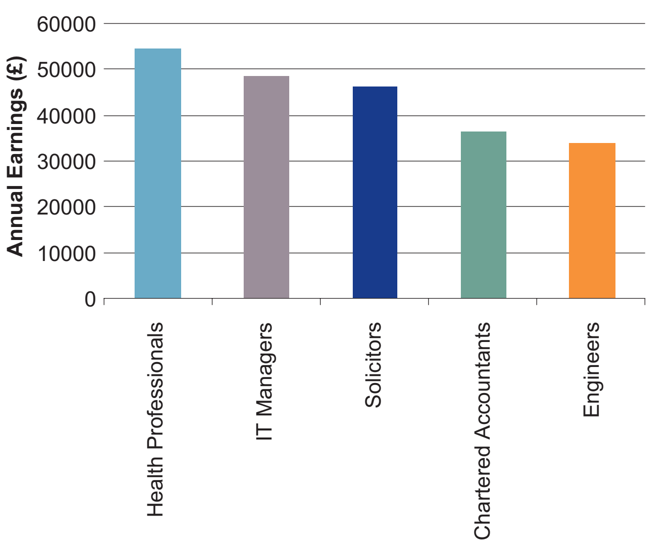
Chart 5.1: Engineering salaries from the new earnings survey

Source: New Earning Survey, ONS (2002)

According to the data presented in Chart 5.1 the average annual gross earnings of professional engineers was £33,300 at the end of 2002. For the purposes of the exercise the data collected focused on the salaries of "professional engineers" – graduates working with skills they have acquired whilst at university.

It is worth noting that there was a spread in the earnings of engineers from software engineers (£37,100) to planning and quality control engineers (£29,100). Chart 5.2 compares the aggregate salary for professional engineers against a number of other professions. Health professionals head the list with average salaries of £54,000, solicitors come in with £45,600, chartered accountants come in at £36,200. In comparison engineering salaries average at £33,300.

Chart 5.2: New Earnings Survey – Comparison of salaries of main professions



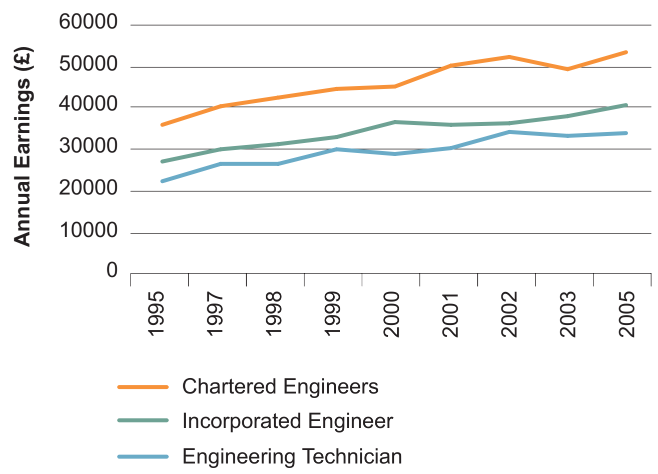
Source: New Earning Survey, ONS (2002)

5.2 etb Survey of Registered Engineers

The engineering salary level of £33,300 outlined in the NES does not present the most positive picture of salary levels for professional engineers. This contrasts with data presented in the Engineering and Technology Board 2005 Survey of Registered Engineers, which put the average annual gross earnings for registered Chartered Engineers in 2005 at £53,000 (this has risen from £49,100 for 2003). This rather large 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 of those surveyed – registration as a professional engineer can happen at a later stage in a persons career. The data contained in the NES includes newly qualified engineers who are years away from professional registration. However it is clear that, whatever the cause, registered engineers earn considerably more than the national average for the engineering profession.

The full salary data from the etb 2005 Survey of registered engineers builds upon salary surveys that were carried out by the Engineering Council. The headline salary figures for average and median earnings of registered engineers and technicians, over the period 1995-2005 are shown graphically in charts 5.3 and 5.4. The average (mean) Chartered Engineer salary was £53,100 (up from £49,100 in 2003), while for Incorporated Engineers it was £40,500 up from £37,800 in 2003. Engineering Technicians' average salary is now £33,800 an increase from the 2003 figure of £33,000.

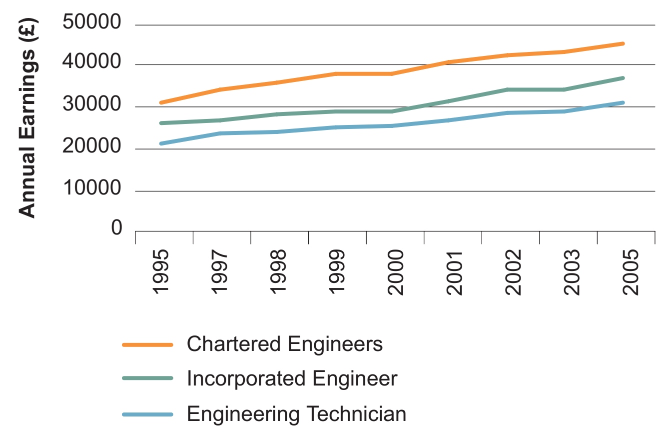
Chart 5.3: Average annual earnings of Registered Engineers and Technicians



Source: Engineering and Technology Board (2005)

The figure for 2005 for Chartered Engineer salaries is a reversal of the trend in 2003 where the survey noted that salaries had actually fallen in real terms. Median salary levels are included in Chart 5.4. 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.

Chart 5.4: Median annual earnings of Registered Engineers and Technicians



Source: Engineering and Technology Board (2005)

The median Chartered Engineer salary in 2005 was £45,500 (up from £43,500 in 2003), while for Incorporated Engineers it was £37,000 up from £34,000 in 2003. Engineering Technicians' average salary is now £31,000 an increase from the 2003 figure of £29,000. Salary figures published in the 2005 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 2003, its members had median earnings of £35,000. This compares directly to the Chartered Engineer median salary of £43,500 for the same time period.

5.3 Summary and Conclusions

- According to ONS data the average annual gross earnings of professional engineers was £33,300 at the end of 2002.
- This contrasts to data presented in the Engineering and Technology Board 2005 Survey of Registered Engineers, which put the average annual gross earnings for registered Chartered Engineers in 2005 at £53,000.
- The median Chartered Engineer salary in 2005 was £45,500 (up from £43,500 in 2003).
- Figures published by the Royal Institute of British Architects (RIBA) show that over the year to April 2003, its members had median earnings of £35,000. This compares directly to the chartered engineer median salary of £43,500 for the same time period.

6. Professional Registration

The promotion of professional registration within UK engineering is a vital mechanism for maintaining and advancing the status and prestige of UK engineering. This section looks at trends in the uptake of professional registration. The material is sourced from the Engineering Council UK (EC^UK) register of professional engineers.

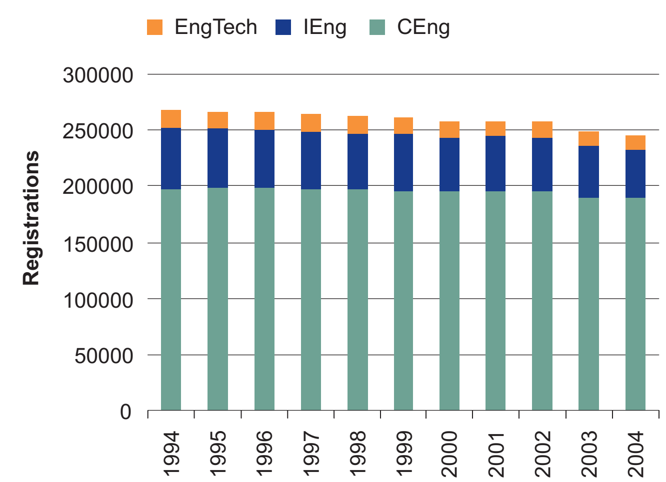
6.1 The EC^UK Register of Engineers

The Engineering Council UK (EC^UK) maintains the UK national register of professional engineers and technicians. In 2005 there were 36 licensed engineering Institutions who had satisfied EC^UK's requirements for membership standards and who therefore were able to submit their members for registration. To gain registration, individuals must demonstrate competence underwritten by education, training and responsible experience, as set out in UK Standard for Professional Engineering Competence (UK-SPEC). Members can be entered in one of three categories on the register: Chartered Engineer, Incorporated Engineer and Engineering Technician.

6.2 Registered Engineers

The total number of registered engineers in each of the last ten years are outlined in Chart 6.1. The total number of registrations has declined from just over 267,200 in 1994 to just under 244,900 in 2004, representing a fall of 8.3% over the decade.

Chart 6.1: Total registrations

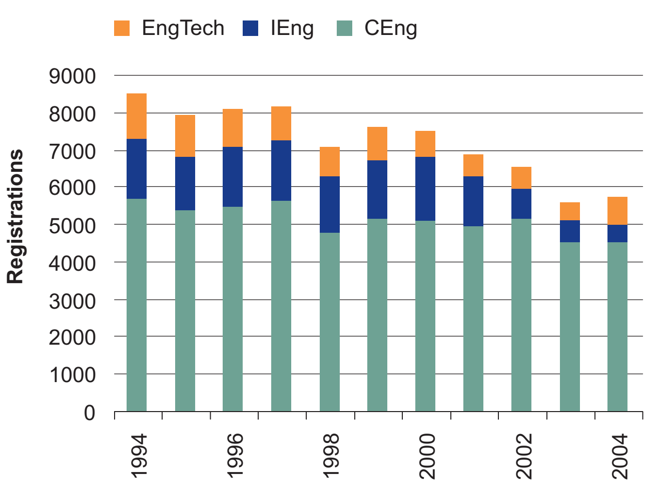


Source: EC^UK

Chart 6.1 also details the breakdown between the three categories of registration. The majority of those registered with EC[UK] are Chartered Engineers. Over the last ten years, the numbers registered have fallen from 197,400 to 189,400 by the end of 2004, representing a fall of 4.1% over the last ten years. Larger declines have been recorded on the other two categories of registrant. At the end of 1994 there were 54,100 Incorporated Engineers but by the end of 2004 there were 42,900. This represents a fall of 20.7%. At the end of 1994 there were 15,700 Engineering Technicians but by the end of 2004 there were 12,600, a fall of 20.25% over ten years.

Chart 6.2 shows the numbers of new additions to the Register annually for the last decade.

Chart 6.2: New registrations



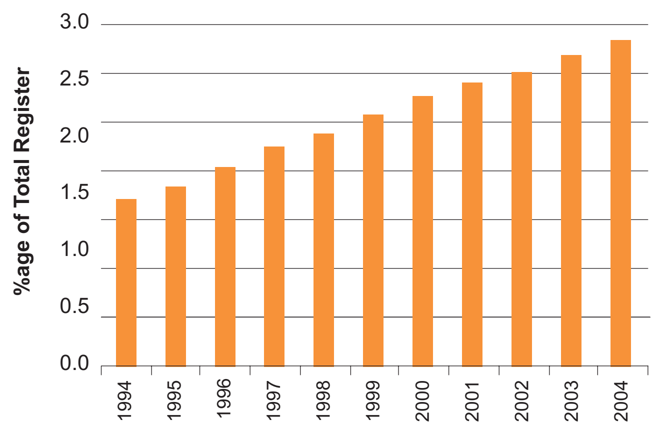
Source: EC[UK]

The picture outlined is one of falling new registrations in the last decade amongst all three categories of registration. However, 2004 saw an increase in new registrations, a reversal in the trend for the first time since 1999.

6.3 Female Registrations

Chart 6.3 shows the percentage of female registrants over the last decade.

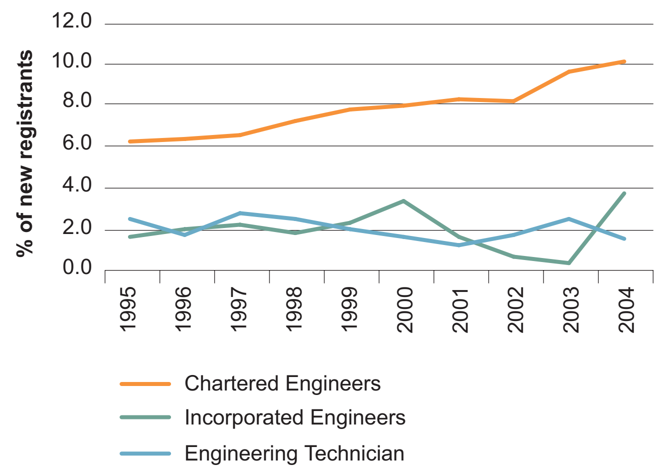
Chart 6.3: Female Registered Engineers



Source: EC[UK]

Encouragingly the trend is a positive one with an increase from 1.4% in 1994 to 2.8% in 1994, although it must be stressed that this increase must be put into perspective; female registrations are starting from an extremely low base. Chart 6.4 looks at the percentage of females as a percentage of new registrations. Here the trend is more positive with increasing numbers of women choosing to seek professional registration, particularly at Chartered level.

Chart 6.4: Percentage of new registrants who are women



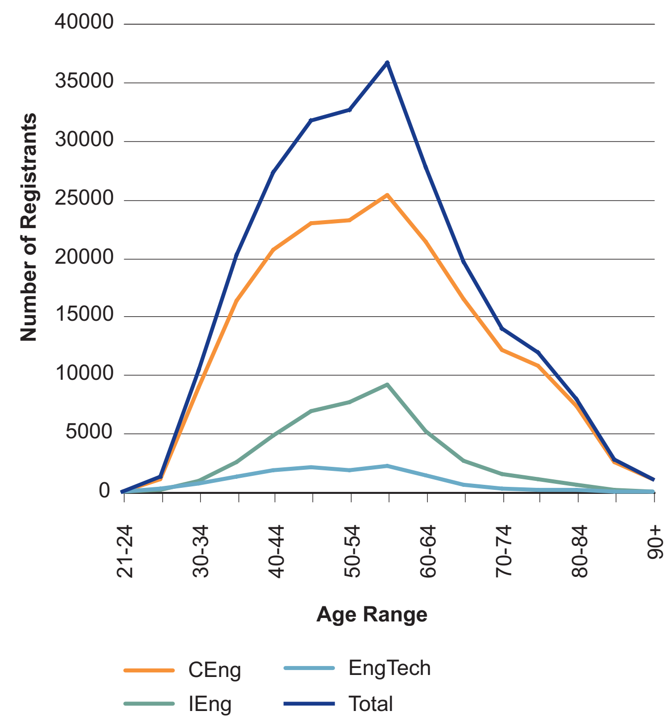
Source: EC[UK]

Chartered Engineer registration saw a positive increase with over 10% of new registrants being female in 2004. Given time this trend should assert itself into the total registration figures, with an increasing percentage of women on the register. However, this increase in the percentage of new registrants must be put into the context of a long term decline in total numbers of new registrants.

6.4 Age Profile

The age profile of those registered as engineers and technicians in 2004 is shown in Chart 6.5.

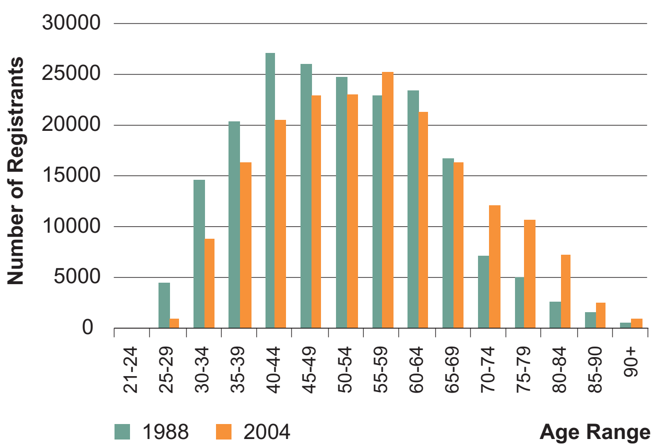
Chart 6.5: Registrants age profile 2004



Source: EC[UK]

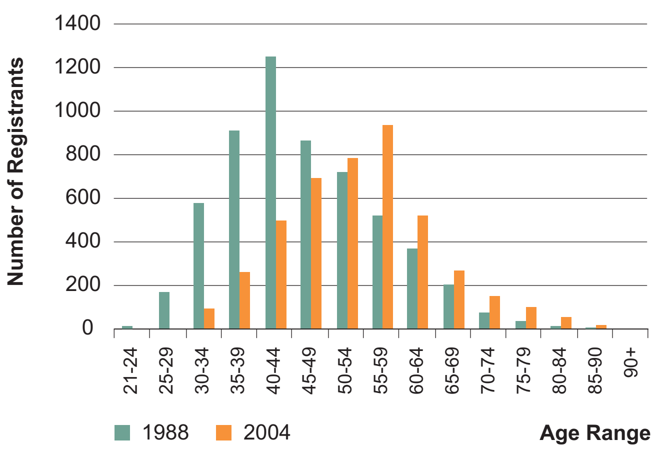
The overall age profile of registered engineers in 2004 has a median age of over 50. Comparing the age profile of registered engineers in 2004 to that of 1988 provides a picture of the changing age profile over time. Age profiles for the three categories of registration are shown in Charts 6.6, 6.7 and 6.8.

Chart 6.6: Chartered Engineer – Age profile 1988/2004



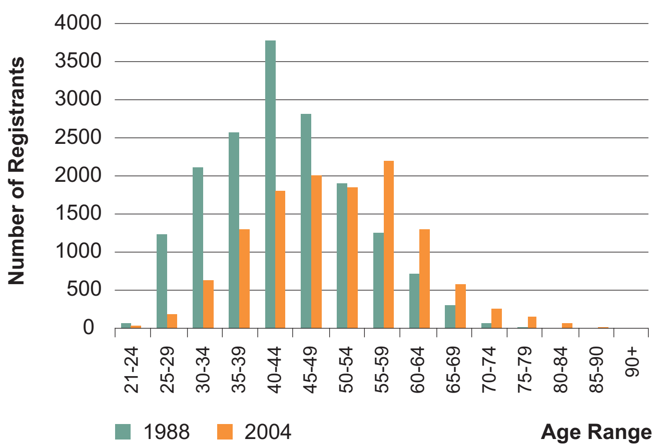
Source: EC[UK]

Chart 6.7: Incorporated Engineer – Age profile 1988/2004



Source: EC[UK]

Chart 6.8: Engineering Technician – Age profile 1988/2004



Source: EC[UK]

These three age profiles clearly demonstrate that the average age of registered engineers is increasing. This is obviously related to the long term decline in new registrations (see Chart 6.2) however the recent upturn in new registrations would have to continue for some time if a more evenly distributed age profile is to be achieved.

6.5 Summary and Conclusions

- The total number of registrations has declined from just over 267,200 in 1994 to just under 244,900 in 2004, representing a fall of 8.3% over the decade.
- New registrations fell over the last decade amongst all three categories of registration. However, 2004 saw an increase in new registrations, a reversal in the trend for the first time since 1999.
- The overall age profile of registered engineers in 2004 reflects their median age of over 50.
- The average age of registered engineers is increasing.

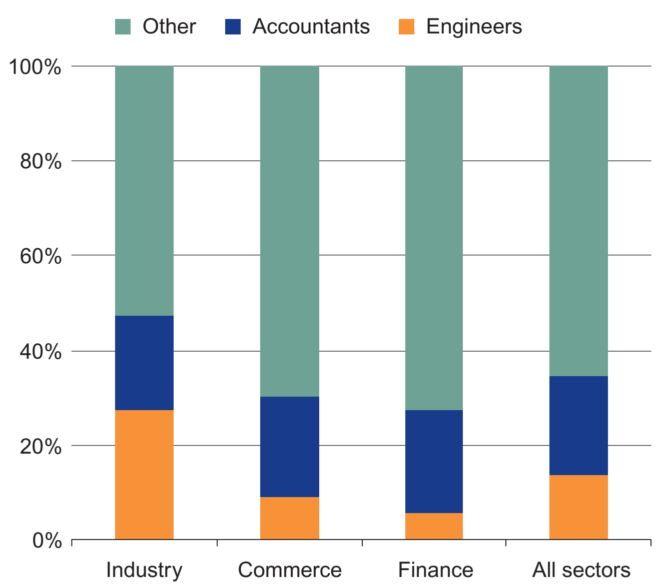
7. Engineers in the Economy

Engineers have a great deal to offer UK industry; as a result engineers are found across UK industry. This section 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 Heading the FTSE 100 Companies

Research jointly commissioned by the Engineering Council and the Royal Academy of Engineering in 1997 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 1 December 1997. The findings indicated that 16% of directors of FTSE 100 companies with a first degree had studied engineering. This was marginally higher than the proportions who had studied science subjects or economics. When professional qualifications were considered, professionally qualified accountants outnumbered professionally qualified engineers 3:2 on all FTSE 100 boards, though within the industry sector 28% of directorships were held by engineers compared with only 20% by accountants. This data is presented graphically in Chart 7.1.

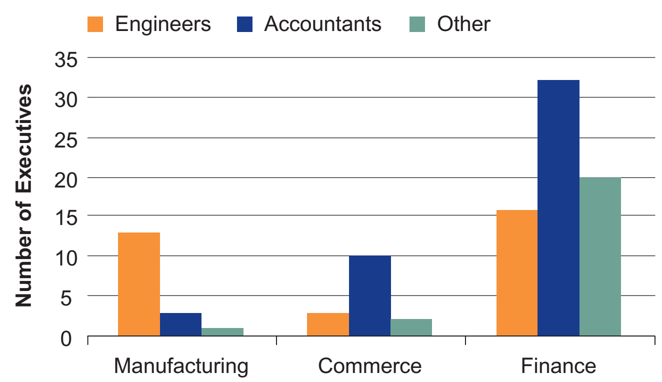
Chart 7.1: Directorships of FTSE 100 companies by subject of director's qualification



Source: Engineering Council / Royal Academy of Engineering (1997) IER: Engineers in Top Management

When the sample was narrowed to the top or chief executives, qualified engineers outnumbered qualified accountants. Of the one hundred top executives, 17 held engineering qualifications, as opposed to 15 with accountancy qualifications. Within the manufacturing sector, the proportion of the top executives who were qualified engineers was as high as 41% (accountants made up only 9%), and even within the finance sector, where only one top executive was an engineer, no more than two were accountants (see Chart 7.2 for further details).

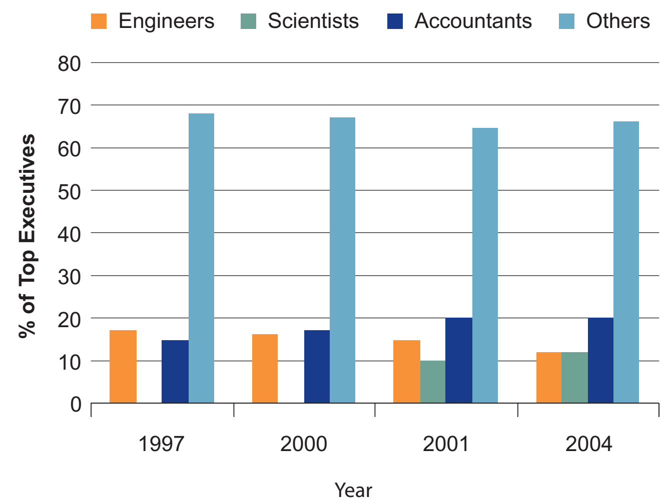
Chart 7.2: Top executives of FTSE 100 companies by discipline



Source: Engineering Council/Royal Academy of Engineers/IER 1997

The Engineering Council UK and the Engineering and Technology Board up-dated the FTSE 100 top-executive study in 2000, 2001, and 2004. The results of these studies are included in Chart 7.3. The trend suggests a falling number of top executives with engineering qualifications, from 17 in 1997 to 12 in 2004. In comparison the number of accountants has increased over the same period from 15 to 20.

Chart 7.3: Top executives of FTSE 100 companies



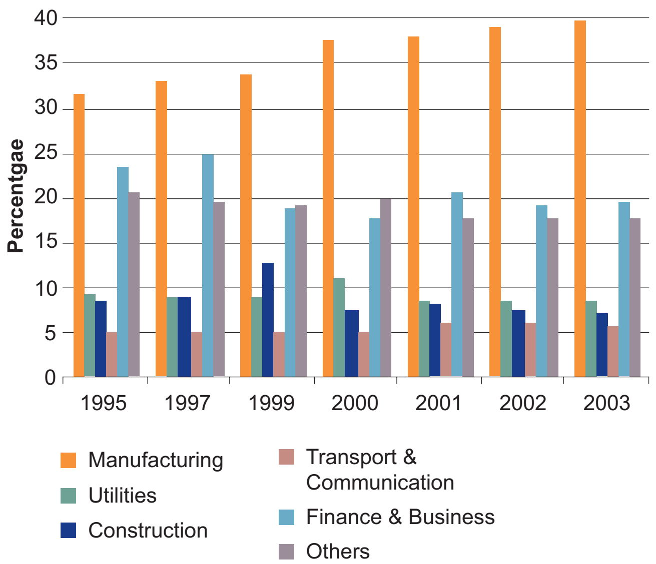
Source: Engineering Council/Royal Academy of Engineers/IER 1997, 2000, Engineering Council UK 2001 and Engineering and Technology Board 2004

It must be stressed that this analysis was based on the university qualifications of the companies top executives – many of whom specialised in different subjects after entering the workforce – 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 anyway, it is in manufacturing companies that engineers are most likely to have achieved a top position. It is important to note that 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 Engineering Council UK was collected as part of the Engineering Council Surveys of Professional Engineers and Technicians and the Engineering and Technology Board Survey of Registered Engineers, carried out between 1995 and 2003. This data is summarised in Chart 7.4.

Chart 7.4: Professional engineers by industrial sector



Source: Engineering Council and Engineering and technology Board (1995-2003)

The most striking feature from the surveys is that the manufacturing sector still dominates the employment of registered engineers. The spread of employment in manufacturing ranges from 32% in 1995 to 40% of employment in 2003. For 2003 the remaining 60% are spread throughout all other sectors of the economy. Notably, finance and business services (which includes engineering consultancy) accounts for the employment of 20% of registered engineers, a figure which has remained steady since 1999. This chart, more than any other information available at present, 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 profession but is unlikely ever to be achieved in the current policy environment. For example registered Chartered Engineers and Incorporated Engineers may only represent about 25% to 40% 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 2001; a net total of 425,000. The total number of UK based Chartered Engineers and Incorporated Engineers working in the UK in 2001 was 158,000. If we assume that the Labour Force Survey figures, include 5% non-UK nationals (in line with the 5% of registered engineers who are not from the UK) then we arrive at a ratio of 158,000 over 404,000 which suggests that only 39% of UK engineers are registered. Efforts are being made by the Engineering and Technology Board, the Engineering Council UK and the professional engineering institutions to promote registration and increase the number of registered engineers.

In 2001, the Engineering Council UK obtained a large matrix of data analysing specific jobs by the Standard Occupational Classification (SOC) and by Standard Industrial Classification (SIC). This data was provided by the Office of National Statistics Labour Force Survey. The analysis suggested that 2.4 million people work in the engineering sector in the UK, however the Engineering Council UK went onto say 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”. Although likely to exaggerate total numbers, there are undoubtedly difficulties using official UK Labour Force Survey data. However, a wider analysis of the Labour Force Survey data using an expanded list of roles based on the Standard Occupational Classifications may permit future Labour Force Surveys to reflect the full universe of engineering roles.

7.4 Manufacturing and The Wider Economy

As noted above, engineers and scientists work across most major sectors of the economy. The latest figures show that nearly 60% of the UK’s exports of goods and services are of manufactured goods – products which are heavily reliant upon the skills and knowledge of scientists, engineers and technologists. The importance of engineering and science to the UK economy was reinforced by work carried out by the Engineering and Technology Board, which highlighted that science, engineering and technology intensive sectors of the economy accounted for over 27% of UK GDP in 2003. Looking at the make up of the economy from an economic account perspective, as defined in the ONS national accounts, manufacturing, production and construction industries combined accounted for 26% of GDP in 2003.

7.5 Summary and Conclusions

- The number of top business executives with engineering qualifications in FTSE 100 companies fell from 17 in 1997 to 12 in 2004.
- The manufacturing sector still dominates the employment of registered engineers. The proportion of employment in manufacturing rose from 32% in 1995 to 40% of employment in 2003. In 2003 the remaining 60% are found throughout all other sectors of the economy.
- Estimates suggest that only 39% of UK engineers are registered with the Engineering Council UK.
- Science, engineering and technology intensive sectors of the economy accounted for over 27% of UK GDP in 2003.

8. Public Perceptions of Science, Engineering & Technology

There is a view that the general public have an inaccurate perception of science, engineering and technology. However, much of this view is based on anecdotal evidence. This section attempts to inject more rigour into the debate by reviewing the findings of a number of studies which have looked at the general public's perceptions of science, engineering and technology.

8.1 Introduction – Perceptions of Science, Engineering and Technology

The UK economy requires significant numbers of scientists and engineers if it is to function well. There are many influences on the decisions by young people to enter these professions. Public perception of science and engineering is clearly a significant factor and has been the subject of a number of recent studies; including one by HM Government Office of Science and Technology and one by the Engineering and Technology Board.

This section reviews the findings of these two studies, then looks at how the career choices of young people are influenced, and the importance of perceptions of science, engineering and technology (SET) on these. The majority of perception studies have tackled the issue of perceptions by addressing different segments of the population. We begin by first examining adult perceptions followed by a look at the views of teachers, and registered engineers, and ending with a review of the perceptions of young people.

8.2 Adult Perceptions of SET

Our starting point is the Finniston Report (1980) which looked at adult perceptions of the engineering profession during the late 1970's. The main conclusion was that professional engineering was seen as more suitable for men, with only 25% of respondents rating engineering as a very good career for women; compared to 60% for men. Table 8.1 outlines how adults rated professional engineering as a career for young people.

Table 8.1: How would you rate professional engineering as a career for a young person?

	Career for a man	Career for a woman
Very good career	60%	25%
Good career	33%	31%
Neither good nor poor career	4%	16%
Poor career	1%	20%
Very poor career	-	5%
Don't know	2%	3%

Note: The response was almost identical from both male and female respondents

Source: Finniston, HMSO, January 1980.

Finniston (1980) also reported that adult impressions and perceptions of professional engineering were very favourable; 68% of respondents at that time thought that professional engineers "did a lot to help the economy of this country". Four out of five respondents also suggested that "Britain needs to develop science and technology in order to enhance its national competitiveness". The Finniston report provides a useful historical benchmark of adult perceptions of engineering and can be compared to more recent studies.

Over two decades later the UK government's Office of Science and Technology took part in a collaborative project with the Wellcome Trust (2000) and commissioned a study examining public attitudes to science and engineering. Table 8.2 outlines some of the findings of the study which indicated that females regard engineering nearly as good a career as males, a great change to the situation reported by Finniston (1980), where engineering was seen as a more suitable career for men rather than women.

Table 8.2: Is a career in science/engineering considered to be a good choice?

	% All	% Male	% Female
Yes	74%	75%	72%
No	4%	5%	3%
Don't know	22%	20%	24%
Not stated	-	-	-

Source: OST / Wellcome Trust (2000)

67% of OST/Wellcome respondents agreed that science and engineering benefited the UK economy (Finniston 68%). The later study also asked the public to describe engineers, with the results indicating little change from Finniston; engineers were still viewed as intelligent, logical, methodological, rational, responsible, enquiring, but mostly male (see Table 8.3).

Table 8.3: Words to describe characteristics of engineers

Percent of all respondents

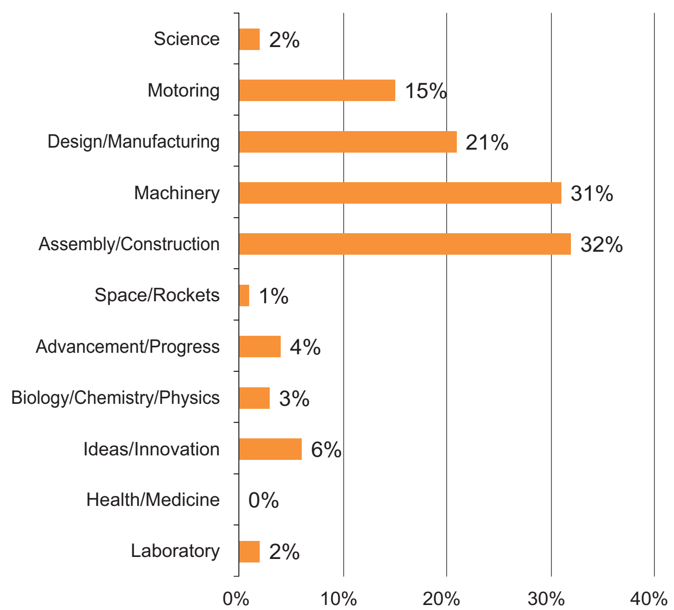
All respondents 2000	Total	Male	Female
A Intelligent	54%	55%	54%
B Logical	36%	37%	35%
C Methodological	32%	33%	30%
D Male/Mostly male	31%	30%	31%
E Responsible	27%	28%	26%
F Rational/Logical	26%	27%	25%
G Enquiring	23%	26%	21%
H Largely funded by industry	21%	24%	19%
I Objective	16%	19%	14%
J Independent	13%	16%	10%
K Friendly	11%	10%	11%
L Socially responsible	11%	11%	11%
M Honest	10%	11%	9%

Source: OST / Wellcome Trust, 2000

One notable difference between the two studies was that the latter asked the public about their views on science and engineering rather than solely engineering. One point of concern in OST/Wellcome (2000) was a divergence of opinion between older respondents and their younger counterparts – the latter having a much less positive view of science and engineering.

The Office of Science and Technology updated their 2000 study in 2005. An element of the research explored the public's image of science, scientists, engineering and engineers. One of the main findings of the research was the fact that the term 'engineering' evoked different associations from 'science', with the former being associated with artefacts, whilst the latter was more concept based. The adults surveyed were asked to describe words they associated with engineering and engineer. These are shown in Chart 8.1 and 8.2 (see below).

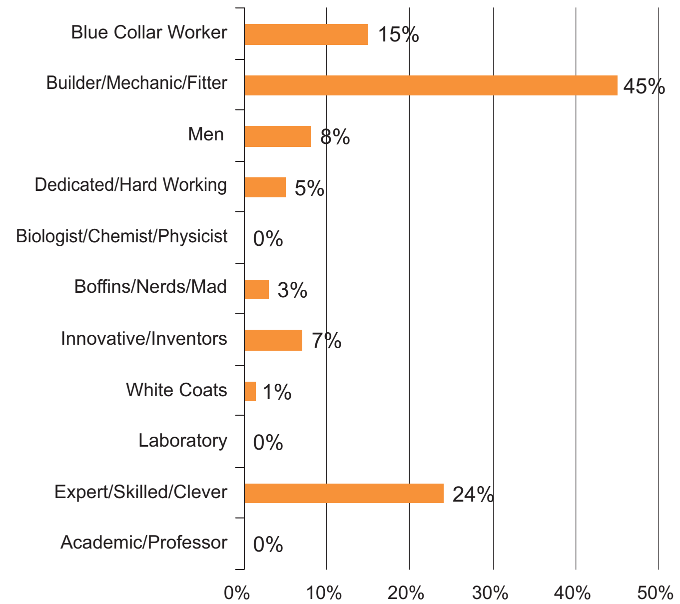
Chart 8.1: Words associated with engineering



Source: OST (2005)

The research indicated that the general public most commonly linked engineering with construction, design and machinery. Engineers were widely seen as involved in practical trades, and are seen in a number of occupations from civil engineers to ship builders and car mechanics.

Chart 8.2: Words associated with engineer



Source: OST (2005)

In contrast scientists were most commonly seen as academics or researchers, and on many occasions were seen in terms of their intelligence and education – although the stereotype of the scientist in a white coat was still held by a minority of those surveyed. One of the key findings of OST (2005) was the identification of a mismatch between the general public's view of the engineering profession and the reality for engineers in the 21st century. On the whole the public's perception of engineering was identified as outdated and based on preconceptions more akin to a view of engineering as manufacturing, from the 1960s and 1970s. This finding is important as it highlights a need for a realignment of the public's view of the engineering profession. The research also provides an indication that the public have a more accurate understanding of the role of science and scientists than is the case for engineering and engineers. In addition the research provides a useful benchmark of public perceptions on which future studies can be compared.

8.3 International Comparisons of Adult Attitudes to SET

The prestige associated with different occupations has been examined in both the USA and Europe. Taylor (2002) highlighted the US public's positive view of scientists, ranking them first amongst 17 occupations in terms of prestige. The engineering profession ranked seventh in the same study (see Table 8.4).

Table 8.4: Prestige of various occupations: 1997-2002

Occupation	1997	1998	2000	2001	2002
Scientist	51	55	56	53	51
Doctor	52	61	61	61	50
Military officer	29	34	42	40	47
Teacher	49	53	53	54	47
Police officer	36	41	38	37	40
Priest/minister/clergyman	45	46	45	43	36
Engineer	32	34	32	36	34
Architect	NA	26	26	28	27
Member of Congress	23	25	33	24	27
Athlete	21	20	21	22	21
Entertainer	18	19	21	20	19
Journalist	15	15	16	18	19
Business executive	16	18	15	12	18
Lawyer	19	23	21	18	15
Banker	15	18	15	16	15
Union leader	14	16	16	17	14
Accountant	18	17	14	15	13

Source: Taylor (2002) The Harris Poll, survey conducted by Harris Interactive, August 15-19, 2002.

Although the public accorded less prestige to engineers than scientists, doctors, military officers, teachers, police officers and the clergy, engineers did command more respect than ten other occupations.

The 2001 Eurobarometer survey (European Commission, 2001) was conducted in all member states of the European Union. The study suggests that that the three professions held in highest esteem by the European public all had a scientific or technical dimension: doctors (71 percent), scientists (45 percent), and engineers (30 percent). The results from the survey reflected an earlier study carried out in 1992. In comparison the two studies highlight the high profile for the scientist in both the US and in Europe. One interesting aspect differentiating the two studies was the higher respect offered to engineers in the US (34%) than that seen in Europe (30%).

8.4 Teachers Perceptions of Engineering as a Career

Research commissioned by the Engineering and Technology Board (2003a) examined the differing views of engineering held by teachers and how they view engineering as a career option for their pupils. The project looked at the views of teachers through a combination of teacher focus groups, followed up by interviews with Government officers, SETNET co-ordinators, Higher Education Institutions, school-industrial link agencies and Class Tutors. The final stage of the study was a questionnaire survey which was sent out to teachers.

The study indicated that science, technology and mathematics (STM) teachers were unclear about how pupils could go on and become engineers, and what qualifications were best suited to this. Both STM and non-STM teachers had positive views on engineers, namely that they are problem-solvers, team players and are financially well-paid. Conversely, they also saw engineering as a dirty, old-fashioned and predominately male career. Also many teachers assumed that engineers would be graduates, rather than entering the profession as technicians or technologists. Most teachers were unclear about different engineering sectors. Most of the respondents were unaware of new developments in engineering, apart from those that related to the school curriculum.

One interesting element in the findings was that teachers felt that STM subjects could be taught in a more "engineering friendly" way, if it were not for time constraints. They strongly supported the idea that STM teaching should promote the skills, understanding and capabilities which tomorrow's engineers will need. Problem solving, mathematics skills, practicality and logic were judged to be the most important qualities for an engineer. Although the teachers recognised the importance of engineering, there appeared to be many difficulties in supporting potential students: communications between schools and industry are not well-used: links between different subjects within schools are often poor; and teachers' understanding of how their subjects link with careers in engineering are lacking, or need to be up-dated. Finally, the study focused on particular factors which teachers felt were blocking the pursuit or promotion of careers in engineering and while there was general agreement that these blockers existed, teachers felt that it was not their job to tackle them, since they have no obligation to promote careers. The study found that, while everyone could agree on how unblocking could take place, or even what these steps should be, teachers did not see themselves as the main agency for these changes.

8.5 The views of Registered Engineers

In the recent past, two questions in the large biennial Engineering Technology Board/Engineering Council Survey of Registered Engineers has sought registrants' views on engineering as a career for young people. In 2001, over 70% of respondents said they would recommend engineering as a career to a young man, and 66% would recommend it to a young woman (see Table 8.5).

Table 8.5: Would you recommend engineering as a career (%)

	To a young man	To a young woman
Yes	71.1 (67.4)	65.8 (61.6)
No	22.1 (24.6)	25.4 (28.8)
Don't know	6.8 (8.0)	8.8 (9.7)

Source: The Engineering Council's 2001 Survey of Registered Engineers

Note: 1999 figures are in brackets

The main reasons registrants took up engineering as a career were because they enjoyed problem solving and were good at mathematics and science (Table 8.6).

Table 8.6: Please state the main reason why you took up engineering as a career (%)

Influence of family or friends	13.0 (11.9)
Desire to help society	1.6 (1.5)
Desire to be creative/enjoyment of problem solving	42.5 (41.7)
Desire for a career change	1.2 (1.0)
Good at maths and sciences	24.9 (25.7)
Financial rewards available	0.7 (0.8)
Good employment prospects	10.2 (11.1)
Good career development opportunities	5.8 (6.3)

Source: The Engineering Council's 2001 Survey of Registered Engineers

Note: 1999 figures are given in brackets

Interestingly women registrants were significantly more likely than men to recommend engineering to young people of either sex. The principal motivating factors in all cases were the challenge of the job and job satisfaction (Table 8.7).

Table 8.7: Please indicate the main reason why you would recommend engineering as a career (% of those who said they would recommend it)

	To a young man	To a young woman
Challenge	55.1 (51.9)	56.2 (54.2)
Excitement	3.1 (2.9)	2.8 (2.9)
Pay	1.7 (1.6)	1.7 (2.0)
Satisfaction	39.6 (43.1)	38.0 (39.8)
Status	0.5 (0.5)	1.3 (1.0)

Source: The Engineering Council's 2001 Survey of Registered Engineers

Note: 1999 figures are in brackets

However, it is also worrying that nearly 25% of respondents would not recommend engineering at all as a career, and that 'excitement,' 'pay' and 'status' were hardly mentioned as reasons by those who would recommend it. This is in contrast to the views of young people on careers which seem to focus more on pay and status as a factor in career choice.

8.6 The Views of Young People

A careers survey published in 2000 by Roffey Park Management Institute provided further evidence from young people of the unfashionable nature of engineering as a career. Most of the 1,681 14-year olds who responded to the survey were unwilling to consider careers in finance, commerce, manufacturing and engineering. Instead they largely preferred jobs in art and design or entertainment. A third of respondents specified as their top choice or "dream job" as a career in the entertainment or leisure industry. Art and design came second with 8.4% of the nominations. Less than 2% chose engineering as a "dream job". However engineering did marginally better when respondents were asked to consider a realistic job choice, a "realistic occupation" rather than a career choice that was preferred but not realistically obtainable. The most popular "realistic occupation" was that of designer, including fashion and interior design. The occupation of teacher came second and that of doctor or nurse third. 10% chose a job in entertainment as "realistic" while 8.4% chose art and design. Fewer than 5% gave engineering as a "realistic" choice of occupation.

In 2001 SEMTA commissioned a survey of secondary-school age pupils in years 7-11; looking at their attitudes towards engineering as a career. The survey (SEMTA, 2001) found that 8% of pupils would choose a career in engineering, though the majority of these were boys: engineering careers were the preferred choice of 17% of boys but only 1% of girls wanted to become engineers, and only 6% felt they were very likely to consider engineering as a career; this is reflected in Table 8.8 and 8.9.

Table 8.8: When you have finished your education, which two of the following jobs, if any, would be your preferred choice? (%)

	Male	Female	Total
Professional sportsperson	27	8	18
Lawyer	14	20	17
Vet	8	21	15
Army/Navy	22	6	14
Teacher	6	20	13
Accountant	11	10	11
Hotel manager	8	13	10
Policeman	11	6	9
Professional engineer	14	1	8
Scientist	9	4	7
Nurse	1	14	7
Construction professional	9	3	6
Fire brigade	9	2	6
Social worker	1	10	6
Any engineering	17	1	9
None of these	11	17	14

Source: SEMTA: Views of Engineering as a Career, 1998, 2001

Table 8.9: How likely or unlikely are you to consider a career in engineering? (%)

	Male	Female	Total
Very likely	10 (9)	2 (1)	6 (6)
Fairly likely	17 (15)	3 (3)	10 (9)
Neither likely nor unlikely	18 (17)	8 (7)	13 (12)
Fairly unlikely	19 (17)	14 (14)	17 (16)
Very unlikely	30 (32)	68 (67)	49 (49)
Don't know	5 (9)	3 (8)	4 (8)

Source: SEMTA: Views of Engineering as a Career, 1998, 2001

Note: 2001 figures are given in brackets

The girls' disinterest in engineering did not seem to stem from views of engineering as a male-dominated profession (asked if they thought it was 'a job mainly for men,' only a minority of girls agreed, though boys were more inclined to believe so), but might be more closely allied to girls' belief that it was a boring occupation, and one which required work in a dirty environment. The research also indicated that girls appeared more interested in the law and the caring professions.

The study indicated that the majority of pupils felt that engineering was important to day-to-day life and recognised that it was particularly associated with transport, new technology and computing. This is in contrast to the findings of the adult-focused Office of Science and Technology (OST, 2005); it would appear that pupils have a more up to date view of the engineering profession. Other findings dealt with access to careers and other information about engineering. Parents, teachers and the media were most frequently cited as sources of such information, and visits to engineering companies scored the most points for providing pupils with useful information. Even so, pupils on the whole did not think they knew a great deal about engineering.

SEMTA (2001) found that there had been little change in young people's perceptions about engineering since SEMTA (1998). The proportion who considered a career in engineering remained around 15% and predominantly consisted of boys. The research suggested that ethnic minorities were also more likely to find the sector appealing as a career; a finding that needs more analysis due to the diverse views of engineering within differing ethnic groups. A job as a professional engineer was still one of the most popular occupations amongst boys but the appeal of engineering amongst girls continued to be very low. Traditional perceptions of engineering continue to decline among young people. The proportion who associated engineering with a dirty environment fell by four percentage points between 1998 and 2001, but remained over a half at 54%. Engineering was associated with working in factories by a quarter of children, dropping from a third in the 1998 survey.

The study suggested that the main obstacle to enhancing the appeal of engineering was that that young people failed to associate it with the factors they found most important in a job; this was particularly the case with girls. Factors thought to be important included good pay and doing interesting work, an area of obvious focus for future promotional work for the engineering profession. It should also be noted that the study highlighted that pupils in both male and female single sex schools were more likely to be favourable towards engineering.

Although there has been no further update of this SEMTA commissioned research Careers Scotland (2004) sought to analyse factors influencing gender stereotyping of careers and career preferences of young school pupils, aged about 7 to 8 years. The findings of this research, although not nationwide were consistent with the findings of the SEMTA/MORI reports. Jobs found to be persistently gender stereotyped included engineer, plumber and electrician. Few girls felt that they were suited to be, only 10% compared to 63% of boys. Many girls also stated that they would "not at all" like to work in engineering, maintenance and garage work (78%), construction (73%) or transport, wholesale and delivery (70%). Pupils' preferences for future jobs appeared to be related to their father's occupation, but not their mother's, with a higher proportion of pupils whose fathers (or step-fathers) worked in "Managerial", "Professional" and "Associate Professional and Technical" wanting to work in "Professional" jobs.

The views analysed in SEMTA (2001) have been confirmed by recent work from the Engineering Employers Federation (EEF, 2004). The EEF report provided evidence which indicated that young males rate the engineering and manufacturing sector in the top two of fourteen possible industry sectors. However this positive message was tempered by the fact that young women remain unconvinced that a career in engineering and manufacturing is for them. The report demonstrated that gender stereotyping by young females is present in engineering. Future work to rectify this imbalance (14.9% male interest as opposed to 1.2% female interest) will be required if this is to be improved. The study concluded that the perceptions of engineering amongst young people were generally quite good. Most pupils surveyed felt that engineering was a well paid career, clean and with a secure and long term future. However pupils also thought that to be an engineer, one needed to be physically strong and that engineering was a dangerous job. It must be noted that the focus of this work was in the West Midlands; an area with an extensive manufacturing industry. It could be expected that young people in this region would have a more positive and accurate view of engineering due to community exposure to manufacturing firms.

A study of young peoples' values and beliefs in relation to science and technology (Nestle, 2004) provided extra context to the views of young people. It found that a third of boys and girls (35% and 32%) would be interested in careers in science. The most striking feature of the research was that girls who were enthusiastic about careers in science were also the most critical of science; particularly its ethical implications. In comparison boys who would like a career in science, saw it as closely aligned with the popular view of science with a focus on space and technology. The report also indicated that 69% of young people agreed that 'Science and technology are making our lives healthier, easier and more comfortable'.

8.7 Summary and Conclusions

- Adult perceptions of SET are positive – the majority of the adult population feel that science and engineering have a positive impact to make on the UK economy. However when prompted the population have an out of date view of science and engineering.
- The public have a more accurate understanding of the role of science and scientists than of engineering and engineers.
- The United States public appear to have a more favourable view of engineering than their European counterparts.
- Teachers were unclear about pathways open to their pupils to enter engineering careers, and what qualifications were best suited to this. Teachers also saw engineering as a dirty, old-fashioned and predominately male career.
- Research indicates that the majority of young people feel that engineering is important to day-to-day life and recognised that it was particularly associated with transport, new technology and computing. It would also appear that pupils have a more up to date view of the engineering profession.

9. Research on Career Advice & Perceptions of Engineering

Efforts to increase the supply of engineers into the UK economy have focused on the provision of inspiring and accurate career information. This section has reviewed some of the research into the sources of career advice used by young people and the influences they rely upon in making career decisions.

9.1 Foskett and Hemsley-Brown

A report by Foskett and Hemsley-Brown (1997) reported on the perceptions and knowledge of careers demonstrated by pupils aged ten, fifteen and seventeen at schools in the South East and the West Midlands. Through focus group discussions and questionnaires, it analysed attitudes towards nursing and engineering as careers, with a view to increasing the effectiveness of careers guidance to pupils.

This report found that by age seventeen, 7.2% of the pupils had chosen engineering as a career; only finance, medicine and the arts were chosen by more, and the older children were more likely than younger ones to prefer engineering. The main reason for choosing engineering was that respondents were interested in engineering, and that they had a role model, typically a father, who was already working as an engineer. Role models were therefore identified as important influences on the decision to enter into a career in engineering. However, those who had chosen engineering tended not to admit it in group discussions, and a number who had opted for engineering-related occupations (including would-be designers and researchers) did not see themselves as potential engineers.

The principal reason for such behaviour was thought to be engineering's 'negative image,' again largely based on the misconception that it is 'dirty', 'manual', 'intellectually undemanding' or even 'boring' work. However, along with law and sport, when engineering was selected as a career, it was chosen, by over half the people opting for it, on the basis of anticipated enjoyment and interest in the career. The motive of 'helping people' does not appear to be a popular reason for choosing a career in engineering (or science excluding medicine), or for with other career areas such as law, finance and business. On the other hand no one gave 'financial gain' as the main reason for their choice of engineering (or science) or indeed for entering the armed forces, emergency services or veterinary science. But, as previously noted role models were a particularly important influence amongst those who choose a career in engineering.

There was also a perception that even graduates would have to 'work their way up' from manual work, and also that sandwich placements involved 'car-mechanic' types of employment. Younger students' perceptions of engineering were biased towards the low skilled manual, vocational training end of the spectrum of jobs within engineering. However, older children and those of middle class parents were more likely to have personal contact with a professional engineer, and hence to know that engineering was a highly educated, well paid profession.

Foskett and Hemsley-Brown (1997) drew together the key findings of their report in order to identify a number of general principles and models so as to aid their understanding of the formation of how individuals might formulate plans for the future. Both qualitative and quantitative data provided a wide range of insights into how people and students perceive particular careers and use these perceptions in decision making. Various lessons were drawn from this about engineering and it would seem to be the case that the apparent invisibility of careers in engineering has the effect of creating significant mis-perceptions about entry levels and routes, and potential career pathways. Peer pressure prevented some more able students from entering engineering because of the perceived low status. It was seen as important therefore to find ways of enhancing the status of engineering among adults and pupils of all ages, not only among those who might consider a maths or science based career. The emphasis on manual work continues to persist and gives the impression that unless students are exceptionally able they will risk entering as a manual worker of some kind and will have to work themselves up from here. This view of engineering is reflected in the recent Office of Science and Technology (OST, 2005) study which highlighted inaccurate perceptions of the engineering profession. Young people on the whole had no notion of the entry point for graduate engineering, or the middle range of jobs found in engineering. Again, the youngest of pupils were most likely to think that engineering was manual labour and is therefore to be rejected. It seems that, unless mis-perceptions of engineering are corrected at an early age, students will be unaware that engineering can be a high status graduate occupation until they are largely committed to another and different career direction. Foskett and Hemsley-Brown (1997) also identified that students did not recognise graduate routes into engineering until they had already embarked on their A-levels; and by then it was often too late to adjust their perceptions.

There have been a number of studies into the effect of careers advice on pupils' choices (e.g. Penn, 2000). Key themes indicate that individuals appear to be influenced by a variety of "significant others", i.e. parents, siblings, relations, friends, teachers and careers advisers. They are also influenced – as are the "significant others" – by general ideas about the worlds of employment, education, training and occupational change. These influences are dependent on the background and environment of individual children. There is however only limited data on how these "environmental influences" relate to future career choices in specific sectors such as engineering, with the focus of much of the work being on gender role models and the influence of social class and job status of the parents.

Although formal career guidance tends not to start until secondary school, it is recognised that career related learning often begins in the primary sector and involves schools working to raise their pupils' aspirations and understanding of society and the world of work (DfES, 2000) There has been some career research relating to younger children, which draws on research into good practice in relation to work related activities in primary schools (DfES, 2000). It notes that "most of the factors unconsciously affecting young people's careers choice are in place by the time they are 13 years old". The report sets out guidance and examples of good practice across all curriculum areas: key messages are about the value of activities that contribute to the pupils' understanding of adult and working life, such as visits to workplaces, visitors talking to pupils about their jobs and the skills required, project work that allows the pupils to apply knowledge and skills in the workplace and school-based projects that raise awareness of the world of work. Findings also suggest that parents became more involved in some activities only when they believe that their children need help – so that in fact the areas in which they get involved may well be the child's weakest areas (Bleeker, 2001).

Decisions about jobs are made at an early age. By late primary school most pupils have rejected most jobs on the basis of their perceptions. These are highly individual and the product of images of jobs they see for themselves, those passed from parents and friends and those from the media. It is not surprising therefore to find that most 16-year-olds pay relatively little attention to information material on careers, either from school directly or from the Careers' Service, when deciding upon their future after the end of compulsory education. Furthermore, where such materials were used, the research indicates that they were not used to influence broad post-16 decisions. Rather young people used them to confirm and reassure themselves about the decisions that they had already made.

More recent work by Foskett for the Nuffield review (2004) looked at 14-19 year olds and the issue of information, advice and guidance on young people's participation decisions. The work identified the importance of informal sources of information and guidance (including parents, friends and the media), over formal sources such as careers teachers and Connexion services. Connexions services are valued more highly than other in-school guidance, which was identified as being subject to spin, in line with a school's priorities rather than the needs of the individual. The need for earlier engagement of young people with understanding of both choice of careers and the nature of the range of career choices was identified as an important theme for future policy development. The work concluded that information and guidance is complicated by the breadth and complexity of choice beyond 16 and by the continuing tension between the need for young people to be informed and advised and the needs of institutions to compete for young people's choices in the education and training market place.

9.2 etb Careers Research

A report commissioned by the etb (2003b) examined the nature of careers guidance literature on science, engineering and technology (SET). A number of familiar themes emerged from the research and some ways of improving the approach to careers advice and guidance were suggested. The report suggested that boys and girls consider certain types of jobs to be specific to one gender from an early age, with parental views having a major influence. Also the view that SET occupations are 'male' tends to put girls off this area of study, while it attracts boys and girls who also perceive SET occupations as being less to do with people and relationships, something which acts as a further deterrent; these themes have been noticed before and are chronicled above. This high level of gender stereotyping was backed up by research by the Equal Opportunities Commission (EOC, 2005), which identified that certain professions, including engineering, had a gender bias which was leading many girls to opt out of engineering careers. The EOC report highlighted that, in particular, work experience opportunities were limiting girls' exposure to engineering careers and that work experience was very influential in career choice.

The etb research also found a new and interesting theme running through current literature on SET career choices, namely the nature of the science and mathematics curricula in England, which are seen as off-putting to children who might otherwise have pursued a SET career. The research suggested that the curricula should be more linked to everyday debates and technologies and less based on abstract theories. The report indicated that formal careers advice could only have a limited impact due to the influence of parents, friends and the media. However, careers advice could be better organised with a more 'joined-up' approach to careers guidance where the many and disparate organisations and individuals involved might be better linked, with more student centred support delivered at the right time for individuals and by an appropriate person. Given that early perceptions and subject choices can serve to block whole areas of SET, it argued that careers advice should challenge assumptions and give early guidance, rather than simply alerting young people to what is available. Finally, while the provision of university careers guidance is seen as excellent, there seems to be less thorough provision for adults. The Connexions programme may address this problem, with internet based advice also helping to deliver more accessible, up-to-date and relevant information. Some of the information found on the internet may however be contradictory.

Two recent projects have been carried out by the etb which have dealt with the issue of career advice and the perceptions of engineering (2005a, 2005b). The first project examined parent's perceptions towards SET careers, and in particular how they influenced their children's decisions about their selection of subjects at school and their child's career choice. Parents reported that their children use a wide range of sources of information to keep themselves informed about a broad range of topics and that these factors collectively influence them. Information sources include media – the internet (which is seen as a major resource); TV and, magazines; friends (another major factor); family; and school. Parents also felt that their influence was more indirect than the influence of teachers or friends on both subject choice and career choice. Parents felt that they played a facilitative role, encouraging their child to select choices that they would enjoy and do well in. Parents supported the idea that they should try to keep their children's career options open as long as possible. Some parents even talked about delaying the choice beyond further or higher education into a gap year. Specialising in any subject areas (such as science or engineering) was seen as something that only a minority of children, who are very clear about their post-education career intentions, would pursue.

Parents did not feel at all informed about SET careers and had limited knowledge about the scale and scope of career opportunities in SET. Parents also felt their information on careers was out-of-date and were unsure where to look for more topical information – apart from a general search on the internet. Parents from across all the groups were unclear about whether SET jobs were in demand or not and not all believed that there were national shortages in SET jobs. Many felt that locally there were few opportunities for SET jobs. Overall, parents were not sure about SET being a long-term career option for their children. Parents in this study felt that career guidance in schools is fairly limited. Parents are largely unaware of what facilities are available in school but are sure that their child has not actively used these facilities to explore different career options. The research suggests caution about an approach that involved developing expensive materials for schools detailing career opportunities within SET. Where materials do already exist and where there are plans to update these, strong visual materials such as DVDs and CD-ROMs would definitely be preferred over written material, especially in the first instance.

Parents are genuinely interested in some of the remarkable achievements of those working in SET industries and it was strongly felt that conveying something of the excitement of the scale and complexity of these achievements would be more attractive than descriptions of the work and possible opportunities.

The second piece of research carried out by the etb (2005b) looked specifically at young people's attitudes to subject choice and SET careers, and how they could be better supported with advice and background relating to career opportunities in SET. The research indicated that two-thirds of students had some degree of interest in SET careers. This suggested that there is a large group of young people who would welcome more information about the wide range of opportunities in that area, to help them decide which, if any, is the right one for them. Other students may have shown a lack of interest because they have misunderstandings about SET careers. Although they may be a more difficult group to attract, it is important that they too are given accurate information which will dispel misunderstanding and may help some to realise that SET is a worthwhile option for them. Students generally appeared to lack knowledge about the variety and range of SET careers, and understanding about what they might involve. They did not realise that engineering, for example, involved skills and knowledge that they already had or would like to acquire, and that its study could lead to an interesting and fulfiling career. This also applied to career opportunities for scientists and technologists. The research indicated that the majority of young people were thinking about future careers when they made their option choices at GCSE. Nearly 80 per cent claimed that they already had an interest in working in a specific area, and they considered that their option choices were appropriate for that area. This emphasises the need to connect with young people early, to provide information about SET careers before they choose a different career path.

9.3 Summary and Conclusions

> Research suggests that the main reason for choosing engineering as a career was that young people were interested in engineering, and that they had a role model, typically a father, who was already working as an engineer. Role models were therefore identified as important influences on the decision to enter into a career in engineering.

> Individuals appear to be influenced by a variety of "significant others", i.e. parents, siblings, relations, friends, teachers and careers advisers.

> Decisions about jobs are made at an early age, at least by Key Stage 3 (Age 11 to 14).

> Information and guidance is complicated by the breadth and complexity of choice beyond 16 and by the continuing tension between the need for young people to be informed and advised and the needs of institutions to compete for young people's choices in the education and training market place.

> Given that early perceptions and subject choices can serve to block whole areas of SET, it is argued that careers advice should challenge assumptions and give early guidance, rather than simply alerting young people to what is available.

> Parents reported that their children use a wide range of sources of information to keep themselves informed about a broad range of topics and that these factors collectively influence them.

> That there is a large group of young people who would welcome more information about SET careers and the wide range of opportunities in that area, to help them decide which, if any, is the right one for them.

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