EngineeringUK

Engineering UK 2009/10

We gratefully acknowledge contributions from

Engineering UK 2009/10 – report
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Engineering UK 2009/10
Foreword
The Rt Hon Lord Mandelson

For centuries, Britain has seized opportunity through its ability to turn scientific and technological innovation into sustainable economic growth. Today, that drive for progress has never been more essential.

As the world's sixth largest manufacturer, a strong engineering base remains integral to us securing competitive advantage in the global economy of the future.

Our transition to a low carbon economy alone makes the next generation of British engineers and scientists potentially among the most important in our history. Standing on the shoulders of Isambard Kingdom Brunel, Hertha Ayrton, Tim Berners-Lee and others, they must transform the way the modern world lives and works.

Thousands of high-quality engineers will be required to make our sustainable future a reality. That growing demand sets us a series of challenges – in education, recruitment and the way we use science to our collective economic benefit.

Building on a decade of strong public investment in our universities, research and science base, the Government set out its approach to equipping our people and British business with the capabilities they need to succeed in Building Britain's Future: New Industry, New Jobs.

The Department for Business, Innovation and Skills is now delivering on that agenda. Bringing forward new frameworks for adult skills and higher education policy that will include tools to track and fill skills needs and demand in our economy, including in science and engineering.

Through the development of our Manufacturing Strategies, increased resources for the Technology Strategy Board and creation of the Strategic Investment Fund, we're ensuring that we can transform more of Britain's knowledge into commercial success. We're also working to increase the finance available to innovative companies through our Innovation Investment Fund and review of capital for fast-growing SMEs.

Most importantly, we need to tackle the misconceptions that still deter too many young people from an engineering career. That's why initiatives like the Big Bang are so important, and we will continue to work with EngineeringUK, the Royal Academy of Engineering and other partners to boost public understanding of the difference engineering makes to our daily lives now and in the years ahead.

This annual report on the state of British engineering will help inform our work to strengthen Britain's engineering for success in the future.

The Rt Hon Lord Mandelson,
Secretary of State for Business, Innovation and Skills

Engineering UK 2009/10
Foreword
Sir Anthony Cleaver

Welcome to *Engineering UK 2009/10*, our annual statistical report on the state of UK engineering. This is the twelfth year we have worked in collaboration with others to provide a comprehensive analysis of supply, demand, education, training and employment trends in the sector. It is also the first year we have taken the name EngineeringUK as the name of our organisation.

One reason for our decision to change our name is the belief that there is a window of opportunity for engineering to raise its profile in this country. The effects of the financial crisis and the growing recognition that the key challenges that face us, from climate change to upgrading our ageing infrastructure, all require the practical solutions that only engineering can provide, have raised public awareness of the importance of engineering dramatically.

We report that 85% of the general public now claim they would recommend engineering as a career to family and friends, up 15% on last year – this surely demonstrates the opportunity we now have to engage and inspire the engineers of tomorrow.

Yet changing our name is just the first of many steps. Our success as a sector and as an organisation depends entirely on collaboration.

The 'about us' section of this report explains in more detail that there have been several significant developments following from this collaboration in the past twelve months. First, The Big Bang Fair, held in the QEII Centre in March, was achieved through the successful partnership of over 50 organisations, spanning government, industry, the third sector and professional institutions. Second, in partnership with the Royal Academy of Engineering, we have formed a new Strategic Delivery Partnership Programme, Tomorrow's Engineers, bringing together five of the leading charities that provide enrichment activities in schools. And third, the 36 professional engineering institutions have come together to form a panel of EngineeringUK to enable coherent communication across the piece. Taken together, these developments mean that the professional engineering community (The Engineering Council, EngineeringUK, the Royal Academy of Engineering, and the engineering institutions) is now confident of its ability to work together in the national interest.

Reading *Engineering UK 2009/10*, you will notice that we have built upon stakeholder feedback following last year's report, producing the most comprehensive report to date, with additional gender, diversity and engineering sub-discipline analyses. In response to those organisations and policymakers that use the report as a strategic resource, you will also notice that this year's report is increasingly contextual.

Engineering has never been of greater importance to society or the UK economy. It forms the bedrock of the UK's manufacturing and construction base, and is critical to the development of new technologies and to solving pressing issues like global warming and infrastructure renewal.

But we still have a long way to go.

When 11–16-year-olds were asked how desirable they believe engineering is as a career, only 15% were enthusiastic. We clearly need to work much harder, using every opportunity we can, to change this perception. One increasingly important avenue is exploiting the various on-line networks and here too we believe that our new name and approach will be a great help.

In providing a robust analysis of UK engineering, *Engineering UK 2009/10* has identified a number of the challenges and opportunities which must be grasped in order to build a productive and resilient economy through engineering. We hope you find the report useful. Please let us know if there is anything we can change or provide for next year. In the meantime, we look forward to working in partnership to promote the vital contribution of engineers, engineering and technology.

Sir Anthony Cleaver,
Chairman, EngineeringUK

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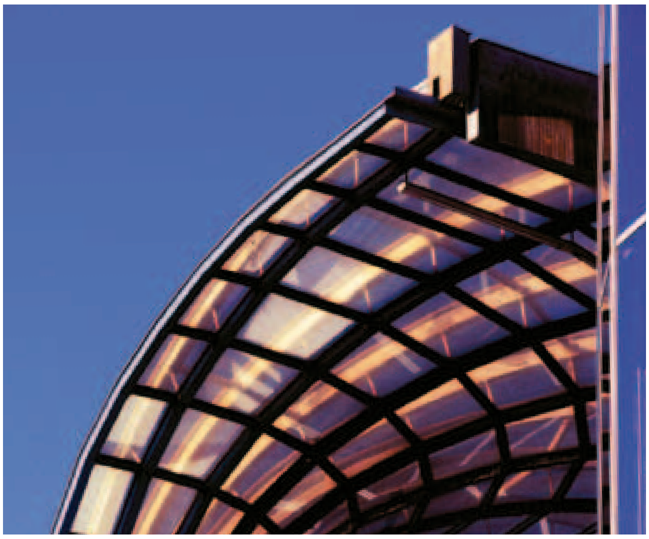
EngineeringUK
About Us



There has never been a more important time for engineering. In the current climate, there is a window of opportunity to raise its profile in a major way and EngineeringUK exists to do just that.

EngineeringUK is an independent, not-for-profit organisation whose purpose is to promote the vital contribution that engineers, engineering and technology make to our society, and inspire people at all levels to pursue careers in engineering and technology.

Formerly known as the Engineering and Technology Board (ETB), EngineeringUK works in partnership with business and industry representatives, education and skills providers, the professional engineering institutions, the Engineering Council, the Royal Academy of Engineering and the wider science and engineering communities, to pursue the following strategic goals:

- To improve the perception of engineers, engineering and technology
- To improve the supply of engineers

Communication is at the heart of EngineeringUK as we work across the UK to engage and inform young people, and those who influence them, of the benefits of engineering careers.

Programme of work

Over the past year we have simplified our work programme to three core strands: The Big Bang; our Strategic Delivery Partnership programme – Tomorrow's Engineers; and our work as a Communications Hub. With a focus on delivering fewer things but with greater impact, we have concentrated on those areas where we can work with our partners to add real value.

The first of these strands, The Big Bang: UK Young Scientists' and Engineers' Fair featuring the National Science & Engineering Competition, was a real success in 2009 attracting over 50 sponsors and 6,500 visitors. The Fair achieved high profile media coverage on GMTV and the Today Programme amongst others. Planning for The Big Bang 2010 is now underway.

The second strand, Tomorrow's Engineers, a joint initiative by EngineeringUK and The Royal Academy of Engineering, has been developed to provide support to a number of organisations currently providing engineering enrichment and enhancement activities. Bringing together a number of organisations which will now reach a further 30,000 students, Tomorrow's Engineers will target hard-to-reach schools across the country.

The third strand, EngineeringUK's 'Communications Hub', has also begun to establish itself, delivering briefing papers and press releases informed by discussions with the Business and Industry Panel, the Education and Skills Panel, the Careers Advisory Panel and the Professional Engineering Panel, as well as holding a number of business, industry and policy discussions and activities at the House of Commons.

EngineeringUK has also developed and managed a wide range of Science, Technology, Engineering and Maths (STEM) websites for different partners over the past year, providing support for the Department for Children, Schools and Families (DCSF) STEM Programme via our involvement in the Careers Awareness work, as well as projects such as STEM Ambassadors, the STEM Directories, Future Morph and the Maths Careers website.

Moving forward

Working in collaboration with partners, we co-ordinate and facilitate a range of promotional programmes to improve the supply and perception of engineers, whilst simultaneously addressing diversity issues in the engineering sector including gender issues via the WISE programme.

The Big Bang

The Big Bang: UK Young Scientists' and Engineers' Fair will take place at Manchester Central Convention Complex, 11–13 March 2010 and will feature the National Science & Engineering Competition. With support from Government, the Northwest Regional Development Agency, Lloyd's Register Educational Trust, AstraZeneca, BAE Systems, Shell and Siemens, amongst others, The Fair will be a three day educational experience for children and young people aged 9 – 19. Showcasing innovation and creativity in all its forms, it rewards science and engineering engagement and achievement through the high profile National Science & Engineering Competition Awards.

This year, as last, the Big Bang kicks off ten days of exciting events celebrating science and engineering across the UK in the form of National Science & Engineering Week (NSEW). Led by The British Science Association with support from EngineeringUK, NSEW engages and inspires children and adults alike to organise and participate in science and engineering events and activities.

The inaugural Big Bang in 2009 set a new benchmark for STEM engagement and aims to at least double its number of attendees in 2010, travelling to different locations around the UK to ensure a truly national reach.

Our ultimate vision for The Big Bang is that every child in the UK should know someone involved with The Fair.

Tomorrow's Engineers

EngineeringUK works in partnership across the UK. This is particularly reflected in our Tomorrow's Engineers Programme, managed jointly with the Royal Academy of Engineering. The programme provides funding, communications and administrative support to organisations currently delivering engineering enrichment and enhancement activities, making for a more targeted and evaluated approach. Current partners include EDT, The Industrial Trust, Primary Engineer, The Smallpeice Trust and Young Engineers, and we are supported by Lloyd's Register Educational Trust.

The aim of Tomorrow's Engineers is to coordinate and expand existing engineering activities working with an extra 30,000 children via a range of organisations, to:

- Address geographical gaps and inconsistencies in current engagement programmes
- Ensure more effective targeting of those schools that have not traditionally been engaged with science and engineering
- Provide support to help existing programmes increase levels of engagement, awareness, promotion, co-ordination and evaluation of activities
- Build closer working relationships between complementary schemes for a more coherent service

Tomorrow's Engineers will also build on the success of the Engineers Make it Happen programme (EMIH) in Wales and Northern Ireland, so taking an increasingly pan-UK approach to enrichment and enhancement activities.

Our ultimate vision for Tomorrow's Engineers is a sustainable programme that can deliver engineering and engagement activities to targeted schools across the UK.

Strength in unity

Engineering has a great story to tell and we are working together to tell it via:

- Business and Industry Panel events, debates and House of Commons lunches
- Education and Skills Panel meetings and papers
- Joint press releases and letters to editors in collaboration with the Professional Engineering Community
- Joint events at the Political Party Conferences
- Joint Consultation responses and other ad hoc responses to engineering policy announcements

We will continue to focus on promoting positive messages about engineering, working alongside partners in business and industry, education and the science and engineering sectors to complement existing cross-community activities such as Engineering the Future.

Acting as a communications hub and using a combination of proactive and reactive media approaches, engagement activities, websites and joint events, we will work with partners across the community and beyond to communicate with and appeal to young people and their influencers. To inform this work, we will continue to seek input from key stakeholders through a number of advisory panels: The Business and Industry Panel, The Education and Skills Panel, The Professional Engineering Panel, and The Careers Advisory Panel, each of which is made up of a number of expert organisations.

Taking advantage of increasingly responsive relationships across the engineering community, we will harness opportunities to promote engineers and engineering to our target audiences by responding with an increasingly unified voice to major engineering announcements.

Our ultimate vision for the communications hub is that the engineering sector speaks with a unified voice so that the benefits of engineering and careers in engineering are widely known across all age-groups.

Underpinning activities

In order to support our core programmes we also provide a number of underpinning activities and resources.

Our primary research output is the *Engineering UK 2009/10* report; an annual statistical guide to the state of engineering and the cornerstone of our wider policy output. Compiled and updated annually, *Engineering UK 2009/10* provides a contextual base for our press and public affairs work, looking at supply and demand issues, skills gaps, emerging technologies, diversity, sector-specific trends, and developments in training and education. Future editions will expand on vocational and a range of other education issues, informing a suite of briefing papers and press releases on topical issues such as emerging technologies and labour trends, and the skills requirements of employers in the current economic climate.

In addition to *Engineering UK 2009/10* and related briefing papers, we also conduct research and analysis into perceptions of engineers and engineering, and provide detailed evaluation for our core programmes.

EngineeringUK also provides a range of on and offline careers resources for young people and their influencers. In the coming year, we will hone and develop these with a view to complementing, supporting and building on recent developments with The Big Bang, Tomorrow's Engineers and community initiatives such as the Department for Children, Schools and Families STEM Programme. In particular, we will:

- Use feedback from our Business & Industry, Professional Engineering and Careers Advisory Panel to promote continued rationalisation of careers resources for the pre-16 age range and their influencers
- Draw on relationships across the engineering community to generate community-wide endorsement and adoption of clear and common careers messages
- Improve links between the Careers and Education and Skills Panels and join up the various activities of the STEM programmes
- Ensure greater integration of careers messages and materials by contributing careers resources, expertise and support from the Careers Advisory Panel through to The Big Bang, Tomorrow's Engineers, and activities such as DCSF STEM Programme and Future Morph.

EngineeringUK

At EngineeringUK we believe engineers and engineering will play a key role in addressing the global challenges of the 21st Century. We also believe that working in partnership can help a good idea go a long way. If you feel the same way, please visit www.engineeringuk.com for more information.

Paul Jackson,
Chief Executive

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Engineering UK 2009/10
Executive Summary

The current economic climate has highlighted the importance of the engineering and manufacturing sectors to the UK. It has also led to wider political, media and public awareness of engineering as a means of rebalancing the economy. Yet, in order to fulfill the popular refrain of 'less financial engineering, more real engineering', and turn the UK into a prosperous, high value manufacturing nation, a number of issues need to be urgently addressed. This report examines the current state of the engineering sector in the UK, the changing face of UK manufacturing, and the challenges and opportunities which lie ahead.

Our report identifies tremendous new opportunities for UK manufacturing in green technologies, reducing waste and hence cost in manufacturing. It also highlights the need for skills training to replenish an ageing skills base which, if left unchecked, will put significant pressure on Further Education (FE) where lecturers are in short supply. By 2017, 587,000 new workers will need to be recruited into the manufacturing sector. In addition the public attitude to engineers is changing for the better, creating a platform for potential public policy changes.

How important is engineering and manufacturing in the UK?

- Based on EngineeringUK's definition of the engineering sector, VAT-registered engineering enterprises had a total turnover in 2008, of £799 billion: an increase of 11.6% on the previous year.
- The UK is the world's sixth largest manufacturer. Manufacturing generated £150 billion for the UK economy in 2008. It accounted for 55% of all exports, 75% of industrial research and development (£22.5 billion) and employed three million people.
- Engineering and technology has been the subject of a number of Government policy initiatives in acknowledgement of the importance of these sectors to the country's economic future – especially during a recession. In particular, the sector looks set to benefit from Government support for power generation, low carbon technologies and other advanced engineering projects.
- In April 2009, the Department of Business, Enterprise and Regulatory Reform (BERR) published *Building Britain's Future: New Industry, New Jobs*, in which it identified several key technologies that should play a larger role in the economy in the future:
  - Advanced engineering
  - Electronics
  - Biosciences
  - Low-carbon technologies
- The engineering research base, which will help drive technological change, appears to be thriving within our Higher Education Institutions. Within the engineering subject area, 59% to 71% of research assessed for the sub-disciplines was classed as being internationally excellent.

What has been the impact of the recession for engineers?

- There has been a short term fall in the overall number of graduate vacancies in the UK, according to the AGR Summer review, with the engineering and industrial sector experiencing a fall of 40.5%. However, the medium to long term projections for graduate level roles remain high.
- Engineers' salaries still compare favourably with pay for other graduate jobs according to the CBI's Education and Skills Survey 2009, with the median salary of a graduate engineer being £22,500.

What is the future for UK manufacturing?

- Currently green technologies are worth £3 trillion to the world economy. There are opportunities to develop global, leadership in this sector creating jobs and wealth for the UK. If we do not develop our own domestic industrial capacity we will risk having to buy in solutions from abroad.
- If the UK is to de-carbonise its energy production then nuclear generated electricity will have a role to play. Building a new wave of nuclear power plants would have considerable economic benefit for the UK.
- 80% of the construction of a nuclear power plant (NPP) utilises conventional construction technology. It is predicted that 70–80% of the construction of NPPs could be sourced in the UK. Building a new generation of NPPs could act as a springboard for UK companies to enter the global supply chain – an opportunity that could be worth £30 billion to the UK economy.
- For innovative companies there are opportunities for major resource savings in manufacturing processes. On average over 90% of the materials used in production are not included in the final product. Companies spend up to 5% of their annual turnover on waste, including unused materials, defects, energy and water. Engineering solutions to these problems could potentially generate a share of £6.4 billion a year in savings through enabling organisations to use resources more efficiently.
- UK manufacturers no longer compete only on price or volume, focusing instead on a broad range of value-adding strategies using intangibles such as branding, customisation, service polices and customer training to add value to the manufacturing process and enable manufacturers to differentiate themselves in a crowded market place.
- Government policy could be adapted to support more SMEs to bid for Government contracts and to incentivise them to invest in technology, research and the workforce. Denmark, Spain and Germany have all pulled ahead of the UK in onshore wind farm technology as a result of providing a long term investment environment which mitigates risk for companies.

What skills will be required to make this happen?

- Working Future III (WFIII) predicts changes in employment for the period 2007–2017. It estimates that, over this period, there will be a net requirement for 587,000 people working in manufacturing. Work by A|D|S predicts that in the aerospace and defence industry, over the next 20 years, close to 60% of the workforce will retire creating a demand for new workers to enter the sector.
- According to WFIII the manufacturing sector is projected to expand over the period 2007–2017 in output terms; however in parallel, efficiency is projected to increase at a faster rate.
- The profile of employees working in manufacturing will change, with significant growth in staff employed as managers/senior officials, in professional occupations and associate professional/technical occupations. At the same time, a fall is forecast in the number of people working in skilled trades and elementary occupations, as well as among machine and transport operatives. Overall there will be a need to recruit new workers at all levels but the proportion of workers at higher levels will increase. Almost 47% of all employees in 2017 will be at associate professional level or higher, compared with just over 32% in 1987.

Is the UK on course to supply these needs?

- Across the science, technology, engineering and maths (STEM) disciplines, 57% to 89% of A level entrants achieved a grade C or above in 2009. Since 2004, this proportion has increased in all subjects, though this year's levels were, for most subjects, consistent with 2008.
- Lifelong Learning UK (LLUK) (2009), with various caveats, reported that there were more than 1.5 million individual learners in the FE sector in engineering-related fields (at all levels) in 2006/07.
- Analysis of LSC data indicates that engineering and technology starts accounted for around a quarter of all apprenticeship starts, with some 35,400 (provisional) starts in engineering and technology sectors, from 1 August 2008 to 31 January 2009. This is out of a total of 140,500 starts across all frameworks and at all levels.
- Only a minority of women gain N/SVQ awards in Engineering and Manufacturing Technologies (EMT) or Construction, Planning & the Built Environment (CP&BE). The gender split for Information and Communications Technology (ICT) N/SVQ awards is more balanced. However, not all these awards will be for ICT *practitioner* skills; many may be for ICT *user* skills.
- Higher Education (HE) applicant numbers are up for most engineering disciplines, with the exception of production and manufacturing engineering, where they continue to fall, by 17% this year.
- STEM degrees account for a quarter of all first degrees achieved: although the number of students enrolling on STEM courses is rising, it is slower than the growth for all first degrees.
- The Destination of Leavers of Higher Education (DLHE) data for 2007/08 shows that 59% of engineering and technology graduates leaving education that year entered full-time paid employment, compared to 55% for all subjects.

What are the challenges ahead for UK engineering and manufacturing?

- According to the Government Actuary's Department the number of 15–24-year-olds is predicted to decline by 8% over the next ten years. In addition it is predicted that by 2010 there will be one million 16–24-year-olds who are not in education, employment or training (NEET).
- Despite the positive results for A levels, it should be noted that currently over half of students with seven GCSEs do not continue their studies.
- In *Engineering UK 2008* detailed analysis showed that the UK economy has a skills shortage of level 3 engineers. Research by Lifelong Learning UK (LLUK) has raised the potential issue that construction and Engineering, Manufacturing and Technology (EMT) have the highest levels of hard to fill vacancies for staff to teach in the whole FE sector. EMT covers a wide range of specialist provision, so it is unlikely that there is a general shortage in this area, however there are likely to be shortages in certain specialist areas.
- Women remain under-represented in the engineering sector. Analysis of new registered engineers and technicians shows that only 11.6% of registrants, in 2008, were female. In 2007, the Equality and Human Rights Commission (EHRC) and the Apprenticeship Ambassadors Network emphasised that (still); "only 2% of engineering apprentices are female, only 4% are from ethnic minority communities and 6% have a learning difficulty, disability or health problem," (EHRC 2007:3).
- Significant numbers of Chartered Engineers and Incorporated Engineers are retiring or approaching retirement and this is reflected in the decline in total registrants in recent years. However, numbers of Engineering Technicians continues to increase, albeit from a lower base.

Changes in perception of engineering

- The Engineers and Engineering Brand Monitor (EEBM) run by the Engineering and Technology Board (now EngineeringUK) has shown a positive shift in public perceptions of engineering between 2008 and 2009. 85% of respondents from the general public stated that they would recommend a career in engineering to their children, friends or family, compared with only 66% in the initial pilot survey in 2008. In addition a higher proportion of the general public now view engineering as a well respected profession (78%), which makes a good contribution to society (86%) and will have a positive impact on our future (91%).
- However despite these positive changes 7–16-year-olds have the least positive opinion of engineering. Art and design was the most popular subject choice among 7–11-year-olds, with design and technology third. However, this group does not tend to associate being an engineer with the designing and creating that they enjoy so much in the classroom.

Engineering UK 2009/10
Conclusions

The engineering and manufacturing sectors are key economic and social drivers for the UK. They contribute £799 billion to the economy and must be well placed to meet the future global technological challenges that lie ahead, such as climate change, low carbon economy, clean water and population growth.

The UK will need to recruit 587,000 new workers into manufacturing over the period 2007–2017. However the profile of workers is predicted to change. Overall, almost 47% of all employees in 2017 will be at associate professional level or higher, compared with just over 32% in 1987. At the same time changing demographics mean the number of 15–24-year-olds will drop by 8% over the next ten years. When coupled with the fact, that by 2010, one million 16–24-year-olds will not be in education, employment or training and that half of students getting seven GCSEs do not continue their studies, there is a clear duty for engineering employers, Government and the education sector to work together to enthuse, train and upskill the future UK workforce while ensuring that a broader pool of talent, particularly women, is also recruited into engineering and manufacturing.

If we are to maintain an adequate future supply of suitably skilled people, the perception of engineering amongst 7–16-year-olds needs to be improved, in line with improvements for older age groups. Specifically we need to link popular school subjects and activities such as art and design to engineering. Crucially the Government, supported by the engineering community, also needs to ensure that there is a core underpinning resource of good quality careers information about the possible qualification routes and opportunities in engineering and technology for young people and those who influence and advise them.

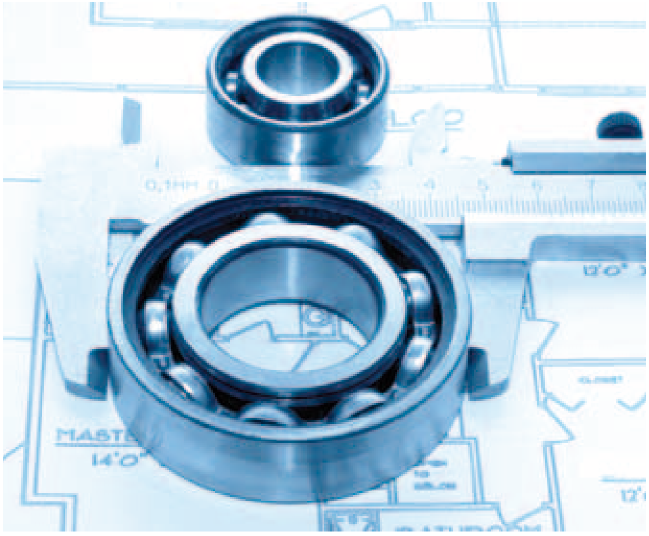
LLUK identified possible lecturing staff skills shortages at Further Education (FE) level in construction and engineering, manufacturing and technology (EMT). The skills shortages within EMT are likely to be in niche areas rather than being generic. However there is a substantial risk that this may affect the ability for colleges to train new EMT students resulting in successful businesses being held back by their inability to recruit adequately trained new staff.

The green economy is currently worth £3 trillion a year and clearly has the potential to generate considerable wealth and employment for the UK economy. For example it is estimated that a new build of nuclear power stations in the UK could be worth £30 billion pounds to the UK economy. At the same time over 90% of the materials used to make a product never make it to the finished article and companies spend 5% of their annual turnover on handling waste products. The sector is currently missing out on a share of £6.4 billion a year in potential savings from using resources more efficiently. In order to realise these opportunities business and government will need to work together. These new opportunities must be pursued in parallel to the existing civil, mechanical and structural engineering where the UK is already globally competitive.

As 58% of VAT-registered engineering enterprises in the UK have fewer than 250 employees, the SME sector is particularly important to the UK economy. Government policy needs to be adapted to support more SMEs to bid for public sector contracts and to incentivise them to invest in new technology, research and their workforce. Additionally all businesses need to invest more in developing and exploiting intangible benefits, such as branding and customisation, to enable them to compete effectively in a crowded market place.

Part 1 Engineering in Context

1.0 Engineering: a sector in the spotlight



Since the last edition of Engineering UK was published in December 2008, engineering and manufacturing have come under the spotlight of Government and policy makers. This is at least one positive of the on-going recession and the retrenchment of the financial sector. Engineering and manufacturing have always been key contributors to the economy and employment. But now, more than ever, it is heartening to see them being appreciated in the corridors of power for the impact they have on the sustainability and social well being of the UK as well.

The scrutiny and recognition these key sectors received during 2009 has been nothing short of remarkable.

In March, the Innovations, Universities, Science and Skills (IUSS) committee produced its report, *Engineering: Turning Ideas into Reality*. The report covered forms of engineering which are of strategic or economic importance to the UK: including nuclear engineering, plastic electronics and geo-engineering. The major focus though was a series of recommendations on how engineering advice could best be provided to the UK Government. The report advocated getting engineers more deeply involved in forming policies from the earliest stages. It called for the civil service to ensure that it is aware of the engineering skills at its disposal and to make more use of the engineering fast stream. It recommended that a Government Chief Engineering Adviser and an Engineering Adviser should sit alongside the Chief Scientific Adviser in each government department. In addition, the report called for increased use of roadmaps to ensure that engineering projects are appropriately planned within Government.

In July, the Cabinet Office Panel on Fair Access to the Professions published its review, *Unleashing Aspiration*. The review noted an overall reduction in UK social mobility and a continuing problem with gender balance. But, despite this climate, it found that engineering came out very well. Initiatives such as STEM Ambassadors and The Big Bang were lauded, as were the great range of routes into the profession.

Also in July, the Department of Business, Innovation and Skills published *Advanced Manufacturing: Building Britain's Future* alongside a package of £150 million of targeted investment.

The final report worth recording is the IUSS Committee Report, *Putting Science and Engineering at the Heart of Government Policy*. This report – also published in July – revisited the committee's recommendations from the *Engineering in Government* case study and reiterated the call for a Chief Engineering Advisor as well as a Science, Engineering and Technology committee with the remit to scrutinise relevant government policy across departments: the Science Engineering and Technology committee has now been enacted. It went on to call for greater clarity in where the Government will be directing research and funding. While the committee supports the Haldane principle to some extent, it calls for reform to make the principle more practical in reflecting regional differences and providing scope for practical implementation.

While these reports are the most visible proof of the increased focus on engineering over the last year, there have also been widespread policy changes relevant to the sector – particularly in relation to the UK education and skills agenda. These are covered in detail in Section 4.

Part 1 Engineering in Context

2.0 Engineering talent in a globalising world

2.1 Recruiting the engineering team from overseas and policy constraints

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Few doubt that globalisation continues apace. It is true that the recent 'credit-crunch' and its effects have both shown the risks of the growing inter-connectedness between economies and brought a check to business confidence that understandably leads governments to think of *protecting their own*. However, it is not clear that the level of protectionist sentiment in most countries is anywhere near what would be needed for any significant move to *put the clock back*.

So it is reasonable to assume that the globalisation of markets will continue, and that, following *product*, and then *service*, markets, labour markets will increasingly cross geographical borders in the coming years. For large companies operating internationally, the 'talent pool' has been a global one for some time. Why would you not recruit local engineers when establishing, and developing, a presence in each export market? And if engineers from these countries prove themselves, it would be natural to offer them opportunities to contribute to the corporate goals in different locations. In addition, of course, there are practical reasons for recruiting in other markets. While most engineering functions are universal, there remain certain aspects of engineering practice that vary between countries: some of these relate to 'environmental' specifics (e.g. requirements for construction in earthquake or tornado zones), but most relate back to regulatory standards. Different governments have approached the setting of standards, whether related to health and safety or environmental impact, differently, and in many countries there is an element of *regulation of practice* around specific, narrow areas of engineering. These differences are likely to come under increasing pressure, since ultimately variations of standards pose threats to the 'level playing-field', and to the benefits that can accrue from greater international competition and trade. In some cases they can be viewed, and indeed act, as protectionist measures.

The aspect of internationalisation of labour markets of which we are most aware is the single labour market within the European Union. Working in the UK has been open to people from Member States since Britain joined the European Union, and significant flows from different countries since 2004 have triggered debate not only about the benefits to the economy but also the effect migrant workers might have on employment opportunities. While there is some limited evidence of reduction over recent years of average wages for the lowest level work, there is no doubt that these workers have filled gaps in the labour market and contributed significantly to the pre-credit crunch economic success of the country.

As a member of the EU, there is no policy constraint to job-seeking in other Member States, and we can expect growing mobility that provides opportunities for younger people, both into and out of our country. However, this increased freedom of movement has inevitably had a certain knock-on effect on flows of migrant labour from *outside* Europe, not least from Commonwealth countries. Work permits are required for those applying for UK jobs from anywhere beyond the EEA, and this poses a range of problems for a country with many strong links with places like Australia, Canada, India, etc. In particular it often poses questions for professional bodies, whose membership generally reaches out well beyond our own shores, and in particular into many Commonwealth countries. It is for this reason that the Engineering Council, and some of the professional engineering institutions, have taken an active role in engaging with the Home Office in relation to managed migration policy. UK policy in this area has recently undergone a significant re-structuring, in particular with a new *points based system* (drawing on certain Australian experiences), and with a new *Migration Advisory Committee* tackling the difficult task of validly assessing skill shortages. While not without its own considerable complexities, the policy in principle views the recruitment of overseas workers (at all levels) as justified, providing there is a serious shortage of supply of that particular skill-set in the UK resident labour market. In principle this sounds (and is) fine: the challenge lies in implementation – in validly and robustly assessing *what is a serious shortage of supply*, and *what is a particular skill-set*.

It is worth recognising that the Migration Advisory Committee, consisting of five labour economists plus ex-officio members, and a secretariat also mostly 'economics' heavy, has – since its creation at the end of 2007 – done much good work, and has genuinely tried to consult as widely as possible, not least with employers and relevant stakeholders. However, the task of implementing the policy principles with the limited quantitative evidence base available is indeed formidable, and the Engineering Council and Semta continue to work to improve the appropriateness of the implementation, in particular by emphasising a) the importance of competence-based (as opposed to purely knowledge-based) qualifications when assessing overseas applicants' skills, and b) the limitations of occupational classifications in validly capturing all engineering activity.

Semta, as the government-recognised Sector Skills Council for Science, Engineering and Manufacturing Technologies, works to support UK businesses in achieving global competitiveness through informed and targeted investment in skills. A major part of its work is clarification of the skill-sets required in the wide range of technical occupations now involved in science and engineering activity. To a large degree, engineering involves handling the 'implementation' of most branches of science and technology, and to the extent that this continues to *differentiate* and any one field continues to grow in complexity, this covers a major fraction of all technical skills in the modern economy. There is therefore a substantial challenge in trying to articulate the skill/competence requirements of all the different engineering occupations, and, as indicated, this is posing a particular problem because the occupational classification used for all official statistics does struggle in trying to capture all the different activities that go on in engineering. For this reason, Semta has convened a 'standing workshop' of stakeholders to try to clarify and thrash out a common position on engineering occupations, in relation to the Standard Occupational Classification (SOC), for which the main quantitative evidence is available. The Engineering Council is contributing to this work, as are some of the engineering institutions.

But the UK engineering profession has been working for many years on tackling the particular practical barriers to international mobility for engineers and technicians, through its work on designing, developing and strengthening mutual-recognition arrangements between countries for the profession's qualifications. Many readers of *Engineering UK* will be aware of the 'Washington Accord', which has, for more than 20 years, developed and refined the handling of the substantial equivalence of university engineering degrees in a number of countries. But the pioneering work of the Washington Accord has led to a number of other mutual recognition arrangements, and there are now multilateral agreements for all three grades of the Engineering Council national register (CEng, IEng, and EngTech), at both the education completion and professional registration level. The leaders of the profession in more than a dozen countries now meet regularly under the auspices of the *International Engineering Alliance*. While there remain issues in some of these agreements, and international mobility of engineers between the countries involved is in practice not always as smooth as it should be, this work deserves recognition as an exemplar of what the profession has achieved internationally without the help of governments. In addition, the Engineering Council has worked long and hard on the relationship between professional engineering qualifications around Europe, in particular through active involvement in the FEANI Index of recognised degrees and the *EurIng* title, and the more recent ENAEE/Eurace work on engineering degree course accreditation.

The recruitment process, of course, has been as affected by the arrival of the Internet as every other aspect of business – in some ways more so. It soon became clear that any employer who did not list vacancies on its website would quickly miss access to interesting applicants (in particular the younger, more technology-savvy, ones), and once vacancies are on websites, in principle the market is global.[1] And of course the employment-intermediary industry quickly realised it would need to embrace the Internet or die, so that the 'internationalising power' of the Internet has effectively removed national boundaries from all recruiting.

The current recession, and accompanying lay-offs, have seen policy-makers wanting to reduce the flows of migrant labour. In principle, falls in employment levels (which are still to be expected for some time) would bring a pool of labour. The consequent overall fall in skill shortages will generally reduce the need for recruitment from abroad. However, fierce international competition for UK companies also requires continuing effort to recruit the best people, and not all of those necessarily currently live in the United Kingdom.

Engineering talent is crucial to the success of innovative companies, and so to the economies in which they operate. Engineering companies (and others who need the skills of engineering professionals) will continue to have to compete for the best people, and this will sometimes involve lifting our gaze beyond the pool available within our country. The profession must continue to work to limit inappropriate constraints from migration policy, when skill shortages could benefit from contributions from engineers on the UK register who normally live overseas. The Engineering Council will continue to lobby the Border Agency for greater recognition of UK professional engineering qualifications in the points based system and Semta will continue to support its sectors' employers to recruit from abroad where there is real evidence of serious shortages in the resident labour market.

1 This poses a particular challenge for one element of UK managed migration policy: the 'Resident Labour Market Test'. This is required before work permits can be considered, unless the occupation recruited for is on the *official shortage* list. Unless a vacancy notice formally excludes applications from outside the UK, they will naturally occur. Once received, it would be natural for the employer to consider them together with all the other applicants.

Part 1 Engineering in Context
3.0 The changing face of manufacturing

As a consequence of the ongoing recession and retrenchment of the financial sector, Government and policy makers are paying greater attention to manufacturing and showing more appreciation for the key contribution it makes to the economy and employment. This interest culminated in July when the Department of Business, Innovation and Skills published *Advanced Manufacturing: Building Britain's Future* alongside a £150 million targeted investment package.

Despite some views to the contrary, the UK manufacturing sector is substantial. The UK has the world's 6th largest manufacturing sector as measured by output. The sector employs three million people in the UK; is responsible for 55% of all UK exports; accounts for 75% of industrial research and development (£22.5 billion) and contributed £150 billion to the economy in 2008.

The changing structure and scope of the UK manufacturing sector has placed it at the cutting edge of global innovation, providing unique opportunities to establish leadership, particularly within the eight key technologies identified by the Technology Strategy Board: namely, advanced materials; electronics; photonics; electrical systems; biosciences; nanotechnology; high value manufacturing and ICT.

For the sector to realise these opportunities it needs to be resolutely supported by Government. It also needs to increase its own focus on the development, design and customisation of production, which will increasingly determine international competitiveness. These twin aims could be achieved through several reforms:

Government procurement: the Exchequer currently spends £175 billion or approximately £1 in every £4 of Government spending on procurement. Taxation needs to be restructured to encourage a wider range of suppliers – including small businesses – to compete for contracts and to incentivise them to invest in technology, research and the workforce. Through employing broader parameters, manufacturing enterprises can be encouraged and incentivised to invest appropriately for their size and growth potential.

Greater emphasis needs to be given to **design and customisation** so that they are recognised as core components of the manufacturing process. The evidence is now overwhelming that 'intangibles' such as branding, customisation, service polices and customer training benefit an organisation's bottom line. This message features in the Government's recent manufacturing strategy but more needs to be done to highlight this key message to all manufacturing enterprises. Design must be recognised as a critical and integral part of the manufacturing process. In this way, design will become a mainstream feature within the new manufacturing model.

Major **resource efficiency savings** could be achieved by considering the entire life cycles of products and services more. Over 90% of the materials used in production do not find their way into the final product and companies spend up to 5% of their annual turnover on waste, including unused materials, defects, energy and water. The sector is currently missing out on a share of £6.4 billion a year in potential savings from using resources more efficiently.

With the global market in **green technologies** now exceeding £3 trillion, there are considerable opportunities for the UK to develop global leadership in this sector. The manufacturing sector will be critical to delivering the low carbon economy and, if encouragement is given to relevant technologies (such as nuclear which has an estimated £20 billion capital expenditure), the UK could sustain the 'first-mover advantage' it has in these technologies and achieve global leadership.

Early indications are that UK manufacturing is rising to the challenges and opportunities highlighted in this article – particularly in making greater use of intangibles to add value. It should also be stressed that the Government's role is to pick winning technologies, rather than individual businesses. It is up to businesses to secure their own success by restructuring their own operations to benefit from innovative technologies.

It is clear that the traditional view of manufacturing as production alone is obsolete. Through effective partnership and support, it is ready to be replaced by a new model.

Part 1 Engineering in Context

4.0 Complementary Government policy

4.1 Introduction

2009 has been another busy period for education policy. As the flagship Apprenticeships, Skills, Children and Learning Bill makes its way through Parliament (see box: The ASCL Bill), the key reference point remains the 2006 Leitch Review of Skills, which has focused post-16 education ever more closely on vocational considerations.

At the same time, engineering and technology have been the subject of a number of other policy initiatives, in acknowledgement of the importance of these sectors to the country's economic future – especially through a recession. In particular, the sector looks set to benefit from Government support for power generation, low carbon technologies and other advanced engineering projects. These are described below along with a visual summary of the policy timeline at Figure 4.0.

4.2 The big changes in education

The biggest structural change of 2009 occurred in June, when the Department of Innovation, Universities and Skills (DIUS) was merged with the Department of Business, Enterprise and Regulatory Reform (BERR), becoming the Department of Business, Innovation and Skills (DBIS). This came as a surprise to many – not least because DIUS had been created less than two years earlier.

The significance of this change is not yet clear, though the implication is that all post-16 education (the remit of DIUS) is increasingly seen in the context of prospective employment and of potential benefit to the economy. In this sense, while the change itself was unexpected, it very much reflects the tone of the main policy changes of 2009 (and indeed earlier). While many in academia have questioned whether the future of independent academic research will be compromised, as yet there have been no policy changes that could give hard evidence either way. However, there have been a number of reports into this subject, most notably by the Innovation, Universities, Science and Skills committee (now the Science and Technology committee).

4.3 Avoiding youth unemployment

2009 has seen growing concern across the political spectrum for young people not in education, employment or training (NEETs). While this has been a focus of education policy for many years, it moved into the mainstream this year. This is largely in response to the recession, which has caused a disproportionate increase in unemployment amongst young people.

From January 2010, every 16–25-year-old in England who has been unemployed for a year will be required to take up a guaranteed job, work experience or training place. The guarantee will be funded through a £1 billion Future Jobs Fund designed to create 100,000 'community' jobs for young people. In May, the Scottish government launched a similar programme called 16+ Learning Choices, which guarantees young people in Scotland a place in learning and training.

4.4 Train to Gain

Train to Gain is the programme through which employers can receive funding from the Government to train staff. After complaints that the system was too prescriptive, new flexibilities were introduced at the start of 2009. These allow small and medium-sized businesses to access funding for a greater range of qualifications. There remain, however, a number of questions about the effectiveness of Train to Gain and it is the subject of some political controversy.

The responsibility for assessing and stimulating skills demand for each sector lies with the Sector Skills Councils (SCCs). There are three that cover different aspects of engineering: Cogent (chemicals, nuclear, oil and gas, petroleum and polymers industries); Semta (science, engineering and manufacturing technologies) and ECITB (the Engineering Construction Industry Training Board).[2]

'Sector Compact' is the name given to the non-contractual agreements between government agencies and SSCs to drive up demand for Train to Gain.[3] The three SSCs that deal with parts of the engineering sector all signed Compacts in 2009 following a successful re-licensing process by the National Audit Office (NAO).

4.5 New industry, new jobs

In April 2009, BERR published *Building Britain's Future: New Industry, New Jobs*, in which it identified the following as examples of industries that should play a larger role in the economy in the future:

- Advanced engineering
- Electronics
- Biosciences
- Low-carbon technologies

These sectors have repeatedly been cited as policy priorities in speeches and press releases throughout the year. The best summary of how this translates into specific programmes is contained in a series of reports, published under the unifying slogan *Building Britain's Future*: in particular, *Low Carbon Industrial Strategy* and *Advanced Manufacturing* (both published in July) and *Jobs of the Future*, published in September, bring together the analysis and pledges contained in all the aforementioned documents, reiterating that the low-carbon economy and advanced manufacturing are amongst the sectors expected to grow in the short and medium term.

In February, BERR announced a review of the engineering construction sector, looking at its productivity and skills. The review is being led by Mark Gibson, formerly the Director General of the Business and Enterprise Group at BERR. The Government has also announced its intention to recruit a Chief Construction Adviser to help develop skills and innovation in this key sector.

2 The ECITB is not technically a Sector Skills Council, though it carries out the same functions. See, for example, http://www.ecitb.org.uk/ecitbresources/139/

3 http://readingroom.lsc.gov.uk/lsc/National/nat-sectorcompact-QandA-v2-MasterFeb09.pdf

4.6 Advanced manufacturing

DBIS published *Advanced Manufacturing* in June, as part of a series of initiatives grouped into three areas (as well as outlining support in particular sectors):

- Access to information and investment
- Skills
- Take-up of new technologies

Access to information and investment

- Expansion of the Manufacturing Advisory Service (£4m over 2009–11)
- Development of the Network of Manufacturing Technology Centres
- Low Carbon Industrial Strategy
- UK Innovation Investment Fund, with 'cornerstone funding' of £150m

The Manufacturing Advisory Service provides help and advice to small and medium-sized companies in the sector, and it will receive £4m in public money to aid expansion from 2009 to 2011. This sum will be matched by investment from the private sector.

The Network of Manufacturing Technology Centres represents a commitment to use existing resources and existing or planned centres in a strategic manner, sharing knowledge and information.

The Low Carbon Industrial Strategy gives further details on how the £405m of investment announced in the budget will be spent. The main commitments include:

- Up to £120m for offshore wind power
- Up to £60m for wave and tidal power
- Up to £15m for civil nuclear power
- Up to £310m for ultra-low-carbon vehicles

Also elaborated on from the budget are the £50m for the Technology Strategy Board and £90 million to fund detailed design and development work for the carbon capture and storage demonstration competition. The strategy further relates the creation of the first low-carbon economic area, in the south west of England, which will focus on marine energy demonstration, servicing and manufacture.

4.7 Skills

- The 14–19 Diploma in Manufacturing and Product Design (beginning in September 2009)
- An extra 10,000 places for students undertaking higher education degrees in science, technology, engineering and maths (STEM) subjects (Autumn 2009)
- The Higher Education Framework setting out how education will support business (Autumn 2009)

The 14–19 Diploma is one of the flagship qualifications of recent education reforms, combining academic and vocational learning. The Diploma in Manufacturing and Product Design will join 14 other subjects, one of which is engineering.[4]

The Higher Education STEM programme, funded by the Higher Education Funding Council for England (HEFCE), began in August 2009 and is hosted at the University of Birmingham. The 10,000 extra places for STEM subjects will be available for the academic year 2009–10, though it should be noted that the principal focus is on science subjects, rather than technology and engineering.

4 http://yp.direct.gov.uk/diplomas/subjects/

4.8 Take-up of new technologies

- £50m for the Technology Strategy Board (announced in the Budget 2009)
- £45m for a research and development programme into low carbon engines
- £40m in support of the Strategic Affordable Manufacturing in the UK with Leading Environmental Technology (SAMULET) aerospace manufacturing programme (announced July 2009)
- New composites strategy (Autumn 2009)
- New plastics electronics strategy (Autumn 2009)

Funding for the Technology Strategy Board has been announced in stages. Almost half of the £50m – £24m will go towards funding of the High-Value Manufacturing Competition. Other investments in new technologies reflect an attempt to support both jobs and new, greener technologies.

4.9 The opposition parties

Given that a general election is due in the first half of 2010, it is worth noting the relevant policy positions of the two major opposition parties:

The Conservatives published education green papers in 2007 and 2008, and their publications and announcements in 2009 followed similar policies. These include:

- A skills agenda similar to that adopted by the Government with a greater focus on increasing the number and quality of apprenticeships. A particular focus in the Conservative proposals is the local provision of apprenticeships
- A commitment to reducing bureaucracy, especially in further education. This includes opposition to the Train to Gain scheme and to structures such as the Learning and Skills Council. The stated intention is to redirect much of this funding to the direct provision of apprenticeships
- Introducing more choice by allowing parents or not-for-profit groups to set up their own schools with public funding

The Liberal Democrats outlined their position in January 2009 in their paper *Investing in Talent, Building the Economy*. Key proposals include:

- Mixing academic and practical learning
- Offering both free tuition and maintenance support to all, whether young or old, in FE or HE, part-time or full-time
- Redirecting resources from the employer-led Train to Gain programme into adult education, adult FE, and adult apprenticeships

It should also be noted that both main opposition parties have voiced concerns about the new Diplomas in terms of academic content, uptake and how they are taught. It is very likely that these would be reviewed if the balance of power between the parties was to change after the next election.

The Apprenticeships, Skills, Children and Learning Bill

The Apprenticeships, Skills, Children and Learning (ASCL) bill is currently working its way through the House of Lords, having passed through the Commons in May. The bill represents the culmination of the Government's educational policy changes, especially those relating to apprenticeships. It has three main strategies:

- To increase the supply of apprenticeship places
- To develop a standard blueprint for apprenticeships
- To consolidate delivery of apprenticeships through the National Apprenticeship Service, which officially launched in April

It sets out to:

- Provide a statutory framework for apprenticeships and create a right to an apprenticeship for suitably qualified 16–18-year-olds
- Introduce a right for employees to take time away from their duties to undertake training. It also places a corresponding duty on employers to consider such requests seriously and to be able to refuse them only for specified business reasons
- Dissolve the Learning and Skills Council
- Transfer the responsibility for funding education and training for 16–18-year-olds to local authorities
- Create four new organisations: the Young Person's Learning Agency (YPLA); the Skills Funding Agency (SFA); a new regulatory body for qualifications (Ofqual); and a new agency to carry out the non-regulatory functions currently performed by the Qualifications and Curriculum Authority (QCA)[5]

Gender

Attracting more women into careers in science, technology, engineering and maths has long been regarded as a potential solution to the UK skill shortage in these areas. It is no secret that fewer girls than boys continue with science and engineering studies at university and even fewer continue into engineering jobs. Indeed, as *Engineering UK 2008* noted, if the UK is to compete in the knowledge and innovation-based economy, it must have a good supply of well-trained, skilled people: women have the potential to contribute significantly to this.

Whilst good progress has been made, the challenge is still there. Secondary analysis by the UK Resource Centre for Women[6] suggests that, of the women who do graduate with a science, engineering or technology (SET) first degree, only 27% actually pursue a SET career compared with 54% of men. The Confederation of British Industry (CBI) report that, of the businesses that need SET workers, 59% are having difficulties recruiting staff.[7] Women could provide an important resource to help fill this deficit, but only if SET businesses have work policies that are more welcoming to them.

The next steps?

The National Skills Forum report on women, skills and productivity, *Closing the Gender Skills Gap*[8] looks specifically at careers education and guidance, work-life balance, and education and training for female learners and makes 27 key recommendations for closing the gender skills gap. The report also estimates[9] the potential increase in GDP at between £15 billion and £23 billion if the proposals were successful.

5 See http://www.aoc.co.uk/download.cfm?docid=EE6EA50F-6BB6-4938-95DB9CB74DE39B58 and http://www.aoc.co.uk/download.cfm?docid=0091F4b6-bcc0-4305-b142ff5645423865 for some useful visual representations of what the system will look like.

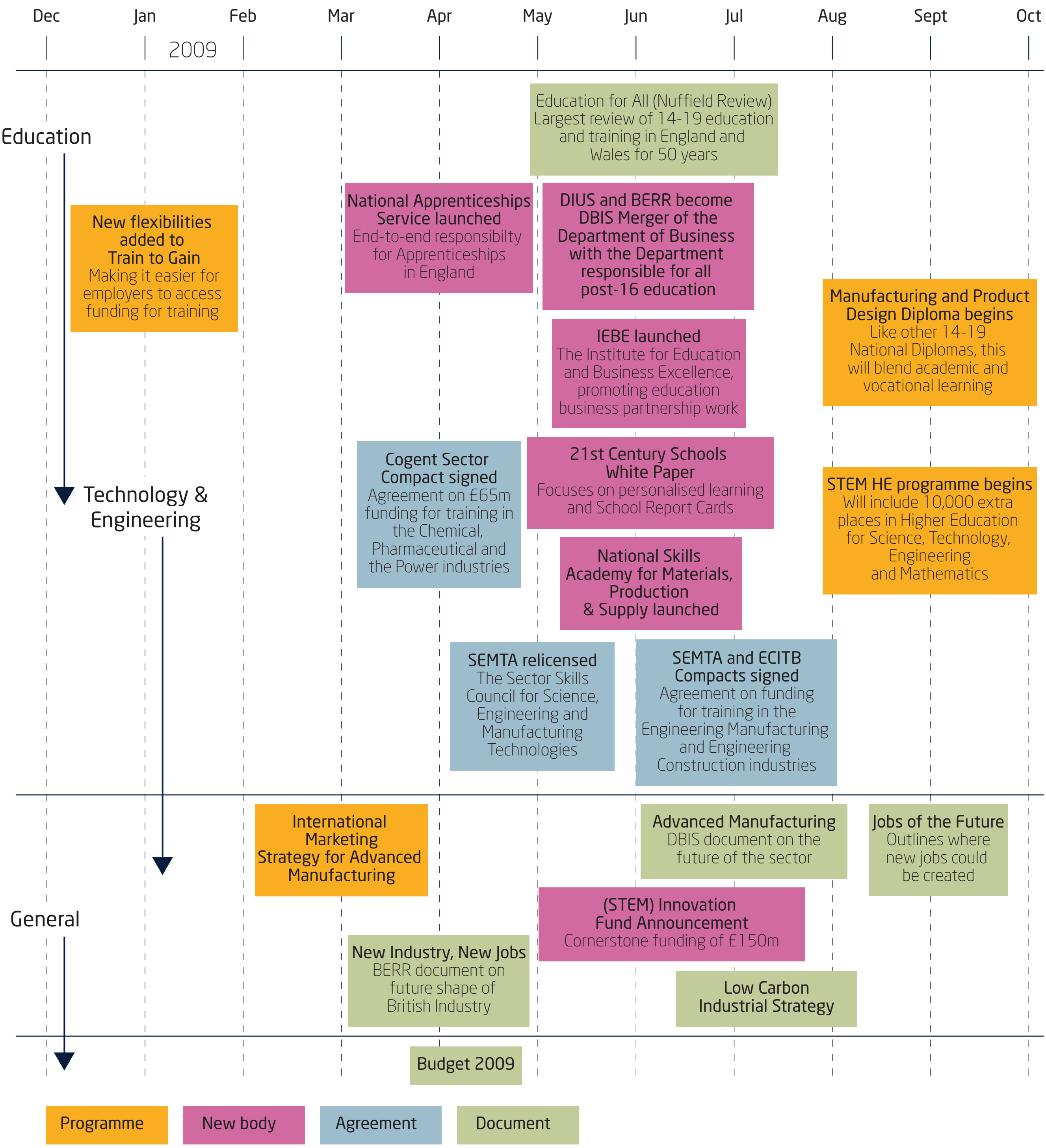
6 Secondary analysis by UK Women's Resource Centre of the HESA (2007) Destination of Leavers of Higher Education 2005/06 data

7 *Taking Stock: CBI Education and Skills Survey 2008* (CBI,2008) p29

8 *Closing the gender skills gap – A national skills forum report on women, skills and productivity.* February 2009, National Skills Forum

9 *Shaping a Fairer Future* (Women and Work Commission, 2006), p.vii

Fig. 4.0: Government policy initiatives



Part 1 Engineering in Context
5.0 UK engineering research quality

If we are to address future global challenges such as climate change, infrastructure renewal, the low carbon economy, clean water and renewable energy, the UK is going to require a steady supply of skilled individuals. Apprentices, technicians and graduates, through to high quality postgraduates will be needed to undertake world class R&D and develop ground-breaking innovations and solutions.

The engineering sector makes a key contribution to the UK's R&D capacity and capability and is in a large part reliant upon the UK Science Base.[10]

The provision of intermediate and high level science, technology, engineering and mathematics (STEM) skills for the UK science, engineering and technology (SET) sector is one of the key challenges recognised within the Lisbon Agenda[11] which was intended as a strategic response to address the low productivity and stagnation of economic growth across the EU. EU target spending on research and development was set at over 3% of EU GDP.

Analysis of the state of engineering R&D within UK HE institutions, as assessed by the 2008 Research Assessment Exercise, finds it in excellent shape. Nevertheless we need to temper this against the fact that initial targets set out in the Lisbon Agenda were far too ambitious. In the current economic climate, it seems most unlikely that the UK will achieve anywhere near its 2.5% target of R&D spend of GDP by 2010.[12]

10 The UK's Science Base can be defined as the research and postgraduate teaching capacity of our universities, research councils, some charities, institutes and laboratories. Royal Society definition http://royalsociety.org/page.asp?id=2537

11 The Lisbon Agenda is an economic action and development plan for the European Union (EU) set out by the European Council in Lisbon in March 2000.

12 *Lisbon or Bust*, the Engineering and Technology Board Briefing Paper, August 2007.

5.1 Background to the Research Assessment Exercise (RAE)

The RAE was introduced to allow the four HE funding bodies to distribute funds selectively based on research quality (Table 5.0). The last assessment was in 2001 (RAE2001). A review by the House of Commons Science and Technology Select Committee concluded that, "the RAE has had positive effects: it has stimulated universities into managing their research and has ensured that funds have been targeted at areas of research excellence". For the purpose of the 2008 RAE, each academic discipline was assigned to one of 67 units of assessment (UOAs)[13] which were then assessed by the panels in order to help the funding bodies determine their research grant allocations with effect from 2009–10.

The RAE 2008 was conducted jointly by the Higher Education Funding Council for England, the Scottish Funding Council, the Higher Education Funding Council for Wales and the Department for Employment and Learning, Northern Ireland.

The total research allocation for 2009–10 is £1.572 billion, including £1.106 billion in mainstream quality-related research and £203m on research-degree programme (RDP) funding (to support the supervision of postgraduates).

Whilst the unit of resource for teaching had been maintained, funding for research has increased by 7.7%.

5.2 Methodology

For RAE 2008 there were 2,344 submissions from 156 higher education institutions which listed the work of over 50,000 researchers, spanning over 200,000 assessed pieces of research.

Fifteen main panels and 67 sub-panels comprising 1000 experts (academics and users of research) carried out a review throughout the year and each research department was graded in 5% blocks based on the following criteria:

Table 5.0: Quality levels

4*	Quality that is **world-leading** in terms of originality, significance and rigour.
3*	Quality that is **internationally excellent** in terms of originality, significance and rigour but which nonetheless falls short of the highest standards of excellence.
2*	Quality that is recognised internationally in terms of originality, significance and rigour.
1*	Quality that is recognised nationally in terms of originality, significance and rigour.
Unclassified	Quality that falls below the standard of nationally recognised work, or work that does not meet the published definition of research for the purposes of this assessment.

It should be noted that the 'international' and 'national' criterion relates to the standard rather than the nature or geographical scope of any subject.

13 e.g. Panel G covered units of assessment (UOA) 24–29: 24 – electrical and electronic engineering; 25 – general engineering and mineral & mining engineering; 26 – chemical engineering; 27 – civil engineering; 28 – mechanical, aeronautical and manufacturing engineering; and 29 – metallurgy and materials.

5.3 Results for engineering and related departments

The results for participating engineering and related departments, as shown in Table 5.1, are impressive. The percentage of research activity rated as 'world leading' ranged between 15% and 20% for engineering and related subjects. All these subjects had over half of their research activity deemed as 'internationally excellent': the highest being civil engineering and chemical engineering, for which an impressive 71% of research activity was rated internationally excellent and above (3* and 4*). Table 5.2 illustrates the percentage of 'internationally excellent' research activity in the engineering and related area.

Table 5.1: Engineering and related units: average[14] outcomes by subject unit of assessment[15]

Unit of Assessment	4*	3*	2*	1*	Unclassified
Applied Mathematics	16%	43%	35%	6%	0%
Biological Sciences	15%	39%	35%	9%	2%
Chemical Engineering	19%	52%	25%	4%	0%
Chemistry	17%	46%	34%	3%	0%
Civil Engineering	8%	53%	22%	6%	1%
Computer Science and Informatics	20%	43%	28%	8%	0%
Electrical and Electronic Engineering	18%	41%	32%	9%	1%
General Engineering and Mining and Mineral Engineering	16%	42%	34%	7%	1%
Mechanical, Aeronautical and Manufacturing Engineering	17%	45%	30%	7%	1%
Physics	18%	39%	34%	8%	1%
Pure Mathematics	18%	39%	35%	6%	1%

Table 5.2: Percentage of engineering and related units research activity at the 'internationally excellent' quality level and above (3* and 4*)

Unit of Assessment	3* + 4*
Applied Mathematics	59%
Biological Sciences	54%
Chemical Engineering	71%
Chemistry	63%
Civil Engineering	71%
Computer Science and Informatics	63%
Electrical and Electronic Engineering	59%
General Engineering and Mining and Mineral Engineering	58%
Mechanical, Aeronautical and Manufacturing Engineering	62%
Physics	57%
Pure Mathematics	57%

14 Averages were weighted by the number of full time equivalent (FTE) staff in each submission

15 http://www.rae.ac.uk/results/selectUOA.aspx

5.4 Share of world engineering citations

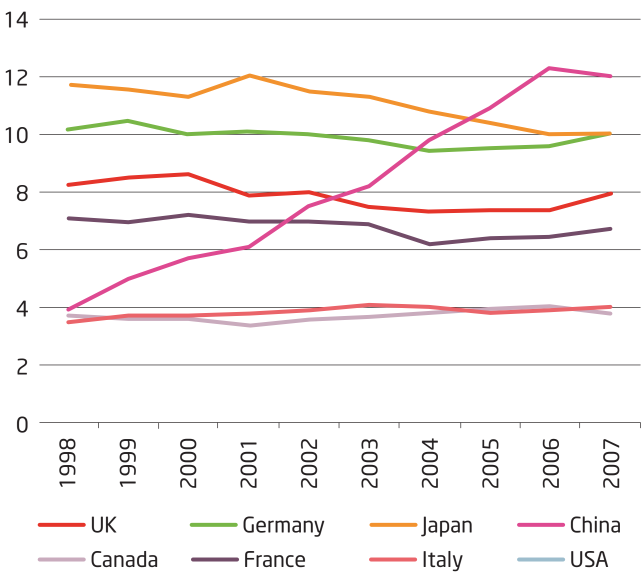
The ability to judge a nation's scientific standing is vital for the UK government and businesses if it is to be able to determine scientific priorities and funding. May[16] established the ground breaking citation analysis of published research papers and their reviews in order to draw international comparisons of countries' scientific impact and strengths. Accordingly, this section draws on evidence from the substantial analyses in the Department of Innovation, Universities and Skills' (DIUS) international comparative study undertaken in July 2008.[17] This report allows the comparison of engineering research at an international level[18] and thereby provides comment on the state of the UK engineering research base.

By studying Figure 5.0: The share of world citations to engineering papers[19] and Table 5.3: Total citations to engineering papers, we can see that within the G8 the UK is a healthy fourth behind the USA (current share 30% not shown on chart), Germany and Japan in volume of engineering papers, with a 7.8% share. The UK has held this position for several years. The relative growth of China's share should be noted. It is also notable that the US, while still number one, has seen its share reduce from 38% to 30% over the past ten years.

Table 5.3: Total citations to engineering papers

	Recent (2002-2006)	Current (2007)	Current relative to Recent
Citations to UK Papers	69,218	4,451	-
Group average citations	41,214	2,622	-
UK/Group average	1.68	1.70	+1%
UK rank within Group	5	5	< >
UK rank within G8	4	4	< >
UK share of world	7.5	7.5	+4%

Fig 5.0: Share of world citations to engineering papers[20]



5.5 Conclusion

Engineering Research within our Higher Education institutions appears to be thriving with 59% to 71% being assessed as internationally excellent or above (3* and 4*). This must not be allowed to fall behind in the future when the UK economy will be more reliant upon R&D and innovation within a knowledge based economy to help meet pressing future global challenges. The competitiveness of the UK in terms of high level research in engineering is further evidenced by the UK's citation share within the G8. This is holding up at 4th behind the US, Germany and Japan.

The decision to ring-fence STEM subjects and give them priority funding, due to their strategic importance, is one that we strongly endorse. As David Eastwood stated: "What we are doing is protecting the proportion of research funding flowing to such subjects at 2008 levels. Not to have done so would have confounded a central position of the Government's ten-year framework."[21] This ring-fence was drawn around 29 science-based units of assessment, and, as a result, stopped £50.3m leaking out of science into other subjects.

16 May, R.M. Science 275, 793–796 (1997)

17 DIUS, International Comparative Performance of the UK Research Base, July 2008.

18 King, D.A. Nature 430, 311 – 316 (2004) – highlighted that citation analyses must not be used to compare different disciplines. However, comparing one discipline across different countries is easier than comparing two different disciplines within one country.

19 DIUS, *Op.cit.* Chart 1.05.07 p39.

20 DIUS, *Op.cit.* p97 –There are 25 countries (the DIUS comparator group) covered in this report in addition to the UK.

21 David Eastwood, CEO HEFCE, Times Higher 5th March 2009, p24.

Part 1 Engineering in Context
6.0 Size of the engineering sector

The Annual Business Inquiry (ABI) obtains details from VAT-registered and/or PAYE businesses in the UK which are classified under the Standard Industrial Codes[22] (SIC) 1992 or 2003. This section follows on from *Engineering UK 2008* and illustrates the number of enterprises, total turnover and average total employment for those businesses which have engineering related SIC codes. These comprise: production industries (SIC 2003 codes C to E) which include mining and quarrying, manufacturing and electricity, gas and water supply; construction (SIC code section F); R&D on natural sciences and engineering (SIC code group 73.1); architectural and engineering activities and related technical consultancy (SIC code group 74.2); and technical testing and analysis (SIC code group 74.3).

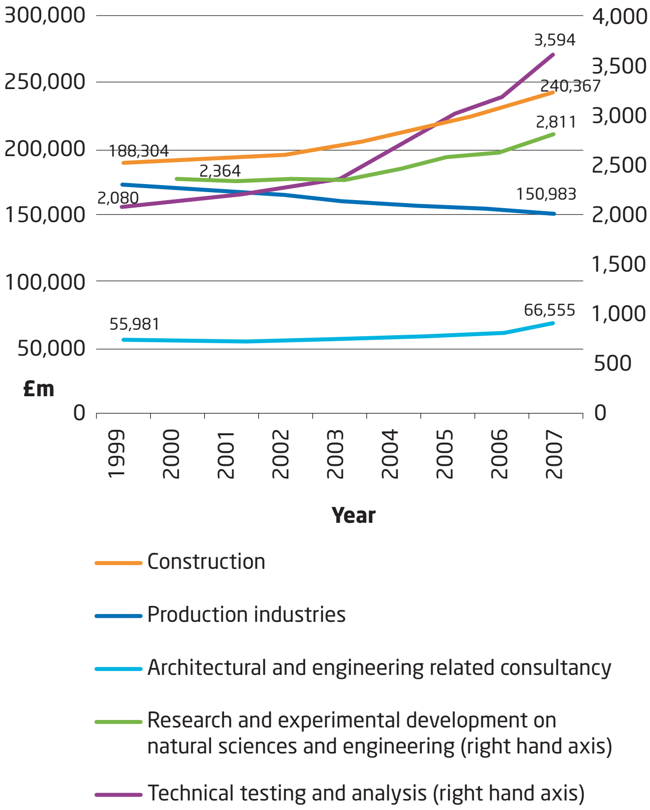
6.1 Number of enterprises

It is important to point out that the ABI covers the period before the recession began, with the most recent data being for 2007. Figure 6.0 shows that the number of enterprises increased across the period for all industries apart from the production industries, where enterprise numbers fell by 12% to 151,000 in 2007. The number of enterprises in the construction SIC code group rose by 27% between 1999 and 2007, bringing the total to a considerable 240,000. The number of companies in R&D on natural sciences and engineering has risen 19% to 2,811 from 2000 to 2007. The number of technical testing and analysis enterprises has increased by over two thirds between 1999 and 2007, and the number of architectural and engineering consultancies has increased 19%.

Manufacturing, in particular, is the subject of much greater attention from Government and policy makers: the challenging economic climate has forced them to recognise the contribution this sector makes to employment and the economy at large. Thanks to changes in structure and scope, UK manufacturing is at the cutting edge of global innovation – a position which delivers unique opportunities to establish leadership.

22 See section 33.3 SIC and SOC Codes

Fig. 6.0: Number of enterprises by SIC code group (1999-2007) - UK

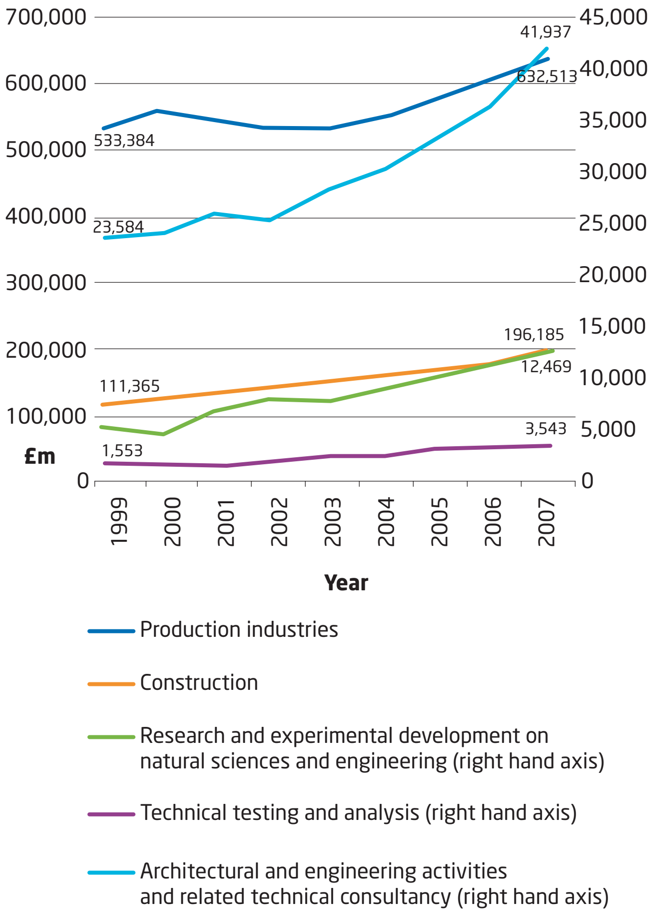


Source: ONS/Annual Business Inquiry 2009

6.2 Turnover

The turnover generated by these industries is huge, and all experienced substantial growth between 1999 and 2007, as shown in Figure 6.1. Production industries account for the largest turnover of the groups and reported a total of £632,500m in 2007, a 19% rise since 1999. £505,000m of this was attributable to manufacturing (SIC code group D). Construction enterprises saw turnover increase a huge 76% over the eight year period, with the housing boom fuelling it to a massive £196,000m in 2007. The turnover from technical testing and analysis and R&D on natural science and engineering companies, though starting from a relatively small base, more than doubled to £3,500m and £12,500m respectively from 1999 to 2007. Architectural and engineering activities and related consultancy businesses reported £42,000m in turnover in 2007, also having risen by a huge 78% in this period of rapid economic growth.

Fig. 6.1: Total turnover by SIC code group (1999-2007) - UK



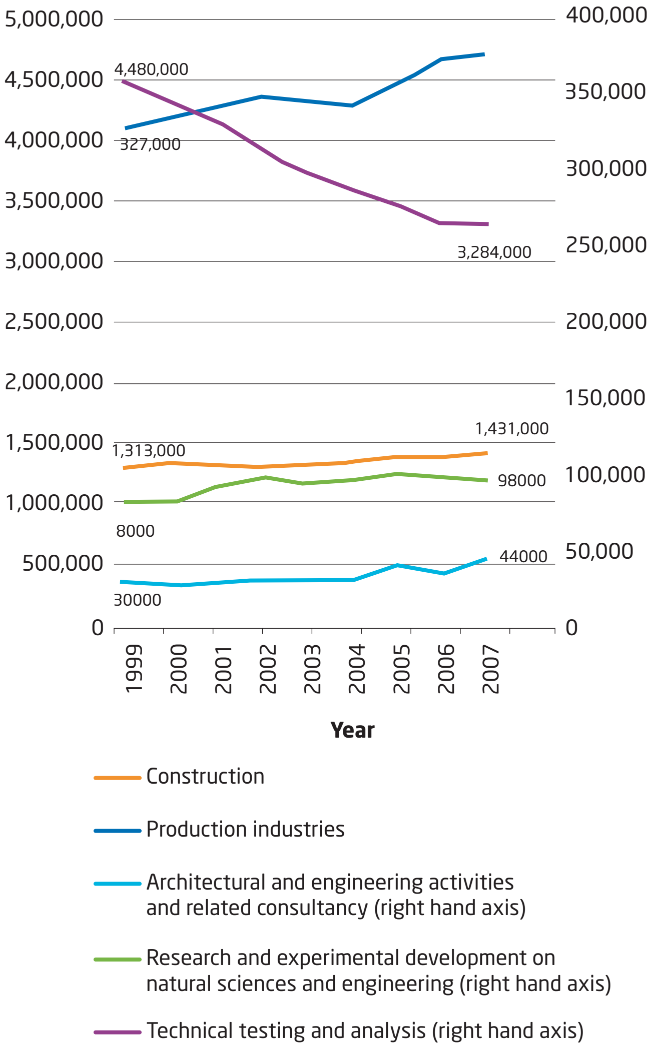
Source: ONS/Annual Business Inquiry 2009

6.3 Employment

Figure 6.2 shows the total employment for the selected SIC codes based on averages for the year. The decline in the production industries' employment figures is immediately evident from the chart, with the group experiencing a fall of over a quarter. The majority of this reduction was in SIC code group D, manufacturing, which employed just under 4,300,000 in 1999 and dropped to approximately 3,000,000 in 2007. The shift from high volume, low value manufacturing to more specialised technical added-value products[23] has meant that, though turnover has risen, factories have continued to close and jobs have been lost. Nevertheless, and despite contrary views, the UK manufacturing sector remains substantial: it is the world's 6th largest as measured by output; it is responsible for 55% of all UK exports; it accounts for 75% of industrial research and development (£22.5 billion) and contributed £150 billion to the economy in 2008.

The construction industry employed 9% more people in 2007 than in 1999. This rise, though positive, is nowhere near as significant as the rise in turnover which reflected the huge rise in value of property at this time. The R&D and architectural and engineering activities groups both saw employment levels increase by 23% over this period. Technical testing and analysis businesses employed 35% more people from 1999 to 2007, though this was starting from a far lower base than the other SIC code groups detailed in this analysis.

Fig. 6.2: Total employment: average during the year by SIC code group (1999-2007) - UK



Source: ONS/Annual Business Inquiry 2009

This is based on a SIC 2003 code analysis and therefore is not inclusive of all engineering occupations or enterprises. Nevertheless, the trends are certainly indicative of the sector as a whole in this period. The two year time lag on ABI data unfortunately means that it will be 2011/2012 before the actual effects of the current economic situation can be quantified in this way.

23 Section 3.0

Part 1 Engineering in Context

7.0 Engineering in the nations and regions

In *Engineering UK 2008*, the Engineering and Technology Board's (now EngineeringUK) inclusive SIC 2003 codes[24] were defined and used to analyse ONS data. Using this definition of engineering, this section examines the Inter-Departmental Business Register (IDBR) by home nation and English region. The IDBR collects information on VAT-registered businesses in the UK and enables a breakdown by number and size of enterprises, share of employment and turnover, as shown in Table 7.0.

Table 7.0: Engineering in the nations and regions (2008) - UK

Home Nation/English Region	Number of enterprises	Number employed	Turnover (£) thousands
North East	13,255	163,832	27,952,691
North West	46,075	429,502	57,755,673
Yorkshire and the Humber	33,910	340,606	45,036,396
East Midlands	34,290	331,284	46,787,592
West Midlands	41,950	455,432	67,407,147
East	54,880	543,072	91,092,602
London	56,465	458,296	146,815,650
South East	82,375	821,059	170,864,347
South West	44,450	353,840	46,555,220
England	407,650	3,896,923	700,267,318
Wales	18,610	189,104	29,070,422
Scotland	29,800	295,159	54,713,254
Northern Ireland	14,245	118,149	15,135,719
Total	470,305	4,499,335	799,186,713

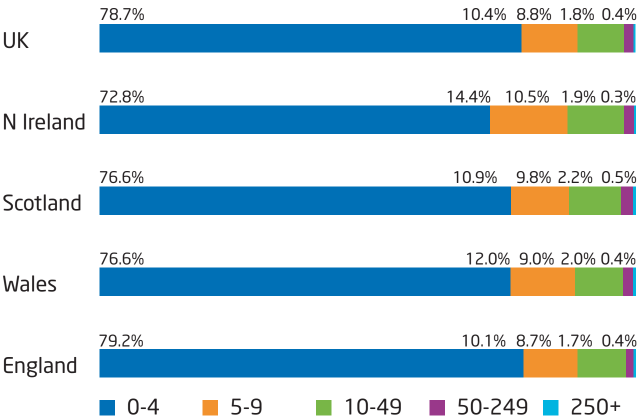
Source: ONS/IDBR

24 Section 33.3

7.1 Size of enterprises

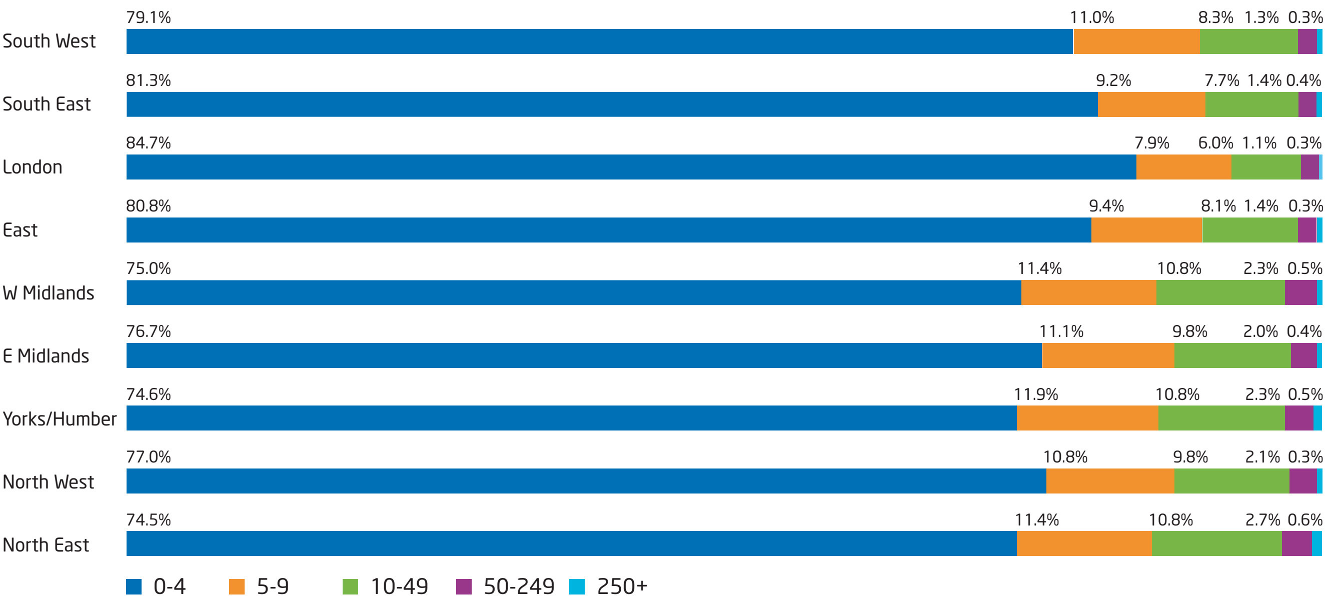
In 2008 there were 470,305 engineering enterprises employing 4.5 million in the UK, the vast majority microbusinesses.[25] Figure's 7.0 and 7.1 show the breakdown by number of enterprises in the home nations and English regions respectively. Nine out of ten engineering enterprises in the UK are in fact microbusinesses. The spread is fairly uniform across the nations, though Northern Ireland has a slightly bigger proportion of SMEs.

Fig 7.0: Share of VAT-registered engineering enterprises by number of employees by home nation (2008)



Source: ONS/IDBR

Fig. 7.1: Share of VAT-registered engineering enterprises by number of employees by English region (2008)



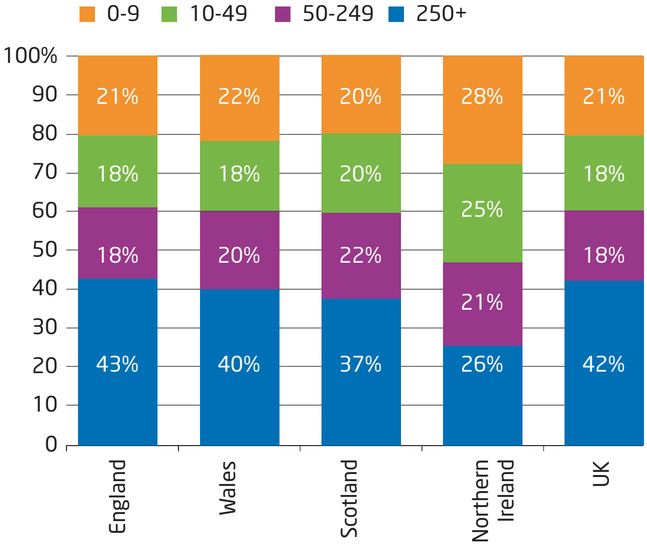
Source: ONS/IDBR

25 Fewer than ten employees and a turnover of < €2m

7.2 Share of employment

When looking at the data by share of employment, the large businesses have the biggest presence, as expected, though overall microbusinesses employ 21% of people in the sector (up from 18% in 2007). Interestingly, in Northern Ireland only 23% of employment is by companies with 250+ staff, compared with the UK average of 42%. The workforce share is almost evenly spread across the four categories.

Fig. 7.2: Share of employment by enterprise size by home nation (2008)

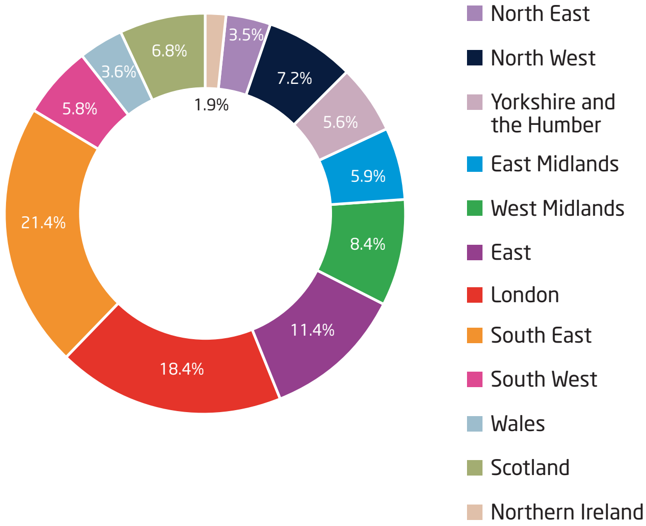


Source: ONS/IDBR

7.3 Share of turnover

Total turnover of VAT-registered engineering enterprises (as defined by the Engineering and Technology Board SIC 2003 codes) has increased from £716 billion in 2007 to £799 billion in 2008; the South East and London regions accounted for 40% of this total. Figure 7.3 breaks this down and illustrates how each English region and the home nations contributed towards this total.

Fig. 7.3: Share of turnover of VAT-registered engineering enterprises by home nation and English nation (2008)



Source: ONS/IDBR

Analysis of the IDBR highlights the contribution made to the economy and the actual presence of microbusinesses within engineering. Since 2007, businesses with fewer than ten employees have increased their share of overall employment in the UK by three percentage points. It is essential that the focus by policy makers towards industry is inclusive, rather than targeting large business alone.

Part 1 Engineering in Context
8.0 Perceptions of engineers and engineering

8.1 Overview

New research from the Engineering and Technology Board (now EngineeringUK) found that, in the current UK social and economic climate, set against the backdrop of the global financial downturn, there has been a marked improvement in the perceived desirability of the engineering profession among education professionals and the general public. However, the research also found that this positive shift in perception has yet to be passed on to the under 24s and it explores ways of resolving this issue by targeting key influencers such as parents and guardians.

Brand of genius

Methodology and background

The monitor was devised and validated in 2008, providing a first cut of data and developing a research methodology capable of remaining consistent over the next four to six years.

This section summarises this year's research findings, examining the changing perceptions of the following groups:

- School children (7–16-year-olds)
- Young people (16–24-year-olds)
- Career changers (aged 25+)
- Parents and guardians
- Members of the general public aged 65+
- Education professionals (teachers/tutors/career advisors from schools, FE colleges and HE institutions)

8.2 Less financial engineering and more real engineering?

In January this year, the Business Secretary, Lord Mandelson, said: "In future we need less financial engineering and more real engineering" in order to rebalance and grow the UK economy. The findings of our research suggest his words have not fallen on deaf ears: there has been a marked positive shift in public attitude towards 'real' engineering.

A promising 85% of respondents from the general public stated that they would recommend a career in engineering to their children, friends or family, compared with only 66% in the initial pilot survey in 2008.

Whether this shift in thinking is directly linked to the loss in confidence of the banking and financial sectors cannot be firmly established without further research, but there are indications that the current economic situation is having a knock-on effect on the public mind-set. For example, when asked what was the most important factor affecting career choice, pay dropped from first place to third this year, with job security and enjoyment rising to joint first.

In addition to the increased desire for job security, a higher proportion of the general public now view engineering as a well respected profession (78%), which makes a good contribution to society (86%) and will have a positive impact on our future (91%). In this respect, the perceived desirability of the profession has increased by 8% amongst the general public. Similarly, almost twice as many people (16%) now recognise and mention the design aspect of engineering, which is perceived to be one of the most appealing and exciting elements of the profession. Linked to this, there was also a substantial shift in the percentage of the general public associating engineers with 'building things' – up to 38% this year from 20% in 2008.

This has been against a backdrop of increased media coverage around large building projects (the Olympic Village being the most obvious example) alongside the much-discussed Government plans for 'speeding up' major public projects and works.

For all these upwards trends however, education professionals continued to be the most likely to have a positive view of engineering, and 11–16-year-olds the least likely: 69% of the former but only 18% of the latter perceived engineering as a desirable career.

The key questions we must now address are: what can be done to address this issue, and how we can galvanise, harness and increase young people's improving perceptions of engineering (up 5% in one year)?

Points of interest:

- The importance of job security is increasing. This is up from 63% in 2008 to 75% in 2009 for the general public
- 62% of education professionals, 35% of the public and 30% of 11–16s had seen, heard of, or visited something in the past year that presented engineering in a positive way and inspired them

Areas of improvement:

- 85% of the general public would recommend a career in engineering to their family, friends or children compared to 66% in 2008
- 62% of parents and guardians view engineering as a desirable or very desirable career compared with 56% in 2008
- 57% of the general public view engineering as a desirable or very desirable career, compared with 49% in 2008
- 45% of 16–24-year-olds view engineering as a desirable or very desirable career, compared with 40% in 2008

Could do better:

- Only 12% of 11–16-year-olds know much about what an engineer actually does
- 38% of 11–16-year-olds view engineering as undesirable
- 18% of 11–16-year-olds view engineering as desirable
- 49% of 7–11-year-olds think being an engineer would be boring

8.3 Appealing to under 24s

Whilst the presence of engineering has recently and increasingly entered the consciousness of young people aged 16–24 across the nation, those aged 11–16 and 7–11 are proving much harder to engage. Their views of engineering continue to differ quite noticeably from those of the general public and education professionals.

Only 12% of 11–16-year-olds currently claim to have some knowledge of what engineers do and a worrying 49% of 7–11-year-olds think it would be 'boring' to be an engineer. Their perceptions of engineers revolve around fixing and repairing things in the manual and mechanical sense plus the view that it is a dirty or messy job. This group does not tend to associate being an engineer with the designing and creating that they enjoy so much in the classroom.

Art and design is the favourite subject among this age group, with design and technology in third place. The key reason 7–11-year-olds gave for preferring these subjects was the enjoyment of the design and building element and the opportunity to be creative. Clearly the task now is to harness and retain this enthusiasm throughout their academic careers and to make the link between such subjects and engineering.

The perceived link between creativity and engineering is something which does currently improve with age, as recognition of the role of design in engineering is much higher amongst the 11–16s than amongst the 7–11s.

Despite this, however, the general lack of awareness or understanding of what engineers actually do means its desirability is low amongst this age group. Indeed, the younger the age group, the more desirability decreases, with only 18% of 11–16-year-olds believing engineering is desirable, compared with 45% of 16–24-year-olds. This is explained by a variety of factors, including the fact that physics is the least popular school subject for the younger age group but is a pre-requisite for most engineering Higher Education courses.

The greatest proportion of 16–24s, however, (38%) are not sure either way about whether engineering is desirable. This at least gives the engineering community a great deal of scope to educate them and broaden their perceptions. Of those students who were positive, the design and building elements and good pay were the main reasons given as to why they saw engineering as a desirable career.

8.4 Career choices

In terms of career choices and influences, the factors which appealed most to the 11–16s in terms of finding a suitable career were enjoyment (95%), something that 'interests' them (91%), and pay (91%). Working conditions and working hours also played an important role and were mentioned by 76% and 72% respectively. Of this group, 60% mentioned 'making a difference' as an important factor, which is perhaps another avenue to explore further when inspiring young people into careers in engineering. Other reports, such as *Engineering UK 2008* for example, reveal that a genuinely green agenda does help to attract new entrants into the profession.

When asked to rank the most important factors in career choice, however, 'being valued' was viewed as the single most important element, with enjoyment second and pay third. This may suggest that engineering employers and others in the sector need to look at presenting themselves as strong all-round employers prepared to invest in their employees.

Unsurprisingly, many of the jobs and careers that are viewed by young people as exciting are those that they come in contact with the most, and therefore understand and recognise. Becoming a teacher, actor, police officer, professional footballer, fashion designer, doctor or pop star/singer were firm favourites, whilst working in an office was down towards the bottom alongside cleaning and refuse collecting. However, this appreciation of exciting, non office-based careers is not entirely negative as it may present a specific window of opportunity in terms of promoting engineering. In addition, the desire amongst young people to make more of a contribution, particularly in relation to the green agenda, presents an opportunity for engineering in this sector.

It is also apparent from the study that more needs to be done to highlight the different progression routes into engineering, as 40% of education professionals and 31% of the general public believe that a first degree is the minimum educational requirement to become an engineer. They are unaware of the large number of engineers who operate at technician level having secured vocational qualifications. Interestingly, vocational qualifications were mentioned by 6% of the general public sample but not by any of the education professionals. It was the 16–24 group who were most aware of this route (36%) which is certainly a positive sign as vocational qualifications were not mentioned at all in the pilot study.

8.5 A brighter future

While many young people remain unsure of the benefits of engineering, there have clearly been shifts in the perception of engineering amongst the general public and amongst education professionals. The research certainly suggests that any negative associations with engineering, particularly among the younger respondents, are down to a simple lack of knowledge. The huge influence that families have on this group (at 73% this was by far the greatest influencer) alongside the encouraging statement that '85% of the public would recommend engineering as a career,' paints a brighter picture for the future. The increasing awareness of routes into the professions among the 16–24s is another positive finding. It is also evident that children enjoy the design and creativity elements fundamental to engineering. This presents a great opportunity for the engineering community to inspire and engage this group.

There is much promise for the future in the finding that 62% of education professionals, 35% of the public and 30% of 11–16s had seen, heard of, or visited something in the past year that presented engineering in a positive way and inspired them. Of these, the majority claimed that a positive representation on television or at an event or exhibition was what stuck in their minds. This suggests that, as methods of inspiring and engendering change, large scale activities do work but they will work even more effectively if targeted specifically at the young people involved, in addition to their influencers.

Key influencers

In order to change perceptions and encourage young people to find out more about engineering, it is vital to understand their key influences and influencers.

When 11–16-year-olds were asked about their career choices, they most commonly cited the advice of family and friends as being the most important influences. Perceptions of the money paid in the profession (51%), and the influence of careers advisers (33%) and education professionals (25%) were some way behind.

- 73% said family or parents/guardians would influence their choice
- 62% said friends would influence their choice
- 51% said their perceptions of the money paid would influence their choice
- 33% said careers advisers would influence their choice
- 25% said course tutors/lecturers/teachers would influence their choice
- 24% said how glamorous the profession was would influence their choice
- 24% said their own preference would influence their choice
- 23% said TV would influence their choice
- 19% said the Internet would influence their choice
- 17% said celebrities would influence their choice

The question of how to draw on and harness these influencers is addressed in the recommendations in Section 8.6.

8.6 Conclusions and recommendations

There must be a real drive towards ensuring that the increasingly positive perception and recognition of engineering amongst the over 24s is passed on to the under 24s, who will be the engineers of tomorrow.

In order to effect this change and keep the UK at the forefront of engineering and manufacturing, the Engineering and Technology Board (now EngineeringUK) makes the following recommendations:

- We advocate greater involvement of parents or guardians in engineering enhancement and enrichment activities, and the creation of targeted activities and promotional materials which parents and children can access either separately or together, communicating the range of benefits and opportunities of engineering careers
- Parents and guardians should be invited and actively encouraged to make use of school careers resources with their children, although young people should remain free to access resources by themselves if they prefer
- Engineering enhancement and enrichment activities should be increasingly introduced in primary schools as well as secondary schools and as an integral part of the many wider science, technology, engineering and maths (STEM) initiatives taking place. These initiatives should also be increasingly targeted at those schools where STEM engagement is historically low, and where they offer the most added value. Greater targeting, evaluating and coordination of existing activities should be introduced in order to identify where greatest social and geographical gaps are, in order to prioritise these areas

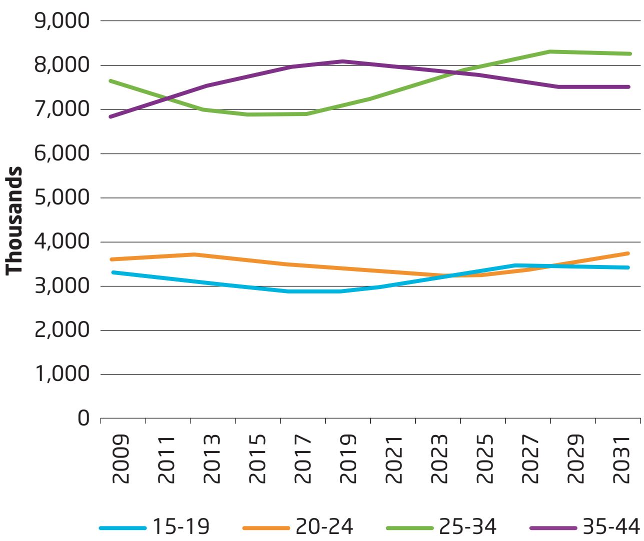
- Enrichment activities should also be aimed at making explicit the link between those elements of their studies that young people enjoy such as design and technology and careers in engineering. Employers should be encouraged to play a significant role in this, providing site visits and work experience opportunities in return for tax incentives and the opportunity to promote their particular business and sector. In addition, by increasing the overall availability of such activities, it would be likely that more young people will have had the opportunity to visit, see or hear of something which will present engineering in a good light
- Finally, greater attention must be given to supporting education professionals and providing them with accurate and engaging materials which make explicit the many different flexible pathways into engineering, including apprenticeships and Further Education routes as well as the traditional Higher Education pathway

Part 1 Engineering in Context

9.0 UK population changes

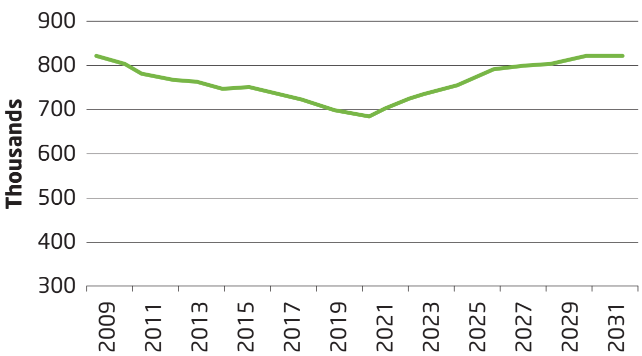
The Government Actuary's Department (GAD)[26] publishes population projections based on data collected in 2006; they focus on a 25 year projection, to 2031, and are produced by age and sex. Figure 9.0 shows the projected population by age band to 2031 and Figure 9.1 focuses on the population of 18-year-olds. The charts both show that in the next ten years the population of 18-year-olds and 15–24-year-olds will fall considerably – 16% and 8% respectively – before beginning to rise again.

Fig. 9.0: Projected UK populations by age last birthday (2006 base year)



Source: Government Actuary's Department (GAD)/ONS

Fig. 9.1: Projected 18-year-old UK population (2006 base year)



Source: Government Actuary's Department (GAD)/ONS

26 http://www.gad.gov.uk/

Part 1 Engineering in Context

10.0 Engineering inclusion

For those of us required to promote equality and inclusion in the workplace, a recession is always a challenge. We have to recognise that employers, whose support we will need to carry forward any initiatives we propose, are facing immediate challenges that may obscure the longer view. While we can provide guidance and advice on helping employers through the downturn[27] we need to keep an eye on the systemic challenges that will come back into sharper focus once the economy starts to pick up.

Of these, the one that presents both a problem and an opportunity is the demographic challenge. We know this from our work with professional bodies in science, engineering and technology. The 16% decline in the annual school-leaver cohort over the next 10 years will challenge all employment sectors, and as the *Engineering UK 2008* report observes, the more developed the nation, the less relevant or sought after engineering and technology careers seem to be. And the challenge isn't all at the higher end. There is already a significant shortage at the technician level: 'the very bedrock upon which engineering depends', to quote the report.

So what can the sector do to ensure that the challenge will be met? And from where will the next cohort of engineers and technicians come?

27 Equality and Human Rights Commission. *A short guide to... Managing the downturn and preparing for recovery.* http://www.equalityhumanrights.com/uploaded_files/managing_the_downturn_1_.pdf [Accessed 21 August 2009]

10.1 The changing landscape

To answer these questions we must look at who is missing from the current cohort. The sector has clearly recognised the under-representation of women, and has launched a number of initiatives to address that. It has recognised the growth in the number of 25–34-year-olds, and has identified these as potential career changers. Such recognition is happening in other professions, so engineering and technology should not expect a clear run. The report of the Cabinet Office on fair access to the professions, *Unleashing Aspiration*[28] has explored this and has recommended that:

"Professional bodies and professional regulators should encourage businesses in their sector to ensure that they meet the best practice in mid-career changes and career inter-change routes. Regulators should publish information on how successful professional employers are being in providing more flexible entry and progression routes."

But there is scope for growth in other areas, including those where under-representation has possibly more profound consequences for social cohesion. Disability doesn't represent a growing population, but constitutes 19% of the working age population. In addition to that, we need to recognise that, within the declining cohort of school-leavers, ethnic minorities are increasing. Recent national statistics demonstrate this (Tables 10.0 and 10.1):

Table 10.0: Percentage of white pupils (2006 and 2008)

	Primary %	Secondary %
2006	81.3	83.6
2008	80.0	82.5

Table 10.1: Numbers of students (2006 and 2008)

	White	Ethnic minorities	Total
2006	5,487,400	1,045,700	6,533,100
2008	5,319,780	1,158,460	6,478,240
		+ 112,760	- 54,860

Source: School Census data, 2006 and 2008

In Cardiff for example – a city with an 8% ethnic minority population at the last census – the primary school representation was 27% in 2008–09.[29] These are the cohorts that need to be won over to grow the sector.

And how might that be done in Cardiff alone? This raises the additional issue of where to intervene, and at what level. Policymakers tend to look at statistics at the national level: the UK or its member countries. So as well as looking statistically at, until now, unobserved groups, we need to focus on local interventions. This in particular is where small and medium-sized enterprises have a role to play. It is also where employers interact with local communities for which social inclusion may be an issue.

These are the untapped markets into which the sector must make inroads to recruit and train the numbers it needs. How should it best do that?

The *Unleashing Aspiration* report identifies the engineering sector as being proactive in this regard, citing its variety of entry routes (BTECs and apprenticeships, as well as graduate entry) and the STEM Ambassadors programme as good practice.

How effective are they at attracting under-represented groups into the sector?

Looking at some data at apprentice level, for example:

- Only 2% of apprentices are female
- Only 4% are from ethnic minority communities, and
- 6% have a learning difficulty, disability or health problem.

(*Daring to be Different: Equality and Human Rights Commission and Apprenticeship Ambassadors Network,* December 2007)

Our engineering heroes, Brunel, Ferguson and so on, were nothing if not enterprising, and the enterprise of engineering will be essential to our future prosperity. But as we move into an era where sustainability will be key to survival, "a sustainable enterprise (will be) one that contributes to sustainable development by delivering simultaneously economic, social and environmental benefits." (Hart, et al., 2003.)[30]

The Commission is a public body charged with helping to create a society where people can live their lives to the full, whatever their background or identity. We are living through rapidly changing times, both economically and socially. We believe that there is a 'diversity dividend'; that the more

28 The Panel on Fair Access to the Professions. *Unleashing Aspiration: The Final Report of the Panel on Fair Access to the Professions.* http://www.cabinetoffice.gov.uk/media/227102/fair-access.pdf [Accessed 21 August 2009]

29 Data from Cardiff City Council, September 2009: includes nursery, infant and junior as well as primary.

30 Hart, S L, Milstein, M B and Caggiano, J. May 2003. *Creating Sustainable Value.* The Academy of Management Executive. Vol 17, no 2. pp.56–69

inclusive we are the more benefits we will reap. There is thus a clear parallel between the human resource needs of the sector, the policy objectives of the Commission, and the wider sustainability objectives of society.

10.2 The way forward

It is well documented that women experience disadvantages in pay and other tangibles across the employment spectrum. The Institution of Civil Engineers has figures to prove it. This results in a waste of talent by the employer, and frustration for the individual. The equality bill will help to close the pay gap and challenge employers to work with the Commission to eliminate it.

How family friendly are the sector's working practices? The Commission's report, *Working Better: Meeting the Changing Needs of Families, Workers and Employers in the 21st Century,*[31] responds to the disparity between the skills levels shown by women, and their underuse in the economy.

The equality bill will allow businesses to better represent the communities from which they recruit, and to select qualified candidates from under-represented groups; breaking down historical social barriers. The Commission will be developing good practice guidance to allow employers to exploit the law to the fullest.

A key objective in our three-year strategic plan, linked to closing the gender pay gap, is to identify and tackle the root causes of occupational segregation, including careers advice and training provision.

How effective is careers advice and guidance in challenging stereotypes and supporting under-represented young people into the engineering sector? The track record is not good. A report by the Equal Opportunities Commission in 2005[32] found that 17% of girls were interested in a job in engineering work – almost double the 9.5% actually employed as engineering professionals – but there was little evidence of support through careers activity and work experience placements. A survey of 566 pupils in 20 schools found that no girls had undertaken an engineering placement.[33]

New research from the Commission into the aspirations of young people found career stereotypes to be still strong and we are following up with a major new work programme into ways of improving equality in subject and careers information, advice and guidance.

We are also involved in the STEM Choice and Careers programme, a national project to improve awareness and take-up of STEM subjects at school as a route to a better range of career opportunities.

The report, *Daring to be Different: the Business Case for Diversity on Apprenticeships*, was published jointly with the Apprenticeship Ambassadors Network in 2007.[34] It contains useful information on the business case for diversity in apprenticeships, and tips for employers to attract diverse groups. There is a more general discussion of this in our guide, *Talent not Tokenism: the Business Benefits of Workforce Diversity.*[35]

31 Equality and Human Rights Commission. Working Better: Meeting the changing needs of families, workers and employers in the 21st century. http://www.equalityhumanrights.com/uploaded_files/working_better_final_pdf_250309.pdf [Accessed 21 August 2009]

32 Equal Opportunities Commission. 2005. *Free to Choose: Tackling gender barriers to better jobs.*

33 Francis, B, Archer, L, Osgood, J and Dalgety, J. 2005. *Gender Equality and Work Experience Placements.* Equal Opportunities Commission

34 Equality and Human Rights Commission. *Daring to be Different: The business case for diversity in apprenticeships.* http://www.equalityhumanrights.com/uploaded_files/Employers/business_case_for_diversity_in_apprenticeships.pdf [Accessed 21 August 2009]

35 Equality and Human Rights Commission. *Talent not Tokenism: The business benefits of workforce diversity.* http://www.equalityhumanrights.com/uploaded_files/Employers/talentnottokenism.pdf [Accessed 21 August 2009]

10.3 Conclusion

In the Engineering and Technology Board's (now EngineeringUK) response to the consultation, *A Vision for Science and Society* (October 2008), it demonstrated an awareness of the challenges facing women with families, and a recognition that the traditional working week is just one way to get the job done. There is clearly an issue around recruitment from ethnic minorities at apprentice and technician level, and this may be part of a wider 'cultural barrier' to the industry. The experience of disabled people is largely unrecorded.

What is important is that the sector seizes opportunities to employ under-represented people, as well as recognising the challenges of this; the Commission is here to help.

The Equality and Human Rights Commission

The Equality and Human Rights Commission was launched in October 2007, taking over the role and functions of the former Commission for Racial Equality (CRE), the Disability Rights Commission (DRC) and the Equal Opportunities Commission (EOC), and assuming new responsibilities for sexual orientation, age, religion and belief, and human rights.

The Commission is a non-departmental public body (NDPB), established under the Equality Act 2006 as a corporate body. Its sponsor department is the Government Equalities Office. It has a board of commissioners who steer its work and direction. For further information see: www.equalityhumanrights.com

Part 2 Engineering in Education and Training
11.0 GCSEs

The educational landscape is changing (see box: The changing educational landscape) and this is likely to impact on the uptake of engineering-related education and training.

The changing educational landscape

The UK Vocational Qualifications Reform Programme (UKVQRP) has been underway for some time and much of the reform is now in place.[36] Aspects of this include changes in the England and Northern Ireland qualifications framework – from the National Qualifications Framework (NQF) to the Qualifications and Credit Framework (QCF) – and in regulatory systems. One of the changes is that all units and qualifications accredited into the QCF (see Annex 31.1) will follow a new titling regime. The QCF does not recognise any qualification types such as NVQ – it only defines qualifications in terms of size (Award, Certificate, Diploma) and demand (credit value and level). The change from NQF to QCF also impacts on the combinations of units prescribed or left optional within them (rules of combination), the specifications of units and qualifications (their content), and the degree to which they are subject to national or other scrutiny and monitoring. Country difference also means that, for example, Scottish Vocational Qualifications (SVQs) will be retained whilst National Vocational Qualifications (NVQs) will exist only in a new guise (see below) and the Apprenticeship framework is under change in England but not in Scotland. At the same time, opportunities arise such as (QCF) unitisation, unit and qualification level descriptors and the introduction of transferable credit.

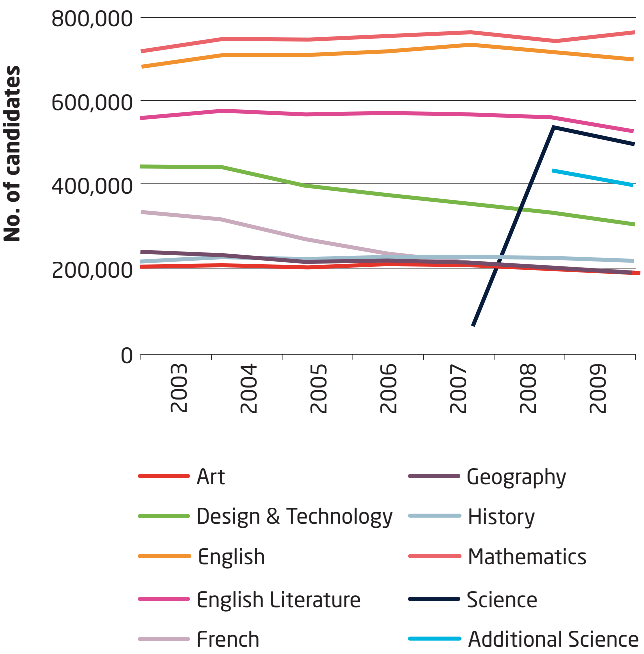
36 The UKVQRP has particular relationships with: *World Class Skills: Implementing the Leitch Review of Skills in England* (the 'Leitch agenda'); Delivering World-class Skills in a Demand-led System (change in the funding structures); and the Framework for Excellence (managing performance across the learning and skills sector). [LSC: http://qfr.lsc.gov.uk/ukvqrp/about/; http://qfr.lsc.gov.uk/ukvqrp/relationships/]

The General Certificate of Secondary Education (GCSE) is the primary qualification taken by secondary school pupils aged 14–16 in England, Wales and Northern Ireland. GCSEs can be taken with other awards, such as General National Vocational Qualifications (GNVQs).

The number of entries for GCSE in the core subjects (English, mathematics and science and Welsh in Wales) is chiefly set by the statutory requirements of the National Curriculum in England, Northern Ireland and Wales. Most of those studying these subjects will take GCSE examinations in them.

The core subjects account for nearly half of all GCSE full course entries (JCQ 2009).[37] In 2009, mathematics remained the most popular GCSE subject by proportion of entries (13.8% of total); English and English Literature being the second and third (12.82% and 9.66% respectively). Science and additional science took fourth and fifth place (9.02% and 7.26%) and design & technology sixth place (5.59%) – the most popular of the non-core[38] subjects.

Fig. 11.0: Top ten GCSE subjects (2009) – all UK candidates



Source: JCQ (2009). GCSE, Applied GCSE and Entry Level Trends 2009 (Chart 3).[39] http://www.jcq.org.uk/attachments/published/1131/GCSE%20Trends.pdf

There were 9.7m full-time and part time pupils in 33,700 (UK) schools in 2007/08, compared with 9.3m pupils in 34,600 schools in 1990/91.

DCSF and National Statistics [UK] (2008:7)[40]

There were 444 further education colleges (of which 95 were 6th form colleges) in the UK in 2007/08.

DCSF and National Statistics [UK] (2008:19)[41]

The proportion of 16–18-year-olds in education and training (in England) was 79.7% at the end of 2008 – the highest ever rate and an increase of 1.7 percentage points from 78.0% at end 2007. The total number of 16–18-year-olds in education and training increased by 34,000 to 1.61m at end 2008 – the highest number ever.

Participation In Education, Training and Employment by 16–18-Year-Olds In England SFR 12/2009 16 June 2009 [42]

37 JCQ (2009b). News release 27 August 2009 (GCSE results): http://www.jcq.org.uk/national_results/news_releases/2009/

38 http://www.jcp.org.uk

39 JCQ (2009a). GCSE, Applied GCSE and Entry Level Trends 2009. http://www.jcq.org.uk/attachments/published/1131/GCSE%20Trends.pdf

40 DCSF/BIS and National Statistics (2008).. Education and Training Statistics for the United Kingdom: V01/2008; November 2008; Government Statistical Service. http://www.dcsf.gov.uk/rsgateway/DB/VOL/v000823/index.shtml

41 DCSF/BIS and National Statistics (2008). Education and Training Statistics for the United Kingdom: V01/2008; November 2008; Government Statistical Service. http://www.dcsf.gov.uk/rsgateway/DB/VOL/v000823/index.shtml

42 DCSF/BIS and National Statistics (2009a). Participation In Education, Training and Employment by 16–18-Year-Olds In England SFR 12/2009 16 June 2009. http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000849/index.shtml

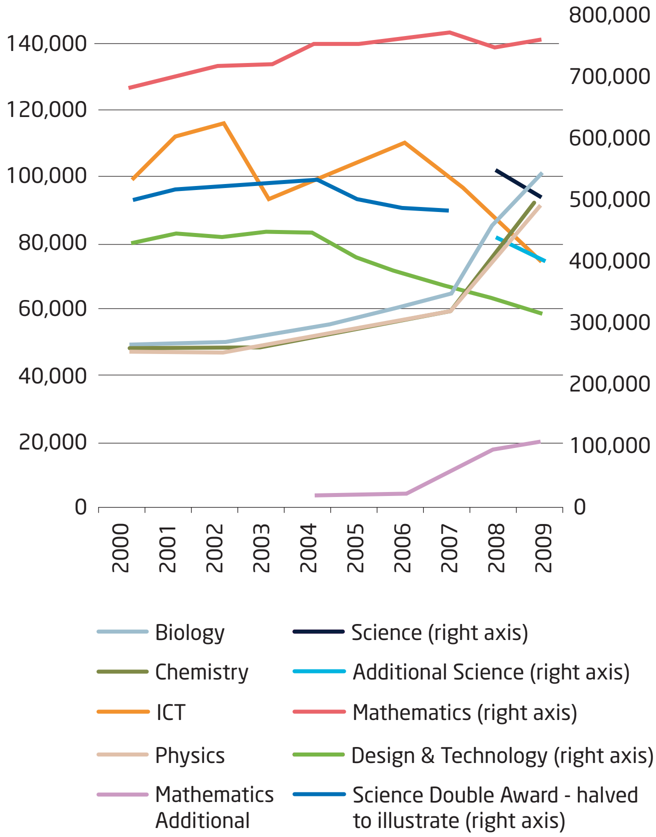
11.1 Entrant numbers

Encouragingly, the entrant numbers for separate single sciences has more than doubled over the period, with the greatest rises happening since 2007 (see Figure 11.1). Last year, entrant numbers to biology rose by 18%, chemistry by 20% and physics by 21%: the increase in physics uptake is particularly important as students will need GCSE and A level physics to progress onto Higher Education in engineering at many HE institutions. The increase in uptake of single sciences is partly due to the recognition of the importance of science education as an economic driver by the Government and the introduction of the requirement from 2008 for all pupils achieving at least a level 6 at Key Stage 3 to study three separate science GCSEs. There is, however, a gender imbalance in those taking separate sciences as illustrated in Figure 11.2 with fewer girls taking physics and chemistry at GCSE.

A new specification for science with a core GCSE and additional GCSE was first examined in 2007 and 2008 respectively and has begun to replace the previous double science qualification (science and additional science). A recent fall in numbers achieving this new double GCSE in science is evident but, with GCSEs chiefly taken by 16-year-olds, the demographic fall in the cohort number may account for at least part of the dip.

Despite the decreasing cohort, the number of mathematics entries increased by 2% in 2009. Additional mathematics continues to increase in popularity with entrant numbers having increased a further 11% in 2009. The fall in design and technology (D&T) entrants probably resulted from D&T being removed from the National Curriculum for 14–16-year-olds. As the mandatory components of the National Curriculum were reduced or replaced in 2004, D&T, along with other subjects such as modern foreign languages, was removed from the 14–16 statutory curriculum, leaving the mandatory core centred around mathematics, English and science and Welsh in Wales. Despite a 14% drop in entrants in the last year, D&T currently remains by far the most popular of the optional subjects (JCQ, 2008).[43]

Fig. 11.1: GCSE full courses entries (2001-2009) – all UK candidates

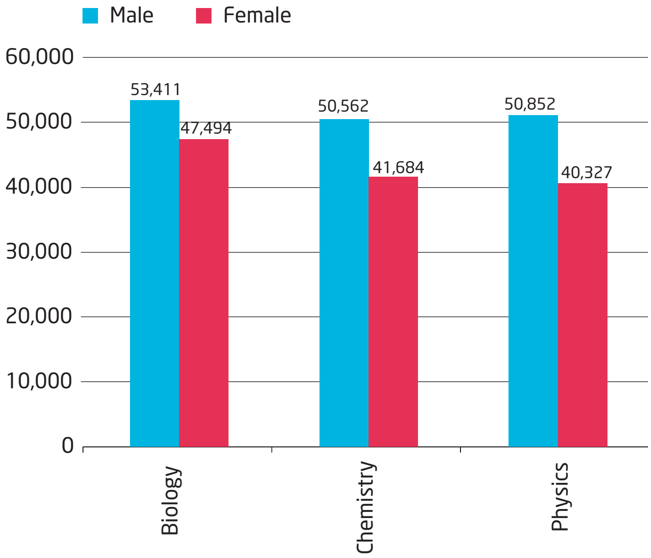


Source: Joint Council for Qualifications (JCQ) (provisional)

NB – Science Double Award candidate numbers are counted twice so have therefore been halved for the purpose of the chart. It was replaced by science and additional science in 2008.

43 JCQ Entry Trends – GCSE, Applied GCSE and Entry GCSE full course trends 2008: http://www.jcq.org.uk/national_results/news_releases/2008/

Fig. 11.2: Entrant numbers to separate science GCSEs by gender (2009) - all UK candidates



Source: Joint Council for Qualifications (JCQ) 2001–2009

In addition to GCSE entrants it is worth noting that BTEC first diplomas make a significant contribution in providing young people with engineering and construction skills. The latest Edexcel figures show growth of 89% and 340% from 2006/07 in entrants to engineering and construction skills respectively. In 2009/10 the entrant numbers to BTEC Firsts were 5,879 to engineering and 4,986 to construction skills.

11.2 A*–C achievement rates

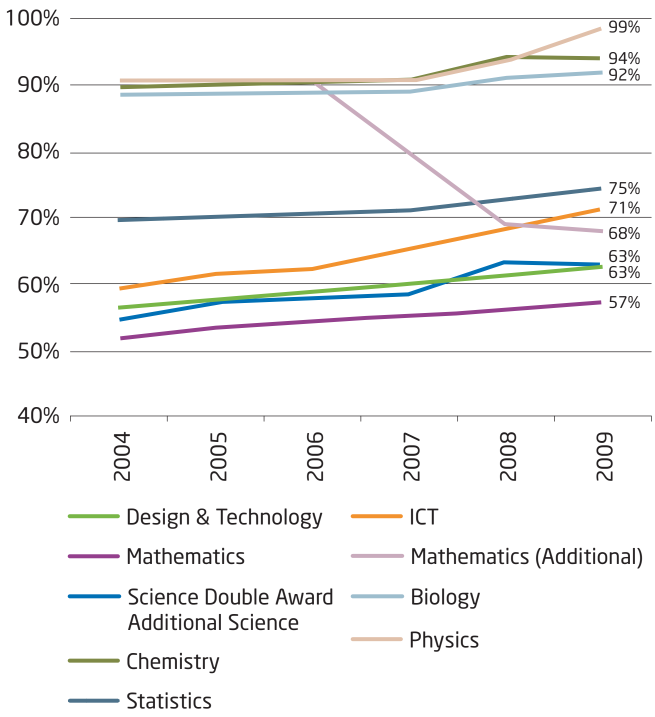
Figure 11.3 shows that, as one might expect, the A*–C pass rate is lower for compulsory subjects, with 57% of mathematics entrants and 63% of entrants to the science double GCSE (previously double award, now additional science) achieving A*–C. Despite substantial increases in the entrant numbers to biology, chemistry and physics, the pass rate remains very high at 92%, 94% and 98.5% respectively. Although there is a current policy push to mainstream these qualifications, they are more usually taken by science-proficient students, often studying in independent or selective state schools. This is illustrated in Figure 11.4.

The pass rate for additional mathematics has dropped over the period as it becomes more inclusive, though, at 68% in 2009, it is by no means low. ICT has increased by 12 percentage points since 2004 to 71.4% of entrants achieving at least a C grade.

The proportion of A*–C grades in design and technology has increased by six percentage points since 2004 to 63%.

The pass rate for statistics has also steadily risen from 70% to a healthy 74% across the period.

Fig. 11.3: GCSE A*-C Pass Rates (2004 - 2009) - all UK candidates

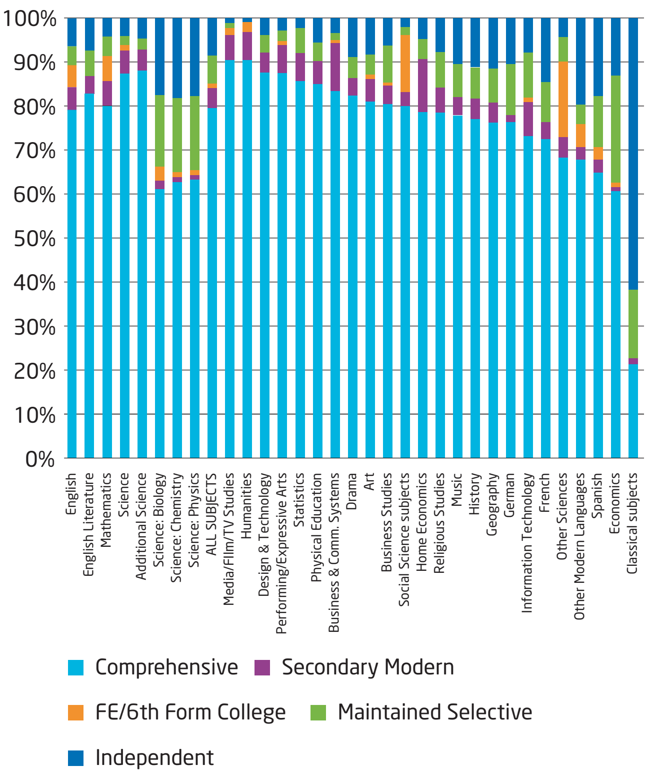


Source: Joint Council for Qualifications

11.3 GCSEs by school type

JCQ analysis (2009)[44] (Figure 11.4) provides a picture of subject choices by school and college type. Media/film and TV subjects (which may include engineering-related technologies), humanities, science, additional science and design & technology feature most highly as GCSE choices in comprehensive school choices. The single ('triple') sciences, economics and classics have the lowest take-up in comprehensive schools. Take-up will of course have some relationship to availability.

Fig. 11.4: GCSE subject choices by school and college type (2009) – all UK candidates



Source: JCQ (2009c). *Data for Centre Types and Regions, GCSE, Applied GCSE, ELC 2009*. http://www.jcq.org.uk/national_results/news_releases/2009/

44 JCQ (2009c). Data for Centre Types and Regions, GCSE, Applied GCSE, ELC 2009. http://www.jcq.org.uk/national_results/news_releases/2009/

Part 2 Engineering in Education and Training
12.0 Scottish Standards

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

Standard Grades or Intermediates are taken by students aged 14–16 in Scotland and broadly align with GCSEs. There are three 'tiered' levels at which Standard Grade examinations can be taken; Foundation, General and Credit. Intermediates are becoming increasingly popular as they are said to align better with the Scottish Higher examinations. The Standard Grade examination is being phased out with gradual realignment to Scottish Credit and Qualification Framework (SCQF); the equivalent levels are detailed in Table 12.0.

Table 12.0 also shows the volume of entries for the different Standard Grade and Intermediate examinations by STEM subject in 2009. SCQF level 5 is roughly equivalent to NQF (England, Wales and Northern Ireland) level 2. Encouragingly, there was an increase in the number of entrants to mathematics (10%) and physics (9%) at credit grade since 2008.

Table 12.0: Standard and Intermediate Grade entry volumes SCQF levels 3-5 (2009) - Scotland

	Standard Grade	Access 3 (Equivalent to Foundation Standard Grade)	Intermediate 1 (Equivalent to General Standard Grade)	Intermediate 2 (Equivalent to Credit Standard Grade)
		SCQF level 3	SCQF level 4	SCQF level 5
Biology	21,028	2,314	5,748	6,924
Chemistry	19,473	1,870	3,058	4,108
Computing	13,586	1,348	2,294	2,948
Mathematics	46,779	10,902	12,061	21,485
Physics	14,780	1,027	2,557	3,796

Source: Scottish Qualification Authority (SQA), Scottish Credit and Qualification Framework (SCQF) – 2009

Part 2 Engineering in Education and Training

13.0 AS levels and A levels

The General Certificate of Education Advanced Level (GCE A level) is the primary post-GCSE qualification taken in the last two years of secondary school, sixth-form college or further education college in England, Wales and Northern Ireland. In 2009 a third of all A levels were taken in a college.

13.1 AS level entrant numbers

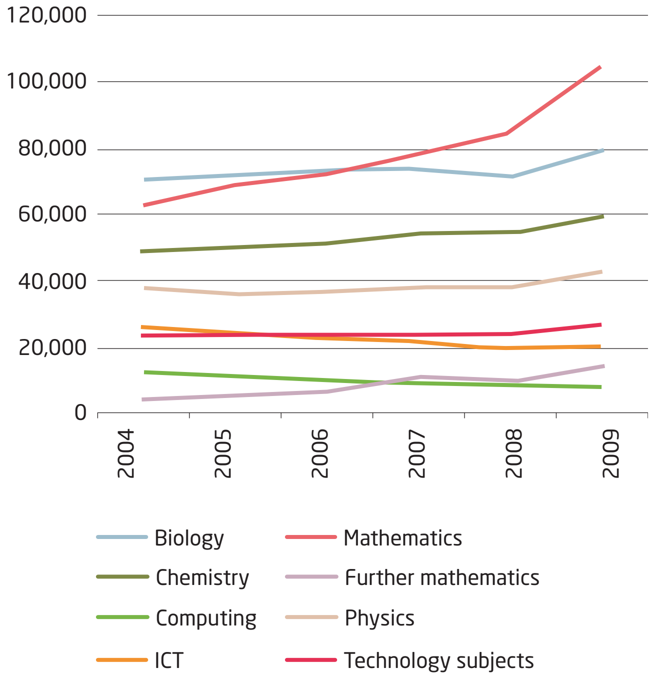
Most STEM AS levels have seen their entrant numbers rise over the six year period, as shown in Figure 13.0. The rise in entrants to AS mathematics immediately stands out in the chart, with numbers increasing by two thirds since 2004. There were over 103,000 students taking AS level mathematics in 2009, by far the most popular STEM AS level.

Most subjects have seen an upturn in entries in the last year, with the exception of computing and ICT. Computing has seen numbers decline from 11,700 in 2004 to 7,500 in 2009 and ICT entrant numbers have fallen by nearly 6,000 since 2004.

The number of students choosing physics AS level has risen by 14% over the period, which includes a 10% rise in the last year. Biology and chemistry entrant levels have both risen steadily at 13% and 21% respectively.

There was a 9% rise in entries to technology subjects since 2008, whereas, in preceding years, grades have remained reasonably static, at around 23,000.

Fig. 13.0: GCE AS level STEM subjects entrant volumes (2004-2009) - all UK candidates



Source: Joint Council for Qualifications (JCQ)

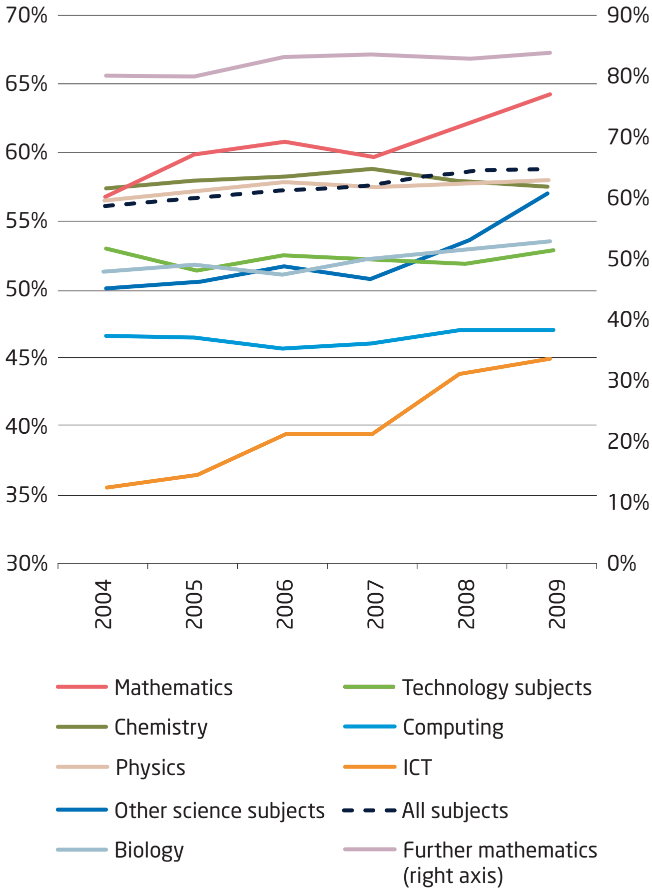
13.2 AS level A-C achievement rates

In 2009 most STEM subjects had a lower proportion of entrants achieving an A–C grade than the average for all subjects, which was 59% (see Figure 13.1). There has been much debate about the relative difficulty of STEM subjects and how it affects people's choices when competing for university places.[45] The relatively low levels of students attaining C or higher in computing (47%) and ICT (45%) certainly would beg the question of whether the perceived difficulty is having an effect on student uptake in these subjects.

Most students who studied AS further mathematics achieved A–C grades. This subject stands out as having particularly high levels across the period, from 80% in 2004 to 84% in 2009. The greatest increase in attainment level is in mathematics; the A–C achievement rate rising up nine percentage points to 64% in 2009.

Biology achievement rates have been steadily increasing, reaching 53% in 2009, whereas rates in physics and chemistry were a little higher at 58% and 57% respectively.

Fig. 13.1: GCE AS level grade A-C achievement rates (2004-2009) - all UK candidates



Source: Joint Council for Qualifications (JCQ)

13.3 AS level gender balance

Analysing each subject by gender, as in Table 13.0 and Figure 13.2, shows that the ratio of male to female students varies greatly within STEM. Chemistry is the only subject with near parity, whereas biology is favoured by female students, who made up 57% of entrants this year. Female participation is lowest in computing, with girls only accounting for one in ten AS entrants in 2009. The split in technology subjects and mathematics is more even: in both, 58% male and 42% female students took AS examinations this year. Fewer females opt for further mathematics (35%) and physics (24%), where the gender imbalance remains an issue.

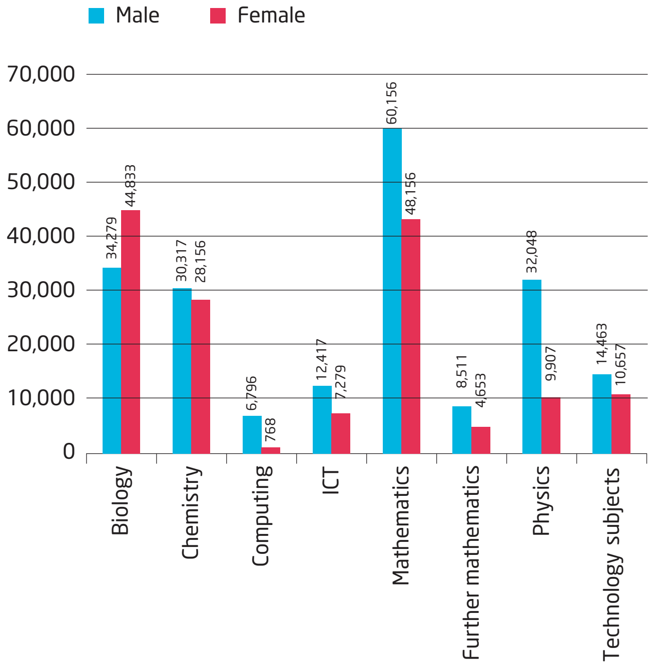
45 Section 1c, page 21, *Engineering UK 2008*

Table 13.0: AS level gender balance (2009) – UK

	Male	Female
Biology	43%	57%
Chemistry	52%	48%
Computing	90%	10%
ICT	63%	37%
Mathematics	58%	42%
Further mathematics	65%	35%
Physics	76%	24%
Technology subjects	58%	42%

Source: Joint Council for Qualifications (JCQ) 2009

Fig. 13.2: GCE AS level entrant volumes by gender (2009) – all UK candidates

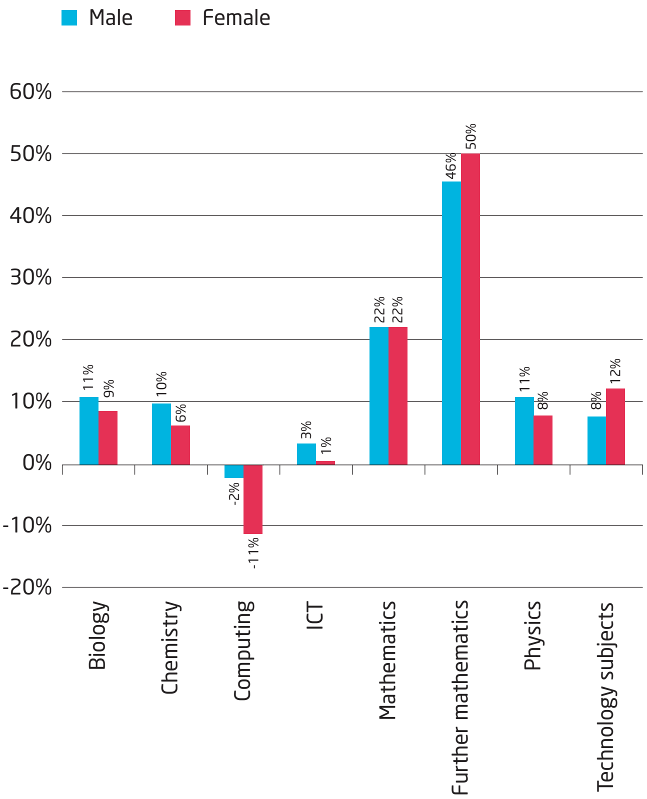


Source: Joint Council for Qualifications (JCQ) 2009

The greatest change since 2008 is the continued rise in the popularity of further mathematics, as illustrated in Figure 13.3, with a substantial 46% rise in male entrants and a 50% rise in female entrants. It should be noted, however, that the numbers are still relatively low.

Computing is the only STEM subject to experience a decrease since last year in entrant numbers, male or female.

Fig. 13.3: Change in GCE AS level entry volumes by gender (2009 vs 2008) – all UK candidates

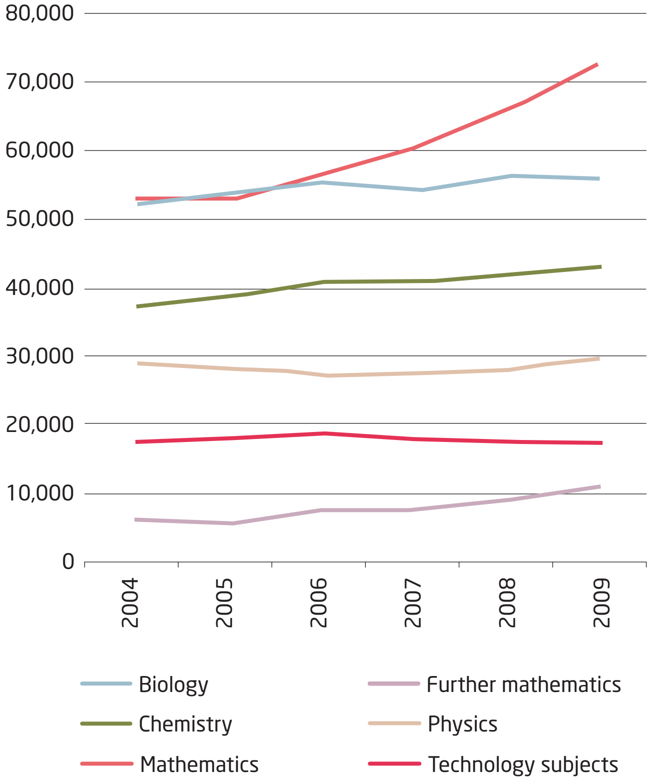


Source: Joint Council for Qualifications (JCQ)

13.4 A level entrant numbers

As shown in Figure 13.4, the positive trend for mathematics at AS level is also evident in the A level entrants. This amounted to over 72,000 this year – a 37% rise since 2004. Further maths entries continue to rise and exceeded 10,000 in 2009. Entries to biology had risen by 6%, chemistry 14% and physics by only 2%. Entrant numbers to physics A level were falling before 2006. Since then, there has been an encouraging rise of 8%. Entrant numbers to technology subjects, however, remain consistently around 17,000 across the period.

Fig. 13.4: GCE A level STEM subject entrant numbers (2004–2009) – all UK candidates



Source: Joint Council for Qualifications (JCQ)

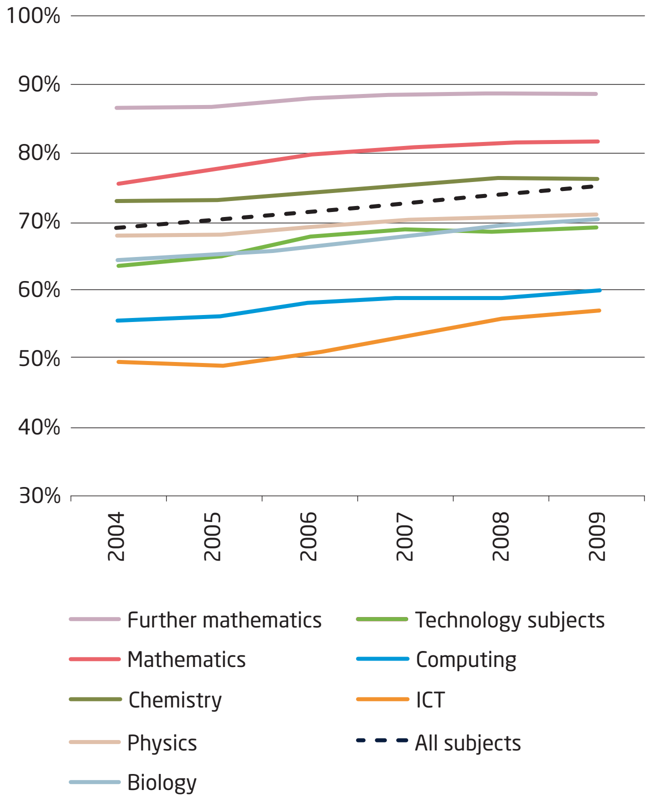
13.5 A level A–C achievement rates

Across the STEM disciplines, 57% to 89% of A level entrants achieved a grade C or above in 2009 (see Figure 13.5). Since 2004, this proportion has increased in all subjects, though this year's levels were consistent with 2008 for most subjects.

Mathematics A level has 82% of students attaining A–C, with even more achieving these grades in further mathematics (89%). Of those taking science subjects at A level, 75% achieve A–C in chemistry, 71% in physics and 70% in biology. Technology subjects have 69% of students gaining a minimum C grade.

Computing and ICT remain the subjects within STEM with a lower proportion of students achieving A–C: at 60% and 57% respectively. However, there has been considerable improvement in the period. In 2004 only 49% of ICT entrants reached this grade.

Fig. 13.5: Proportion achieving grade A-C at GCE A level (2004–2009) – all UK candidates

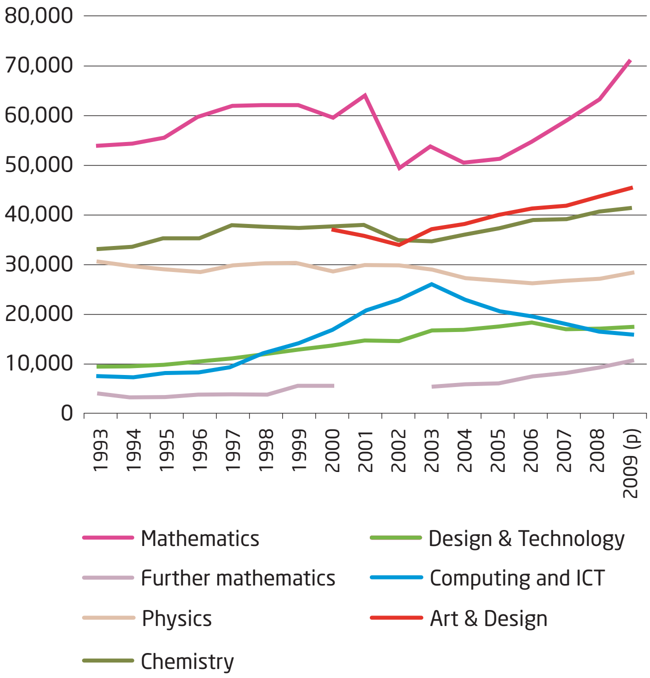


Source: Joint Council for Qualifications (JCQ)

13.6 17-year A level trend: 1993-2009

Looking at a much longer time scale – 1993–2009 – we can observe that the fall in mathematics achievements in 2002 followed the A level revision in 2000 (see Figure 13.6). Problems with this were rectified and the number of achievements has since regained impetus, rising again in 2008 to meet the 2001 high point and rising further in 2009. Numbers of achievements in chemistry and in further mathematics continue to rise and in physics a recent slight upturn is evident. Achievements in design & technology started to fall slightly in 2008, perhaps following from the downturn in numbers taking GCSE (see earlier), but rose again in 2009. Achievements in computing and ICT have seen quite a marked decline from 2003 – possibly following from an apparent downturn in the UK ICT jobs market post the millennium. Given that art & design has always been an optional National Curriculum subject at ages 14–16, it enjoys remarkable success at A level.

Fig. 13.6: GCE A levels achieved in selected A level subjects (1993-2009) - all UK candidates



Source: Joint Council, AQA / JCQ

13.7 Gender balance within STEM A level

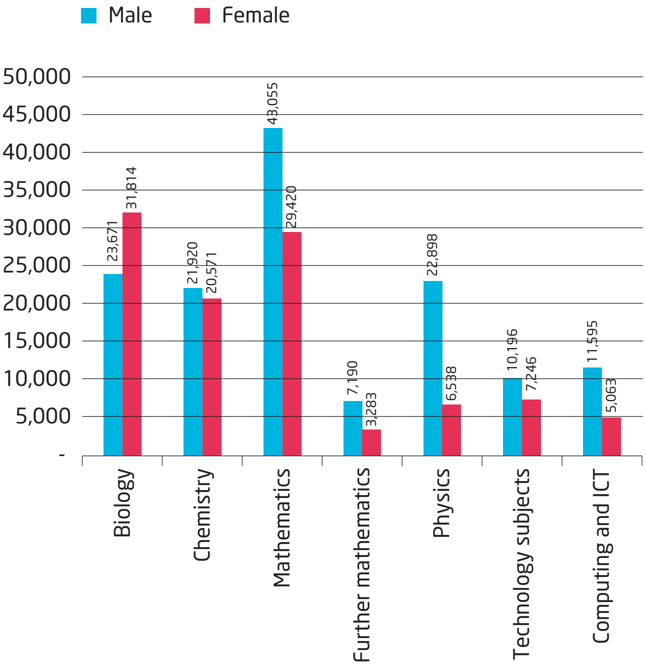
The gender balance between STEM subjects at A level in 2009 is illustrated in Table 13.1 and Figure 13.7. Unsurprisingly, the pattern is more or less the same as the AS level entrants, with chemistry having near parity between male and female students and mathematics, ICT and technology subjects having a male to female ratio of around 60:40. The balance between entrants to biology is slightly more female biased (57%) whereas physics and computing remain heavily male dominated.

Table 13.1: Gender balance within STEM A levels (2009) - UK

	Male	Female
Biology	43%	57%
Chemistry	52%	48%
Computing	90%	10%
ICT	61%	39%
Mathematics	59%	41%
Further mathematics	69%	31%
Physics	78%	22%
Technology subjects	58%	42%

Source: Joint Council for Qualifications (JCQ)

Fig. 13.7: GCE A level entry volumes by gender (2009) – all UK candidates



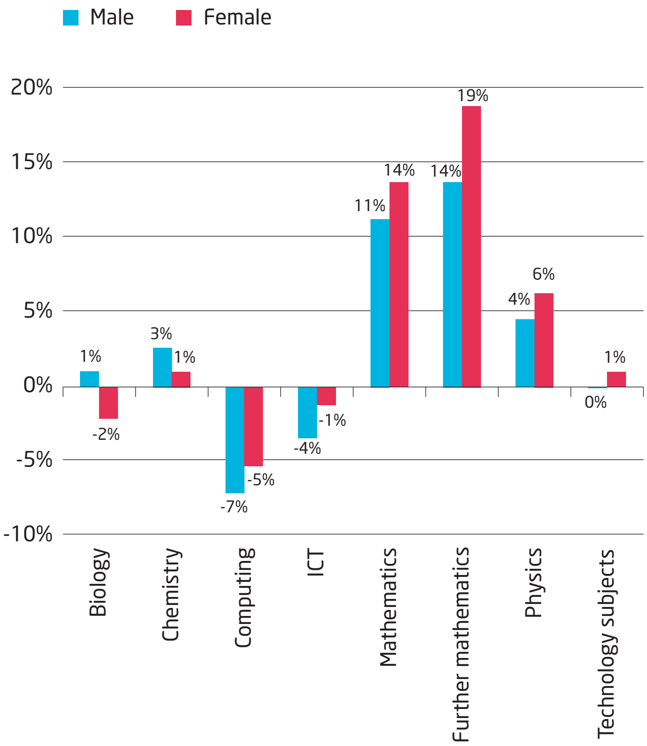
Source: Joint Council for Qualifications (JCQ)

Figure 13.8 shows the percentage change in entrant numbers to STEM A level subjects by gender. The increasing popularity of mathematics and further mathematics is evident again – as is the fall in computing and ICT.

13.8 Choices and achievements by school/college type

The Guardian online's analysis of 2009 A level results,[46] based on JCQ 2009,[47] includes two charts. One chart looks at subjects taken by school/college type (Figure 13.9). At its extremes, this illustrates the dominance of design & technology A level entries in comprehensive schools and of classics in independent schools. Mirroring of GCSE choices is evident (see Figure 11.4). The other (Figure 13.10) shows the dominance of A grade achievement in independent schools (50% of A grades according to the BBC).[48] The proportion of 18-year-old students in independent schools is around 20% of the cohort (HoC 2008).[49]

Fig. 13.8: Change in GCE A level entry volumes by gender (2008–2009) – all UK candidates



Source: Joint Council for Qualifications (JCQ)

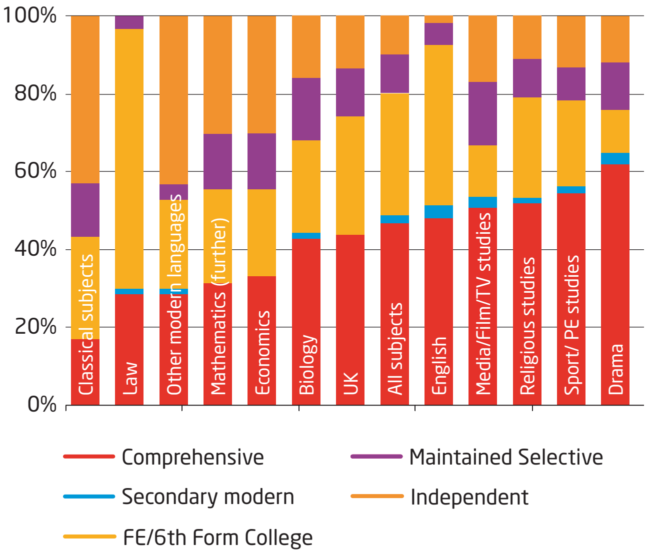
46 Guardian online (2009b): A levels: interactive guide. http://www.guardian.co.uk/education/interactive/2009/aug/20/a-levels

47 JCQ (2009e). Data for Centre Types and Regions, GCE, Applied GCE, AEA 2009. http://www.jcq.org.uk/national_results/news_releases/2009/

48 BBC News online 20 August 2009: Record top A level grades awarded: http://news.bbc.co.uk/1/hi/education/8211245.stm

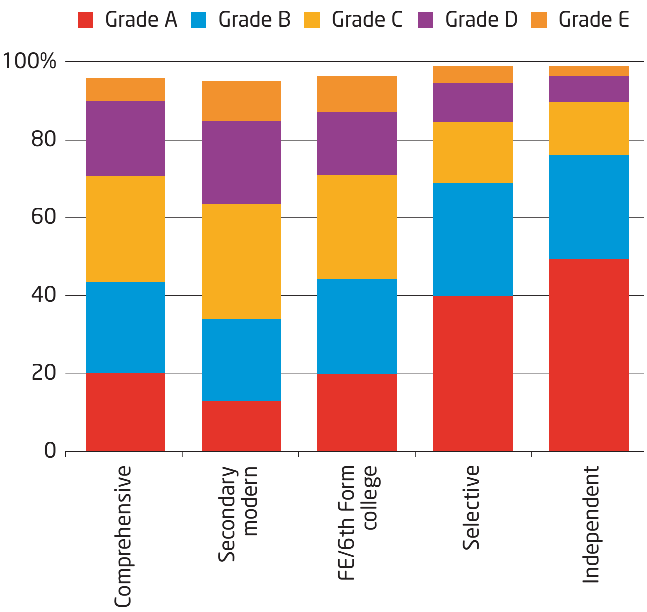
49 House of Commons Committee of Public Accounts (2008). *Staying the course: the retention of students on higher education courses: Tenth Report of Session 2007–08*. http://www.publications.parliament.uk/pa/cm200708/cmselect/cmpubacc/322/32202.htm

Fig. 13.9: Guardian analysis of A level subjects by school/college type (2009) – England



Source: Guardian online: http://www.guardian.co.uk/education/interactive/2009/aug/20/a-levels and JCQ

Fig. 13.10: Guardian analysis of A grades achieved at A level by school/college type (2009) – England



Source: Guardian online: http://www.guardian.co.uk/education/interactive/2009/aug/20/a-levels and JCQ

Part 2 Engineering in Education and Training

14.0 Scottish Highers

In Scotland, the equivalent qualifications to A levels are the Higher Grade or Advanced Higher Grade, usually known as 'Highers'. These are set at SCQF level 6, roughly equivalent to NQF level 3.

Tables 14.0 and 14.1 show the volume of entries and pass rates for Highers and Advanced Highers in 2009 with the 2008 figures for comparison. There have been a few minor changes, both positive and negative, to entrant numbers and pass rates across STEM. The upward trend in the number of mathematics entrants in AS and A levels wasn't evident in the Higher, though the number of entrants to the Advanced Higher in mathematics had risen a substantial 10%. There were more entrants to computing Higher and Advanced Higher in 2009 than 2008. Pass rates across STEM remain consistently high.

Table 14.0: Higher entries and passes SCQF levels 6-7 (2009) - Scotland

SUBJECT	Entries 2008	Entries 2009	Pass Rate 2008	Pass Rate 2009
Architectural technology	65	62	53.8%	59.7%
Biology	9,130	9,104	70.3%	70.8%
Biotechnology	35	28	65.7%	67.9%
Building construction	39	36	56.4%	50.0%
Computing	4,252	4,305	67.0%	66.9%
Human biology	3,754	3,989	67.9%	67.8%
Information systems	1,484	1,413	71.0%	71.6%
Mathematics	19,633	19,631	71.6%	69.7%
Mechatronics	13	25	76.9%	100.0%
Physics	8,762	9,001	74.1%	76.0%
Product design	2,122	2,390	68.4%	65.8%
Technological studies	755	621	61.3%	74.2%

Source: Scottish Qualification Authority (SQA), Scottish Credit and Qualification Framework (SCQF) – 2009

Table 14.1: Advanced Higher entries and passes (2009) - Scotland

SUBJECT	Entries 2008	Entries 2009	Pass Rate 2008	Pass Rate 2009
Applied mathematics	305	305	75.4%	74.4%
Biology	1,955	2,095	74.4%	71.6%
Chemistry	2,143	2,183	75.4%	77.8%
Computing	366	411	74.0%	79.6%
Mathematics	2,752	3,027	69.0%	65.4%
Physics	1,403	1,550	77.0%	76.8%
Technological studies	90	85	73.3%	74.1%

Source: Scottish Qualification Authority (SQA), Scottish Credit and Qualification Framework (SCQF) – 2009

Part 2 Engineering in Education and Training
15.0 Non progression

Though AS and A level trends are for the most part positive, there remains a significant loss of potential talent through able students not progressing to level 3 after GCSE. Table 15.0 shows that over half of students with seven GCSEs do not advance their studies.

Table 15.0: Non-progression to level 3 from GCSE, by number of GCSEs held – England

GCSEs (A* to C) at 16	Number not progressing to level 3 by 18	Percentage of the relevant group
None	154,000	99%
1 to 4	122,000	90%
5	21,000	70%
6	19,000	61%
7	18,000	52%
8	17,000	39%
9	16,000	21%
10+	19,000	14%
Total	386,000	60%

Source: HEPI 'Demand for Higher Education to 2029' 2008

Whilst Geoff Stanton and colleagues (2008)[50] chiefly discuss the HE sector, they argue that the "whole educational ecology", involving stages of selection (overt or hidden), which begins well before the age of 16,[51] impacts in lack of diversity and exclusion further up the system, including damaging "the status of vocational provision by associating it in the public mind with lower levels of achievement". (Stanton et al. 2008:9) (See box Stanton et al).

50 Stanton G. et al. (2008). Unfinished business in widening participation – the end of the beginning. London: Learning and Skills Network (LSN)

51 For example: Boaler, J. (1997). Setting, Social Class and Survival of the Quickest. British Educational Research Journal, 1997, 23 (5) 575–595.

Bourdieu, P. (1966). The school as a conservative force: scholastic and cultural inequalities. In J. Eggleston (Ed.), 1974, Contemporary Research in the Sociology of Education. London: Methuen. 32–46.

Bourdieu, P. and Passeron, J–C. (1990). Reproduction in Education, Society and Culture: Second edition. London, Thousand Oaks, New Delhi: Sage Publications.

Keddie, N. (1971). The Social Basis of Classroom Knowledge: A Case Study. In M. F. D. Young (Ed.), Knowledge and Control, 1971, (pp.133–160). London: Collier-Macmillan.

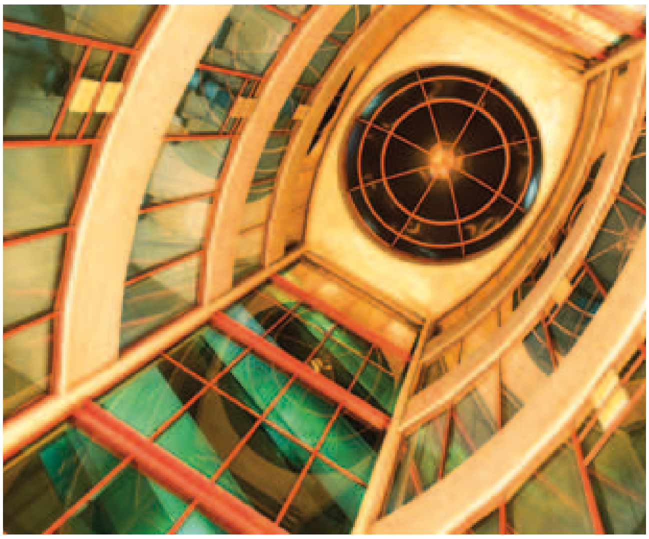
Stanton et al (2008)

"Achieving five or more 'good' GCSEs (that is, passes at grades A* to C) gives individuals access to the 'royal route' to university, via A levels. Half the population does not cross this GCSE threshold by this age, nor, I will argue, should it be expected that they should. However, if they do not, two other factors come into play.

- They tend to be excluded from the most prestigious and best-resourced forms of 16–19 education, which are not socially inclusive
- Only the vocational route is asked to cater for this half of the 16+ population. The task is not shared by a general education route designed for post-16 participation. This has two further consequences:
    - It damages the status of vocational provision by associating it in the public mind with lower levels of achievement
    - It tends to distort the integrity of otherwise effective vocational qualifications by requiring them to provide access to Higher Education as well as to the world of work

This nation of 'two halves' – one more privileged than the other – extends into adulthood."

Source: Stanton G. et al. (2008:9). *Unfinished business in widening participation the end of the beginning.* London: Learning and Skills Network (LSN)



Part 2 Engineering in Education and Training

16.0 NEETs

The significant issue of NEETs (not in education, employment or training) is worthy of recording as the figures for short-term 16–24-year-old unemployment show that 927,000[52] young people are currently unemployed, with youth unemployment expected to exceed 1m in 2010. Within the 16–18 year cohort, the proportion of NEETs increased from 9.7% at the end of 2007 to 10.3% at the end of 2008. In 2007, 56% of young people not in education or training were in work. In 2008, this fell to 49% (SFR 12/2009).[53]

This issue has been recognised and hopefully will be addressed by Government when all young people in England will be required to continue in education or training to age 17 by 2013 and to age 18 in 2015. This does not, however, mean that they will all be in full-time or even part-time schooling or college. They may, for example, be fully employed and undertaking an apprenticeship or other work or community-based learning programme.

52 http://www.centreforcities.org/index.php?id=908
DCSF and National Statistics (2009a). Participation

53 DCSF and National Statistics (2009a). *Participation In Education, Training and Employment by 16–18-year-olds In England.* SFR 12/2009 16 June 2009 http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000849/index.shtml

Part 2 Engineering in Education and Training

17.0 14–19 Diplomas

This section focuses on the Diplomas in Construction and the Built Environment (C&BE), Engineering and IT with contributions from CSkills, Semta and eSkills.

The Diploma is a new qualification that combines theoretical study with practical experience and is part of the 14–19 reform programme being rolled out over the next five years.

The reform programme is designed to educate young people for the fast changing world they are growing up in; it offers exciting choices and opportunities to equip young people for adult life and to help them enjoy a brighter future.

GCSEs and A levels are also being updated and the number of apprenticeships is being increased. Taken together, these changes will mean that all young people can choose a qualification which suits their interests and learning style.

The introduction of the Diploma is part of this national programme.

Diplomas will cover 17 subjects, or lines of learning, and will be available in areas across the country by 2011.

All Diplomas will require students to achieve a minimum standard in English, mathematics and ICT, complete a project and do a minimum of 10 days' work experience.

The Diploma will provide students with an integrated programme of study made up of different courses and awards. Foundation and Higher Diploma students can go on to study for the next level of Diploma, take a different type of qualification such as a GCSE, A level or Apprenticeship, or go on to a job with training.

An Advanced Diploma can lead on to university or into a career. The Diploma will help students make decisions about their future direction without closing down options.

Source: Department for Children, Schools and Families

17.1 Construction and the Built Environment (C&BE) 14–19 Diploma

The Diploma in construction and the built environment (C&BE) has been designed to provide a programme of applied and practical learning which introduces young people to the fabric of the world in which we live and its impact on individuals and communities. It progressively builds up an understanding of the physical extent and significance of the built environment and of the activities which shape, develop and influence it.

Aims of the Diploma in C&BE

The Diploma aims to give learners:

- Opportunities to practise and acquire essential functional skills in English, mathematics and ICT which are relevant to the level and delivered and assessed in the context of construction and the built environment
- Relevant personal, learning and thinking skills in a construction and the built environment context
- Progression routes to other diplomas, further training and apprenticeships
- Effective transition to Further Education, work-based learning or Higher Education and to adult and working life
- A motivating learning experience through a blend of general education and applied learning within a coherent and motivating programme

Structure of the Diploma in C&BE

The Diploma in C&BE is offered at three levels: Foundation (equivalent to 5 GCSE grades at D–G), Higher (equivalent to 7 GCSE grades at A*–C) and Advanced (equivalent to 3.5 A levels).

At each level it comprises principal learning, generic learning and additional/specialist learning based round the three themes of:

- Design of the built environment
- Creation of the built environment
- Value and use of the built environment

Foundation level Diploma

This gives a broad introduction to the nature and extent of the built environment, the factors influencing its design and construction and its impact on people and communities.

Higher level Diploma

This gives the learner an opportunity to develop and apply a range of skills and knowledge in relation to the design, creation, maintenance and use of the built environment.

Advanced level Diploma

This level provides the learner with an opportunity to analyse, evaluate and explore principles and practices relating to the social, economic and cultural contribution of the built environment and the wider factors influencing its design, creation, maintenance and management.

The principal learning:

- Covers the skills, knowledge and understanding central to the Diploma in C&BE
- Is at least 50% practical
- Is designed and endorsed by employers

Generic learning:

- Functional skills in English, maths and ICT
- Personal learning and thinking skills (independent enquiry, creative thinking, reflective learning, team working, self-management and effective participation)
- A project, linked to the principal learning

Additional/specialist learning:

Subjects are chosen from a variety of optional units which are designed to broaden and deepen the learning programme and can help towards progression.

constructionskills

Delivery of the Diploma in C&BE

The Diploma in C&BE was one of the first five to be developed and 44 consortia started delivering the two year programme to 1,710 learners in September 2008. Eighty seven further consortia have been approved to start delivery in September 2009 to between an estimated 4,000 and 5,000 learners. In September 2010, another 57 consortia have been approved to start delivery.

The principal learning is accredited by Edexcel and City and Guilds/AQA. Various awarding bodies are developing the specialist and additional learning.

Employer support

Employers have played a vital role in helping develop the content of the Diploma in construction and the built environment and are now fully engaged in helping teachers and college lecturers to deliver it. Over 1,000 employers have signed up to help with work-related learning. These vary from major contractors and the large utilities companies to local businesses such as plumbers, painters, electricians and double glazing installers. Councils, through the planning department, housing associations and estate agents are also involved.

Further information is available at www.cbediploma.co.uk

17.2 Engineering 14–19 Diploma

Fig: 17.0: Engineering 14–19 Diploma

1. Objective

To provide summary of the current situation, facts and figures relating to the Diploma in Engineering

2. Background

The Diploma in Engineering commenced delivery during the Autumn Term 2008. Diplomas will appeal to young people wishing to stay in full-time education, but who want to undertake a blend of high quality applied learning and generic skills.

The aims of the Diploma are to:

- provide a strong applied learning experience for young people, enabling a mix of general education and applied learning within a coherent and motivating programme
- develop young people who, when they enter employment, have the essential skills and capabilities to meet employer needs
- aid effective transition from college or school to further and higher learning and to adult and working life

Diplomas at the relevant level provide progression to:

- GCSE and A level
- Vocational qualifications such as BTEC and City & Guilds
- Apprenticeships and Advanced Apprenticeships
- Higher education

3. Structure of the Diploma (numbers refer to Guided Learning Hours)

	Total	Principal learning	Additional and Specialist Learning	Functional Skills	Project	Personal Learning and Thinking Skills
				Generic Learning		
Foundational	600	240	120	120	60	60
Higher	800	420	180	80	60	60
Advanced	1080	540	360	0	120	60

Principal Learning
Key themes in Diploma in Engineering at all three levels:

- The engineered world
- Discovering engineering technology
- Engineering the future

The Advanced Diploma also includes study of Analytical Methods for Engineering.

Additional and Specialist Learning
At each level, students can develop particular engineering interests further by taking specialist courses relating to their chosen subject and career ambitions. Students can also broaden the course by taking an additional subject that reflects other interests and career ambitions – like a language, a science, or a creative subject like music.

Functional Skills
Skills to an appropriate level in functional English, mathematics and IT.

Project
Linked to the Principal Learning, the project which is individual or team-based.

Personal Learning and Thinking Skills
Skills which enable students to be independent enquirers, creative thinkers, reflective learners, team workers, self managers, and effective participators

4. The Diploma in Engineering in delivery

Awarding bodies: Principal Learning is accredited by Edexcel, OCR, City and Guilds and ABC. Others, including EAL, have accredited individual Additional and Specialist Learning.

Number of Consortia: 62 Consortia are delivering the Diploma in Engineering in 2008/09. 83 Consortia have been cleared to commence delivery in Sep 09. For Gateway 3 (starting in 2010), 11 consortia passed the Gateway with no reservations, another 14 with some reservations. 22 received Category 3 status, which means they may still be ready for delivery on time. 5 consortia from Gateway 3 have already improved their status and will deliver in 2010.

Number of students: There were 2,780 starts on the Diploma in Engineering in September 2008 (accounting for 23% of the overall Diploma student numbers). By March 2009, 2,542 remained on the programme, and it now accounts for 25% of the total Diploma student numbers. The split at each level is approx 15%/64%/21%. We believe the Engineering Diploma has the highest number of all the Diplomas at the Advanced Level. The number is expected grow exponentially by a factor of 3 for at least the next 2 years.

Characteristics of students
7.3% female (significant under representation in the cohort)

25% with some form of Special Educational Need (average for 14–15-year-old boys)

15.7% eligible for free school meals (average for cohort)

5. The Entitlement

From 2013, 14–16-year-olds will have an entitlement to study a Diploma line out of a choice of the first 14, and out of a choice of 17 for 16–18-year-olds. The Local Authority will be under a duty to secure all young people's access to these lines, and maintained schools will have a duty to secure their KS4 students' access to the first 14 lines. (source – Diploma Gateway Key Principles – Planning towards the 2013 Entitlement from UKCES)

6. The Engineering Diploma Development Partnership (EDDP)

The EDDP is chaired by Graham Lane. The Steering Group contains employer representation from Rolls Royce, the JCB Academy, Dyson, MBDA, Jaguar, RWEnpower and SMC. The professional institutions are represented by the Royal Academy of Engineering, IMechE, and the IET. The EDDP will continue to operate in 2009/2010 and will now concentrate on: Communications / Leadership and Management, Qualification Development (including a major upgrade to the Additional and Specialist Learning Catalogue), Employer Engagement, and Workforce Support and the production of materials.

7. Ongoing timeline – key events

Timetable 2009	Jul	Aug	Sep	Aug 2010	Sep 2010	Aug 2011	Sep 2013
Phase 1 one year programme							
Results for first cohort (post-16 at Levels 1 and 2 – approx 1,000 in total across all 5 Phase 1 subjects)		■					
Second cohort begins			■				
Results for second cohort				■			
Phase 1 two year programme							
First cohort begins second year of programme			■				
Second cohort begins first year of programme			■				
Results for first cohort				■			
Second cohort begins second year of programme					■		
Results for second cohort						■	
Consortia							
Gateway 1 for Phase 1 begins second year of delivery			■				
Gateway 2 for Phase 1 begins first year of delivery			■				
Gateway 2 for Phase 1 begins second year of delivery					■		
Gateway 3 for Phase 1 begins first year of delivery					■		
Entitlement to first 14 Diplomas in place							■

e-skills uk

17.3 IT 14–19 Diploma

Diplomas are new qualifications for 14–19-year-olds which combine theoretical and applied learning. Diplomas in five subject areas, including the Diploma in IT, were launched in September 2008. Eventually Diplomas will be offered across 17 subject areas.

The Diploma in IT is an innovative and inspiring course developed with more than 600 employers in a partnership led by e-skills UK, the Sector Skills Council for Business and Information Technology. The Diploma in IT is built around the themes of business, people and technology. It prepares young people with the knowledge and skills they need for life in a technology-enabled world, particularly those who are thinking of a career in technology or business.

The Diploma in IT will help to address some of the challenges facing the technology industry in the UK. Technology contributes significantly to the UK economy, with nearly one in every 20 people in employment working in IT and telecoms. With the UK's IT industry set to grow at more than five times the national average over the next decade, we need to ensure we have a ready stream of talent, but there are challenges to address. Every year, 140,000 new entrants are required to fill the increasing number of IT professional roles. However, the number of young people choosing to study IT is declining. The proportion of students taking IT-related GCSEs declined from 17% to 11% between 2000 and 2008, and the number of students taking A level computing has declined by 45% in the last four years.

The Diploma in IT will be more appealing to young people than existing IT qualifications because the input of industry brings the qualification to life. Due to the involvement of companies in the development and delivery of the Diploma, students can be confident that what they are learning is up-to-date and relevant to the fast-paced technology sector.

"The Diploma will provide students with a sound understanding of the contribution of technology and of what can be achieved through commitment and entrepreneurship."
Ian Smith, Regional Senior Vice President, Oracle UK, Ireland and Israel

Over the past year, Diploma in IT students have benefited from the participation of companies providing insights into the use of technology in business. For example, in February 2009, e-skills UK hosted an event for 200 Diploma in IT students at Microsoft in London. Students heard from a number of Microsoft employees about their experiences working in IT and the importance of technology to the wider world. They had a chance to work in groups to design the 'next big idea in technology' and present their ideas back to their peers and professionals from Microsoft, including Gordon Frazer MD, UK and VP, Microsoft International. A 15 year-old Diploma in IT student said of the day, "You get to see how, where and when IT is used in business. You also get a better idea and understanding of the working world."

In March 2009, e-skills UK held an event for all Diploma in IT teachers. The aim of the event was to highlight support available to teachers and share best practice. There was a range of interactive workshops based around a number of key areas including employer engagement, teacher resources, curriculum delivery and assessment, and workforce support. Delegates also had the opportunity to meet with employers, Higher Education institutions and Government stakeholders.

In the first year of delivery of this progressive qualification, 403 schools and colleges in England have offered the Diploma in IT to their students. To date, 1800 students are studying the Diploma in IT, and this figure is set to double in 2009/10. Students are enjoying the added value of involvement from business, and employers have been delighted to see the drive and enthusiasm of young people.

Karen Price, CEO of e-skills UK, said: "To compete in the technology-intensive globalised economy, we need an inspiring curriculum in schools that attracts increasing numbers of talented students into technology-related degrees and careers. The Diploma in IT does just that, and the hands-on involvement of companies really helps to inspire and motivate students."

For more information about the Diploma in IT please visit **www.e-skills.com/diploma**

e-skills UK is the Sector Skills Council for Business and Information Technology. It works on behalf of employers to ensure the UK has the technology skills it needs to succeed in the global economy.

Part 2 Engineering in Education and Training

18.0 Further Education Sector

The Further Education (FE) sector in the UK encompasses 433 general FE colleges, specialist colleges and sixth form colleges (see box, Overview of Further Education colleges in the UK) as well as (possibly) around 600[54] independent learning/training organisations. The FE sector also includes some Higher Education provision (HE in FE) and work-based learning (for example, apprenticeships) and continuing training in workplaces (continuous professional development).

Overview of Further Education colleges in the UK

359 colleges in England

- 233 general Further Education colleges
- 93 sixth form colleges
- 16 land-based colleges[55]
- 4 art design and performing arts colleges
- 10 special designated colleges[56]

23 colleges and 2 FE institutions in Wales

43 colleges in Scotland

6 colleges in Northern Ireland

Source: Association of Colleges (AoC) 2009[57]
http://www.aoc.co.uk/en/about_colleges/index.cfm

The FE sector is arguably the most flexible of the education and training sectors, responding to learner, employer, society and State needs and demand and providing for learners from age 14 to those well into retirement years. The sector also embraces those with learning difficulties, in custody, training to enter the workforce and re-training to re-enter or move within it. Catering for a million more learners a year than the Higher Education sector, it is subject to ever changing external pressures.[58]

54 Figure taken from paper presented to the STEM Higher Level strategy Group February 2009. However, number cited there refers to Work-based Learning Providers.

55 For further information: Land Based Colleges Consortium: http://www.lbcnc.org.uk/moodle/index.php

56 "Special designated colleges are ... for students who want to carry on learning after Year 11 and have a disability and/or learning difficulty". http://www.connexions-direct.com/index.cfm?pid=80

57 AoC (2009). Accessed 30 May 2009. http://www.aoc.co.uk/en/about_colleges/index.cfm

58 For a recent overview see for example:

Edexcel Policy Watch: *Who does what in the 14 –19 system*. 26/04/2009: Available from: http://www.edexcel.com/Policies/Pages/PolicyWatch.aspx

Edexcel Policy Watch: *WGON Second Half*. 2008 20/01/2009: Available f rom: http://www.edexcel.com/Policies/Pages/PolicyWatch.aspx

Edexcel Policy Watch: *New Year Reading part two*: 07/01/2009. Available from: http://www.edexcel.com/Policies/Pages/PolicyWatch.aspx

Edexcel Policy Watch: *Who does what in the skills system*. 20/11/2008 Available from: http://www.edexcel.com/Policies/Pages/PolicyWatch.aspx

During the academic year 2006/07 (UK) 3.6m learners were engaged in Further Education.[59] This was one million more than in HE in the same academic year.[60]

Framework for Excellence: headline outcomes in 2009

Learner satisfaction: a very successful survey with over 520,000 learners participating. It shows a high level of learner satisfaction.

Learner destinations: these results show that the sector is performing well in helping young people and adults to fulfil their potential and move into further learning or improved employment outcomes.

Qualification success rates: more than 80% of colleges and providers are graded at least satisfactory, with over 50% good or outstanding.

Source: LSC July 2009c:5–7[61]

Furthermore, regarding intake of younger people, the FE sector is in competition with school sixth forms for post-16 learners. Schools will wish to retain their more highly academic pupils as their reputations and funding often depend on doing so. Particularly where sixth form colleges have taken the place of school sixth forms, progression to a sixth form college may also be a more familiar option than entering a general FE college.[62]

However, despite the variety of challenges they face, as can be seen from Table 18.0, non sixth form FE sector colleges enter around 28% of the total 16–18-year-old cohort for a level 3 qualifications at least the size of one A level. Around 22% of 16–18-year-olds (1 in 5) achieve at level 3 in BTEC/OCR and NVQ/VRQ routes (DCSF/National Statistics, 2009b).[63] At ages 16–18, Advanced level GCE (A and AS level) dominates the level 3 achievements of candidates in England. Yet A levels are by no means only studied in schools – for example, according to the STEM Higher Level Strategy Group, 25% of science A levels are taught in FE colleges.[64]

Over 90% of non sixth-form sector college candidates achieve qualifications which are equivalent in size to two or more passes at A level: the average QCA point score per entry is close to that of schools and the same as that of sixth form colleges (Table 18.0).

Table 18.0: Level 3 achievements of candidates[i] aged 16-18,[ii] by type of establishment (2005/06-2007/08) - England

		16-18-year-old candidates entered for level 3 qualifications at least equivalent in size to one GCE/VCE A level	Average QCA point score[iii] per candidate	Average QCA point core[iii] per entry	Percentage of candidates achieving 2 or more passes at A level equivalent size	16-18-year-old candidates entered for GCE/VCE/Applied A levels and Double Awards	Percentage of candidates achieving 3 or more A grades[iv] at GCE/VCE/Applied A Level and Double Awards
All schools	Total	183,565		211.7	96.5	177,323	14.2
Sixth Form colleges	Total	55,468	794.8	206.3	97.7	50,149	9.3
Other FE sector colleges	Total	92,364	618.9	206.3	91.3	29,150	4.2
All FE sector colleges	Total	147,832	684.9	206.3	93.7	79,299	7.5

i. Students entered for a GCE or VCE A level or other level 3 qualification equivalent in size to an A level
ii. Age at the start of the 2007/08 academic year i.e. 31 August 2007
iii. Cumulative results obtained in academic candidates aged 16–18, by type of establishment and gender.years 2005/06 and 2006/07
iv. A GCE/VCE Applied Double Award at grade AA counts as two grade As. An award at grade AB counts as one.

Source: DCSF National Statistics. SFR01 2009 (Final) 14 January 2009. GCE/VCE/Applied A/AS and Equivalent Examination Results In England, 2007/08 (Revised). Table 1: Level 3 achievements of candidates[i] aged 16–18[ii], by type of establishment and gender.

59 DCSF: Education and Training Statistics for the United Kingdom (2008a). 27th November 2008 / updated February 2009 http://www.dcsf.gov.uk/rsgateway/DB/VOL/v000823/index.shtml

60 DCSF: Education and Training Statistics for the United Kingdom (2008a). 27th November 2008 / updated February 2009 http://www.dcsf.gov.uk/rsgateway/DB/VOL/v000823/index.shtml

61 LSC (2009c). *Framework for Excellence: Headline Outcomes in 2009.* http://readingroom.lsc.gov.uk/lsc/National/Framework_for_Excellence_Outcomes_-_FINAL.pdf

62 For example: Foskett, N. (2004). IAG (Information, Advice and Guidance) and young people's participation decisions 14–19: *Nuffield Review of 14–19 Education and Training Working Paper 25.* www.nuffield14-19review.org.uk/cgi/documents/documents.cgi?a=47&t=template.htm

63 DCSF/National Statistics.(2009b). SFR01 2009 14 January 2009. GCE/VCE/Applied A/AS and Equivalent Examination Results In England, 2007/08 (Revised). Table 8: Level 3 achievements of candidates aged 16–18 by qualification route and gender. http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000827/index.shtml

64 STEM Higher Level Strategy Group (2009c), Minutes, 12 June 2009.

Table 18.1 provides a guide to qualification framework levels and qualifications across the UK and Ireland. The engineering & technology sector tends to draw chiefly on those with a level 3 or above qualification and/or equivalent working experience.

Table 18.1: Qualifications can cross boundaries – a rough guide to comparing qualifications and levels in the UK and Ireland

Main stages of education / employment	Framework for higher education qualifications in England, Wales and Northern Ireland www.qaa.ac.uk/academicinfrastructure/fheq	National Qualifications Framework for England,Wales and Northern Ireland* www.qca.org.uk/qualifications www.wales.gov.uk www.ccea.org.uk www.qca.org.uk/openquals	Credit and Qualification Framework for Wales www.cqfw.net	National Framework of Qualifications for Ireland www.nfq.ie	The Scottish Credit and Qualifications Framework www.scqf.org.uk
	Level	Level	Level	Level	Level
Professional or postgraduate education, research or employment Higher education Advanced skills training Specialised education and training Qualified/Skilled worker Entry to higher education Completion of secondary education Progression to skilled employment. Continuation of secondary education Secondary education Initial entry into employment or further education Qualifications can be taken at any age in order to continue or return to education or training	08 Doctoral Degrees 07 Master's Degrees, Integrated Master's Degrees, Postgraduate Diplomas, Postgraduate Certificate in Education (PGCE), Postgraduate Certificates 06 Bachelor's Degrees with Honours, Bachelor's Degrees, Professional Graduate Certificate in Education (PGCE), Graduate Diplomas, Graduate Certificates 05 Foundation Degrees, Diplomas of Higher Education (DipHE), Higher National Diplomas (HND) 04 Higher National Certificates (HNC), Certificates of Higher Education (CertHE) The table gives an indication of how you can compare qualifications across national boundaries. Examples of major qualifications at each level are provided. For more detail of the qualifications in another country, you will need to consult the website given at the head of each column. This leaflet is designed to give some information to help you begin this process, for example, by telling you what your qualification, or qualifications you are interested in studying, are broadly comparable to in other countries. **Qualifications can cross boundaries** – a rough guide to comparing qualifications in the UK and Ireland. March 2009.	08 Vocational Qualifications Level 8 07 Fellowships, NVQ Level 5, Vocational Qualifications Level 7 06 Vocational Qualifications Level 6 05 NVQ Level 4, Higher National Diplomas, (HND), Higher National Certificates (HNC), Vocational Qualifications Level 5 04 Vocational Qualifications Level 4 03 NVQ Level 3, Vocational Qualifications Level 3, GCE AS and A Level, Advanced Diplomas 02 NVQ Level 2,Vocational Qualifications Level 2, GCSEs at gradeA*–C, ESOL skills for life, Higher Diplomas, functional skills Level 2 (English,mathematics & ICT) 01 NVQ Level 1, Vocational Qualifications Level 1, GCSEs at grade D–G, ESOL skills for life, Foundation Diplomas, functional skills Level 1 (English, mathematics & ICT) **Entry Level** Entry Level Certificates (sub levels 1–3), ESOL skills for life, functional skills Entry Level (English, mathematics & ICT)	08 Doctoral Degrees 07 Master's Degrees, Integrated Master's Degrees, Postgraduate Diplomas, Postgraduate Certificate in Education (PGCE), Postgraduate Certificates 06 Bachelor's Degrees with Honours, Bachelor's Degrees, Professional Graduate Certificate in Education (PGCE), Graduate Diplomas, Graduate Certificates 05 Foundation Degrees, Diplomas of Higher Education (DipHE), Higher National Diplomas (HND) 04 Higher National Certificates (HNC), Certificates of Higher Education (CertHE) 03 NVQ Level 3, Vocational Qualifications Level 3, GCE AS and A Level, Welsh Baccalaureate Qualification Advanced 02 NVQ Level 2, Vocational Qualifications Level 2,Welsh Baccalaureate Qualification Intermediate, GCSEs grade A*–C 01 NVQ Level 1, Vocational Qualifications Level 1, GCSEs at grade D–G, Welsh Baccalaureate Qualification Foundation **Entry Level** Entry Level Certificate (sub levels 1–3)	10 Doctoral Degree,Higher Doctorate 09 Master's Degree, Postgraduate Diploma 08 Honours Bachelor Degree,Higher Diploma 07 Ordinary Bachelor Degree 06 Advanced Certificate, Higher Certificate 05 Level 5 Certificate, Leaving Certificate 04 Level 4 Certificate, Leaving Certificate 03 Level 3 Certificate, Junior Certificate 02 Level 2 Certificate 01 Level 1 Certificate	12 Professional Development Awards, Doctoral Degrees 11 SVQ Level 5, Professional Development Awards, Postgraduate Diplomas, Master's Degrees, Integrated Master's Degrees, Postgraduate Certificates, 10 Bachelor's Degrees with Honours, Professional Development Awards, Graduate Diplomas, Graduate Certificates 09 Bachelor's/Ordinary Degrees, Professional Development Awards, SVQ Level 4, Graduate Diplomas,Graduate Certificates 08 Higher National Diplomas, SVQ Level 4, Professional Development Awards, Diplomas of Higher Education (DipHE) 07 Professional Development Awards, Higher National Certificates (HNC), Certificates of Higher Education (CertHE) SVQ Level 3, Advanced Highers 06 Highers, SVQ Level 3, Professional Development Awards, National Progression Awards, National Certificates 05 Intermediate 2, Credit Standard Grade, SVQ 2, National Progression Awards, National Certificates 04 Intermediate 1, General Standard Grade, Scottish Vocational Qualifications (SVQ) 1, National Progression Awards, National Certificates 03 Access 3, Foundation Standard Grades, National Progression Awards, National Certificates 02 Access 2 National Progression Awards, National Certificates 01 Access 1

Source: QCA et al. Qualifications can cross boundaries – a rough guide to comparing qualifications in the UK and Ireland (Last updated: 20 Apr 2009). Accessed 26 May 2009: http://www.qca.org.uk/qca_22197.aspx

18.1 Engineering-related learning

In the FE sector, engineering & manufacturing technologies (EMT), construction & the built environment and ICT are often found in different college departments or units of other training establishments. They may be grouped together in practice but a difficulty, including with gathering statistics, is that 'engineering' is often perceived as only referring to EMT, whereas for professional engineering the landscape is much broader. Furthermore, UK-wide FE sector data is elusive.

Lifelong Learning UK (LLUK) (2009) reports total numbers and percentage of learners by subject and provider type. Allowing for caveats that not all learners reported as studying in particular areas (particularly ICT) will be engaged in engineering-related study, the LLUK data, based on the Individualised Learner Record,[65] indicates that there were more than 1.5m FE sector learners in engineering-related fields (at all levels) in 2006/07 (Figure 18.0 and Table 18.2). The fairly even spread of engineering and manufacturing technology (EMT) learners across colleges and work-based learning is particularly notable, as is the relatively small number of ICT learners in work-based learning and the very low numbers engaged in adult community learning across EMT and construction & the built environment.

Fig. 18.0: Total number of learners in FE in selected subjects by type of provider (2006/07) – England

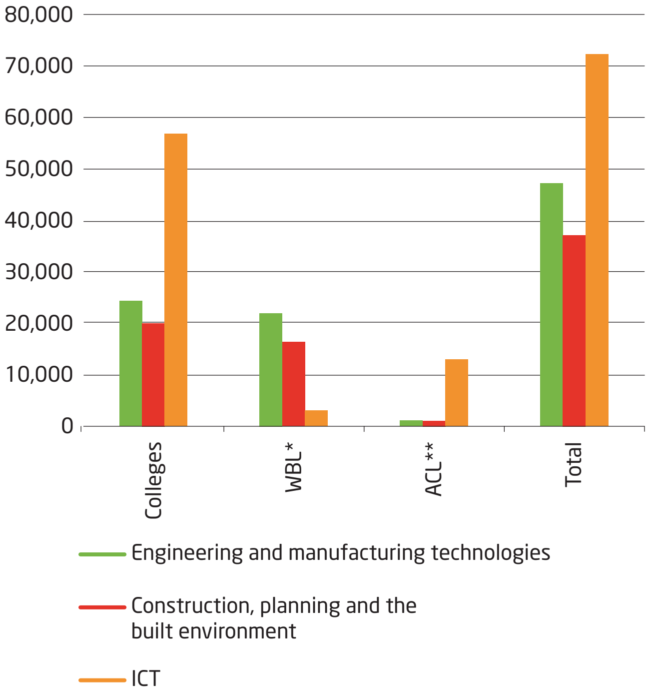


Table 18.2: Total number and percentage of learners in FE in selected subjects by type of provider – England

	Colleges	WBL*	ACL**	Total
Engineering and Manufacturing Technologies	241,960	221,929	6,640	470,529
Construction, Planning and the Built Environment	201,334	165,248	6,869	373,451
ICT	567,658	29,019	129,598	726,275
TOTAL				1,570,255

% by type of provider	Colleges	WBL*	ACL**	Total
Engineering and Manufacturing Technologies	5.2	4.8	0.1	10.2
Construction, Planning and the Built Environment	4.3	3.6	0.1	8.1
ICT	12.3	0.6	2.8	15.7

* Work-based Learning
** Adult & community learning

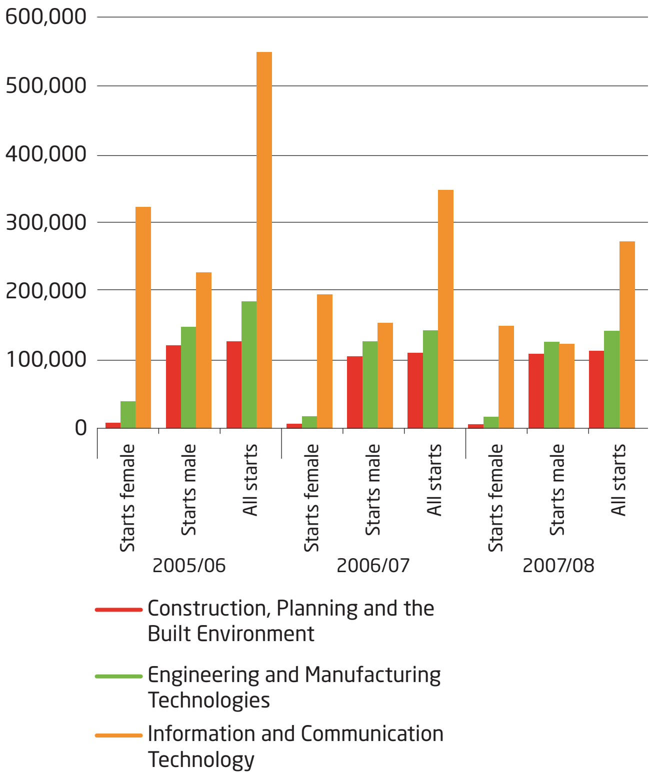
Source: LLUK (2009). *FE Sector Gap Analysis: Final Report*: Tables 2.2 and 2.3.[66]

65 The ILR is collected from providers that are in receipt of any of the following types of funding: 16–18 Learner Responsive, Adult Learner Responsive, Employer Responsive or Adult Safeguarded Learning (ASL); and from providers funded by LSC co-financed European Social Funds (ESF). http://www.lluk.org/documents/Drive-helps-further-education-providers-snap-up-vocational-specialists.pdf

66 LLUK (2009). *FE Sector Gap Analysis: Final Report*: http://www.lluk.org/2960.htm

Reflecting the college-based learner numbers above and according to the Data Service, there appears to have been some half a million starts across all levels and ages in engineering & technology sectors in English FE institutions in 2007/8 (Figure 18.1). The overall numbers seem to have dropped over time but it is hard to be sure from the 'success rate' data (Figure 18.1) which is based on a calculation that does not include all starts.[67] In the wider landscape, the increase in work-based learner numbers (e.g. apprenticeships) may counter-balance any fall in, for example, college-based numbers, as may the increased numbers of learners without an FE experience directly entering Higher Education establishments. On the other hand, as noted earlier, not all the starts recorded and illustrated in Figure 18.1 will be directly related to engineering & technology disciplines – particularly those in ICT – because some of the ICT learners will be ICT user, not ICT practitioner,[68] learners. It appears, however, that the trend is towards a decline in number of starts in FE institutions within the selected subject areas. Whatever the 'starts' picture, the gender imbalance in construction, planning and the built environment and engineering and manufacturing technologies remains a major concern (see Section 19.4).

Fig. 18.1: Success rates in all FE institutions by selected sector subject area and gender (2005/06-2007/08) - England



Source: Adapted from: The Data Service. DS/SFR2 March 2009 Statistical First Release on Post-16 Education & Skills: Learner participation, outcomes and Level of Highest Qualification held

Table SR3: Success rates (2005/06 to 2007/08) in all FE institutions by sector subject area, gender and expected end year[69]

67 Success rates are based on the individual aims that were expected to end in the academic year. They are calculated as the number of learning aims achieved divided by the number started, excluding the aims of any learners that transferred onto another qualification within the same institution. Starts figures given in this chart are only for aims that contribute towards the success rate.

68 see ICT *Tech* website for clarification of ICT practitioner: http://www.icttech.org.uk/

69 The Data Service (2009b). DS/SFR2 March 2009 Statistical First Release on Post-16 Education & Skills: Learner participation, outcomes and Level of Highest Qualification held. Table SR3 : Success rates (2005/06 to 2007/08) in all FE institutions by sector subject area, gender and expected end year.

http://www.thedataservice.org.uk/NR/rdonlyres/6BD921D0-7E1D-4259-9DE3-66E8DEE84B59/0/nat_Table_SR3_FE_Success_rates_by_Sector_Subject_Area_march09.xls

Part 2 Engineering in Education and Training

19.0 Apprenticeships[70]

Apprentices are employees and learn job-specific and other skills through working with colleagues and achieving a National/Scottish Vocational Qualification (N/SVQ). They also study for other qualifications with a training provider, often on a day release basis. Apprenticeships are available at level 2 (Apprentice), level 3 (Advanced/Modern Apprentice) and at higher levels. Qualifications as an outcome of an apprenticeship programme are typically an N/SVQ, key/functional skills, rights & responsibilities at work, and a technical certificate (a Vocationally Related Qualification – VRQ)[71].

70 http://www.apprenticeships.org.uk/

71 LAD: http://providers.lsc.gov.uk/LAD/aims/NewFrameworkMandKSsearch.asp

The engineering & technology sector has a longstanding interest in take-up (starts), completion (success) and progression in and from apprenticeships, particularly the Advanced/Modern Apprenticeships. Integrated training and experience provided by many engineering-based Advanced Apprenticeships (level 3) may lead directly to Engineering Technician (EngTech) and ICT Technician (ICTTech) registration (Engineering Council 2008a/b)[72] as well as enable progression to Higher Education studies – HNC / HND / Foundation and Honours degrees – and beyond. Up-to-date data[73] on progression within the engineering profession remains on the wish-list. But from individual life stories we are aware that: "Many of those joining the profession as apprentices have gone on to achieve a high status in engineering, becoming Incorporated Engineers (IEng) or Chartered Engineers (CEng). And several Presidents of Professional Engineering Institutions are themselves former apprentices," (Engineering Council, 2009).[74] Consequently, it is heartening that The Skills Commission (March 2009) recommended that "all apprentices should be made aware of the qualifications and experience required to join the Professions," (The Skills Commission 2009:14).[75]

As can be seen from Figure 19.0 (TUC 2008a), Advanced Apprenticeship numbers (across all sectors) began to drop off from around 2000 and the level 2 Apprenticeship began to decline from 2006/7.

72 Engineering Council (2008a). UK-SPEC. London: Engineering Council http://www.engc.org.uk/ukspec/default.aspx

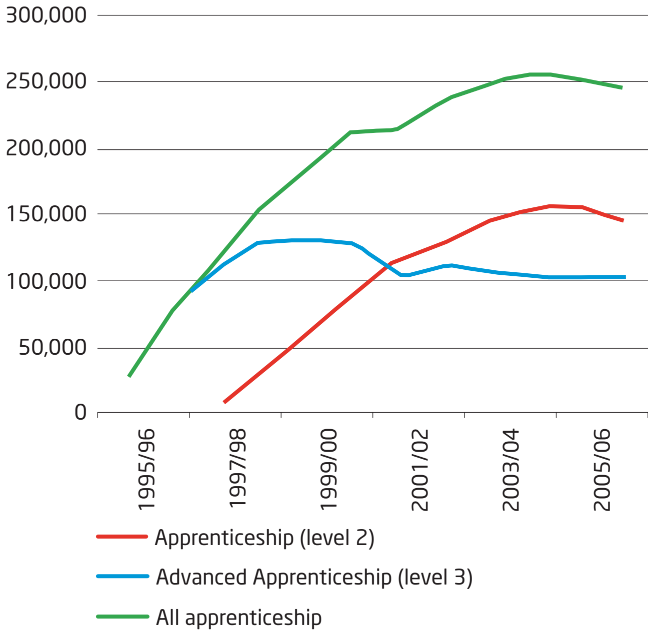
Engineering Council (2008b) Information and Communications Technology Technician Standard. London: Engineering Council http://www.icttech.org.uk/icttech-standard.aspx

73 The most recent substantive work in the field was carried out as a contribution to the Finniston Inquiry (1980): Berthoud, R. and Smith, D. Policy Studies Institute (1980). The education, training and careers of professional engineers. London: HMSO.

74 Engineering Council (2009). Engineering Council welcomes launch of National Apprenticeship Service; 29/04/2009; in Engineering Council: http://www.engc.org.uk/news/default.aspx

75 The Skills Commission (2009). Progression through apprenticeships: The final report of the Skills Commission's inquiry into apprenticeships. London: The Skills Commission. http://www.policyconnect.org.uk/content/skills/sc/resources/gen/MTAyOTowOjA

Fig. 19.0: Apprenticeships: average in learning by level (1995/96-2006/07) - England



Source: TUC (2008a) *Still more (better paid) jobs for the boys*: Chart 1: Apprenticeships: Average in Learning 1995/6 to 2006/7[76]

The recent drive to increase the number of apprenticeship places and take-up in the UK arose from the recommendations of the Leitch Review – *Prosperity for All in the Global Economy: World Class Skills* (HM Treasury December 2006)[77] – and was further underlined by, for example, *World-class Apprenticeships: Unlocking Talent, Building Skills for All* (DIUS & DCSF January 2008).[78] The Government committed in early 2008 to substantially increase spending to support apprenticeship expansion, projecting that over the period 2001/02 to 2010/11 more than 900,000 young people and adults would have completed an apprenticeship and that by 2020 this figure would be over two million.[79] Meeting this target would require some 260,000 starts and 190,000 successful completions each year from 2001 to 2011– involving a shift in completions from 24% (2001) to 63% (early 2008) to 70% or more (2010/11) and sourcing a far greater number of employed-status apprenticeship places. Perhaps as a direct consequence of this raised profile of support for apprenticeships, the volume of all apprenticeship starts in England in 2007/08 was, at 224,800 (21.9% up from 2006/7), said to be the highest level ever recorded.[80]

However, trend figures are hard to establish. The Apprenticeship Review (DCSF and DIUS, 2008)[81] recommended change in the way in which numbers of apprentices are measured and reported. This measure had been based on an 'average in learning' at a given point in any one year figure – which did not allow for any meaningful analysis. But from early 2008, it has moved to measure and report on take up of employer places (starts) and on successful completions. It is therefore not possible to provide a detailed pre- and post-2008 picture of achievements. But in general terms, it appears that the number of people completing at all levels of apprenticeship has risen from around 40,000 in 2001/02 to over 100,000 per year at end 2007.[82] Whilst calculated to take account of certain exclusions from the data and subject to the cautions outlined above, Table 19.0 (taken from Higher Education Funding Council for England 2009)[83] indicates substantial growth in the numbers of individuals completing Advanced Apprenticeships between 2002/03 and 2006/07.

Table 19.0: Number who completed an apprenticeship (2002/03-2005/06) - England

	2002/03	2003/04	2004/05	2006/07
Advanced Apprenticeship completions	15,390	13,900	16,875	26,215

Source: Adapted from HEFCE, 2009. *Pathways to higher education: apprenticeships.* Table 2.

76 TUC (2008a). *Still more (better paid) jobs for the boys: Apprenticeships and gender segregation.* http://www.tuc.org.uk/extras/genderreport.pdf

77 HMT (2006): http://www.official-documents.gov.uk/document/other/0118404792/0118404792.asp

78 DIUS and DCFS (2008). *World-class apprenticeships: Unlocking talent, building skills for all.* January 2008; DIUS & DCSF (DIUS lead); England. http://www.dius.gov.uk/

79 Expanding Apprenticeships, developing World-Class skills. 28 January 2008. in DIUS: http://www.dius.gov.uk/news_and_speeches/press_releases/apprenticeships_expanding

80 SEMTA and Post-16 Education: Learner participation and outcomes in England 2007/08 – 22nd December 2008, The Data Service: No longer available.

81 DIUS and DCSF (2008). World-class apprenticeships: Unlocking talent, building skills for all. The Government's strategy for the future of Apprenticeships in England. London: HMSO. http://www.dius.gov.uk/~/media/publications/W/world_class_apprenticeships

82 DIUS (2008). Expanding Apprenticeships, developing World-Class skills. 28 January 2008. in DIUS: http://www.dius.gov.uk/news_and_speeches/press_releases/apprenticeships_expanding

83 HEFCE, 2009. Pathways to higher education: apprenticeships. http://www.hefce.ac.uk/pubs/hefce/2009/09_17/

Achievements in Advanced Apprenticeships also appeared to substantially increase during 2007/08. Across all sectors in 2007/08 (England only) there were 28,000 Advanced Apprenticeship programme starts[84, 85] and 36,200 Advanced Apprenticeship completions[86] with a completion rate of 62.7%.[87] The (all apprenticeships) framework achievement rate for adults[88] in England was 64.5% in 2007/08, an increase of 6.2% on 2006/07.[89] Completions are important both for individual and economic reasons. The Learning and Skills Council (2008c) reports that "18% of those on Advanced Apprenticeships who had stopped their course early were unemployed at the time of the survey, compared with just 4% of those who had completed their training," (LSC 2008c:21).[90] (Also see Section 19.1, regarding wage returns).

Over all frameworks, completion rates are improving, with the Advanced Apprenticeship completion rates in England at 63% in 2006/07, compared with 38% in 2004/05[91] and 31% in 2003/04.[92] This step-change goes beyond meeting the target set by the Apprenticeship Task Force of 60% completions (all levels) by 2010 and moving towards the 75% completion rate target set for 2013/14.[93] Scotland's Modern Apprenticeships had a completion rate of 54% in 2003/04[94] and this had risen to 60% as early as 2006.[95]

Given the caveats about changes to measures and reporting, success rates in apprenticeships from 2005/06 to 2007/08 in three sector subject areas are illustrated in Fig. 19.1, but again, only with reference to all levels of apprenticeships. A further caution should be noted regarding apprenticeship completion/success data. SEMTA, the Sector Skills Council for the 106 Engineering Apprenticeship framework, reports that in the Engineering Apprenticeship 2006/07, "completion rates are above average, at 69% for Advanced Apprenticeships and 65% at Apprentice level," (SEMTA, 2008a:3).[96] However, LSC data for 2006/07 (Figure 19.2) reports 61.7% completion rates in England for engineering and manufacturing technologies (EMT) apprenticeships (all levels). It may be that the SEMTA data covers the UK and/or it may well be that EMT covers more than the 106 Engineering framework. Similar uncertainties occur regarding Table 19.1 where LSC data is shown by apprenticeship framework – so 'engineering' is likely to refer to the 106 framework. Here, success rates in 2007/08 are reported as 51% for level 2 (Apprenticeship) and 48% for level 3 (Advanced Apprenticeship). This does not tally with EMT in Figure 19.1 2007/08 where success rate (all levels) is reported as 59.4%. However, in Figure 19.1, growth is indicated, but success (completion) rates vary by nearly 12% within the three sector subject areas illustrated.

84 The Data Service Statistical First Release (2008). DS/SFR1 v2 22 December 2008 (England). Table 8: Apprenticeship Starts by Level and Age (2005/06 to 2008/09): Programme Starts http://readingroom.lsc.gov.uk/lsc/National/nat-ds_sfr1-dec08.pdf

85 Starts: "The number of qualifications/ programmes that have begun in a given time period, usually monthly, quarterly or annually. A start is assigned to the month/ quarter/ year that it began and is only counted once. However, a learner undertaking more than one qualification will be counted for each qualification/ programme. For example, a learner starting a level 2 apprenticeship and then transferring to a level 3 apprenticeship will be counted as two starts." (The Data Service (2008). DS/SFR1 v2. *Post-16 Education: Learner participation and outcomes in England 2007/08* (22 December 2008) p 7

86 "Completions: Although a learner may complete and not achieve, the term 'completions' refers to learning activities that have been successfully achieved and, where appropriate, the certification obtained. A successful apprenticeship 'framework completion' requires all elements of the framework to be completed." (The Data Service (2008). DS/SFR1 v2. Post-16 Education: Learner participation and outcomes in England 2007/08 (22 December 2008) p 8

87 The Data Service Statistical First Release (2008). DS/SFR1 v2 22 December 2008 (England). Table 9: Apprenticeship Framework Completions by Level and Age (2005/06 to 2007/08): Framework Completions http://readingroom.lsc.gov.uk/lsc/National/nat-ds_sfr1-dec08.pdf

88 Those age 19 or over

89 The Data Service (2009c): Post-16 *Education & Skills: Learner participation, outcomes and level of highest qualification held.* DS/SFR2 England 26th March 2009. http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000838/index.shtml

90 LSC (2008c). *Research into Expanding Apprenticeships*. Coventry: Learning and Skills Council. http://readingroom.lsc.gov.uk/lsc/National/Research_into_Expanding_Apprenticeships_for_release.pdf

91 LSC (2008a). Apprenticeship Training Module. http://readingroom.lsc.gov.uk/lsc/National/natapprenticeshipworkshoppresentationmar09.ppt

92 Apprenticeship Ambassador Network: http://www.employersforapprentices.gov.uk/index.cfm?action=Researchcategory&categoryID=5

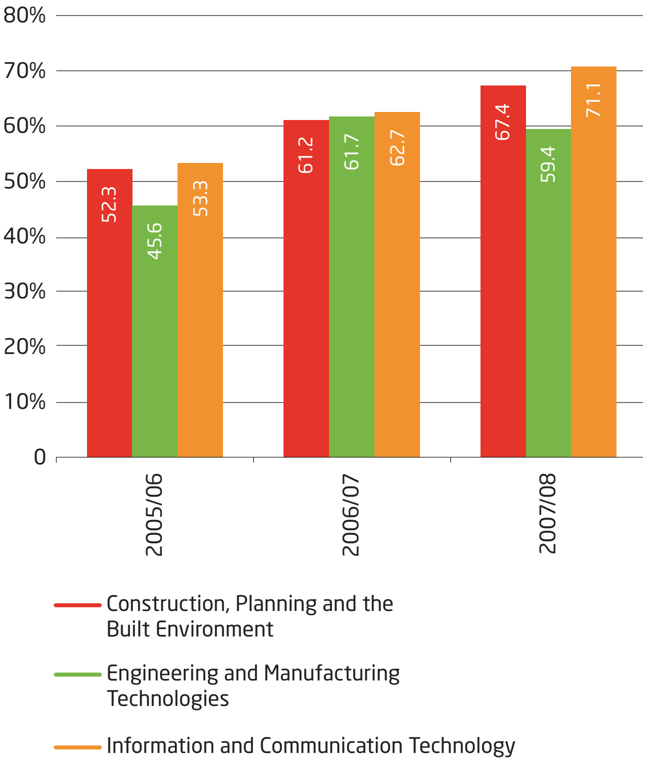
93 Apprenticeship Ambassador Network: http://www.employersforapprentices.gov.uk/index.cfm?action=Researchcategory&categoryID=5

94 West, J. (2005) Improving Completion Rates in Apprenticeship: A Comparative and Numerical Approach. http://www.employersforapprentices.gov.uk/docs/research/Research_1_309.doc

95 Park, J. (2008). The Apprenticeship (Scotland) Bill: Public Consultation. http://www.scottish.parliament.uk/s3/bills/MembersBills/pdfs/ApprenticeshipsBillConsultation.pdf

96 SEMTA (November 2008a). Skills Commission Inquiry into Apprenticeships – SEMTA response. http://www.semta.org.uk/Docs/0830%20-%20Semta%20response.doc

Fig. 19.1: Apprenticeship (all levels) completion rates (%) by selected sector subject area (2005/06-2007/08) - England



Source: Adapted from: The Data Service (2009c). DS/SFR2 March 2009 Statistical First Release on Post-16 Education & Skills: Learner participation, outcomes and Level of Highest Qualification held Table S3.3: FE and Apprenticeship Success Rates by Sector Subject Area (2005/06 to 2007/08) – Percentage.[97]

As discussed earlier, whilst individual Sector Skills Councils provide some public data, the numbers of recent starts and completions in Advanced Apprentices across engineering-related sectors are difficult to pin down. As LSC reports: "There is no national data set that holds comprehensive information about employer engagement with Apprenticeships," (LSC, 2009d:13).[98]

An LSC study investigating expansion of apprenticeships in the public sector notes that: "Market penetration of apprenticeships is highest in the construction sector (20%), followed by the other services sector (16%), the manufacturing sector (14%) and the education, health and public administration sector (13%)," (LSC 2008c:7).[99] Whilst it is welcome that some of our sectors do well compared with others, clearly there is extensive scope for expansion.

Analysis of DS/SFR2[100] indicates that engineering & technology starts accounted for around a quarter of all apprenticeship starts, with some 35,400 (provisional) starts in engineering & technology sectors during the period 1 August to 31 January 2008/09, from a total of 140,500 across all sector frameworks. However, this covers all levels of apprenticeship and does not provide the detail needed regarding level 3 in particular.

Figure 19.2 (LSC 2009d) provides an indication of the proportions of Apprenticeships and Advanced Apprenticeships within some engineering & technology sectors (by Sector Skills Council) compared with some other sectors. It can be seen that, of the Sector Skills Councils most closely associated with engineering & technology, SEMTA has the largest proportion (around 50%) of its apprenticeships at Advanced Apprenticeship level. ConstructionSkills and SummitSkills have around 42% at this level and Cogent has around 40%. AutomotiveSkills has, however, only around 30% at the Advanced Apprenticeship level.

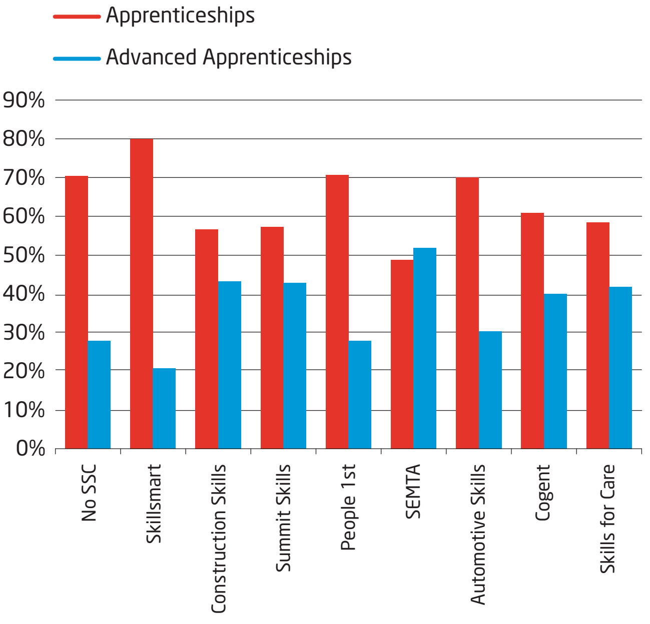
97 (The Data Service 2009c): http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

98 LSC (2009d). Identifying sectors with prospects for expanding the number of apprenticeships. Coventry: LSC Figure 4.3 Standalone NVQs which could be part of a framework by sector. www.lsc.gov.uk/LSCGOVUK/Scripts/PublicationDownload.aspx?id=cb74013a-5a3e-4d30-b049-08b584b15e05

99 LSC (August 2008c). *Research into Expanding Apprenticeships*. Coventry: Learning and Skills Council. http://readingroom.lsc.gov.uk/lsc/National/Research_into_Expanding_Apprenticeships_for_release.pdf

100 The Data Service (2009c). DS/SFR2 March 2009 Statistical First Release on Post-16 Education & Skills: Learner participation, outcomes and level of highest qualification held. Table S11.1 Apprenticeship Starts - (2007/08 to 2008/09) - Geographic, sector framework code and equality and diversity breakdowns http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

Fig. 19.2: Apprenticeships by sector and level of study – England



LSC source: ILR 07/08 W12

Source: LSC 2009d: Identifying sectors with prospects for expanding the number of apprenticeships. Figure 4.13: Apprenticeships by sector and Level of study[101]

Table 19.1 (LSC 2009)[102] provides an indication of apprenticeship numbers, success rates and proportion by sector as well as by level. LSC (2009) notes that: "Apprenticeship delivery is concentrated across a small number of frameworks. Of a total of 128 frameworks featuring in the ILR, just 10 frameworks account for 69% of all apprenticeship delivery," (LSC 2009d:v). Notably, construction, engineering, electrotechnical and vehicle maintenance and repair appear in the 'top ten' frameworks.[103] From this table it can be seen that success levels at level 3 (Advanced Apprenticeships) in construction and engineering – both with large cohorts – vary only by 6%. Electrotechnical, with a smaller cohort, has a slightly lower success rate and vehicle maintenance and repair – with the smallest cohort listed here – has a relatively high success rate at 74%. However, it should be noted that many factors apart from cohort size contribute to or work against fully completing an apprenticeship, such as 'got a job/changed jobs' (West 2005),[104] and this may be influenced by the length of the apprenticeship.

101 LSC (2009d). *Identifying sectors with prospects for expanding the number of apprenticeships*. Coventry:LSC Figure 4.13: Apprenticeships by sector and Level of study. www.lsc.gov.uk/LSCGOVUK/Scripts/PublicationDownload.aspx?id=cb74013a-5a3e-4d30-b049-08b584b15e05

102 LSC (2009d). *Identifying sectors with prospects for expanding the number of apprenticeships*. Coventry:LSC. www.lsc.gov.uk/LSCGOVUK/Scripts/PublicationDownload.aspx?id=cb74013a-5a3e-4d30-b049-08b584b15e05

103 For detail about individual apprenticeship frameworks see the Data Service LAD: http://providers.lsc.gov.uk/LAD/aims/NewFrameworkMandKSsearch.asp

104 West, J. (2005). Improving Completion Rates in Apprenticeship: A comparative and numerical approach. http://www.employersforapprentices.gov.uk/docs/research/Research_1_309.doc

Table 19.1: Ten largest apprenticeship frameworks (2007/08) - England

Framework	Apprenticeship numbers	Apprenticeships (% of total)	Completion rates Level 2	Level 3
Construction	39,956	9.8 %	44%	54%
Hairdressing	33,284	8.2%	49%	50%
Engineering	33,218	8.2%	51%	48%
Customer service	30,828	7.6%	54%	57%
Business administration	29,130	7.2%	53%	61%
Children's care learning and development	27,844	6.8%	46%	41%
Hospitality and catering	26,172	6.4%	47%	48%
Electrotechnical	21,148	5.2%	50%	44%
Health and social care	19,695	4.8%	39%	46%
Vehicle maintenance and repair	18,531	4.6%	59%	74%

Source: LSC (2009d). Identifying sectors with prospects for expanding the number of Apprenticeships. Figure 4.5: Ten largest apprenticeship frameworks.[105]

Whether or not an apprenticeship is completed depends on various factors – all of which must be balanced. Some argue that longer apprenticeships contribute to a deeper level of practical skill and understanding, so long as they are accompanied by a supervised and structured workplace learning programme and time to reflect on that learning. Others argue that the same result can be achieved through workplace learning after the apprenticeship and that apprentices are less likely to complete long apprenticeships. However, the level of skill acquired is probably important – particularly if apprenticeships are to retain their quality branding. Gladwell (2008)[106] suggests that it takes 10,000 hours (10 years) to achieve mastery. Typically, Advanced Apprenticeships in Engineering (106 Framework) take 42 months to complete for those aged under 25,[107] whilst some vehicle maintenance and repair apprenticeships may take 24 months.

105 LSC (2009d).Identifying sectors with prospects for expanding the number of apprenticeships. Coventry: LSC Figure 4.5: Ten largest apprenticeship frameworks. www.lsc.gov.uk/LSCGOVUK/Scripts/PublicationDownload.aspx?id=cb74013a-5a3e-4d30-b049-08b584b15e05

106 Gladwell, M. (2008). Outliers: *The Story of Success.* Penguin Books.

107 SEMTA (Undated). Framework Issue Number 9 V6 code 106. http://www.semta.org.uk/pdf/A%20and%20AA%20framework%20guide%20issue%209V6%20%20.pdf

Table 19.2 is adapted from LSC (2009d) to show Sector Skills Councils with 'top five' frameworks which include engineering & technology sectors. The 'top five' are measured by the number of apprentices (all levels of framework). Highlights have been added to indicate likely *directly* engineering & technology–related frameworks.

Key for Table 19.2

- Construction frameworks
- Engineering frameworks
- Plumbing frameworks
- Electrotechnical frameworks
- Heating, ventilation, air conditioning and refrigeration frameworks
- Vehicle maintenance frameworks
- Chemical, pharmaceutical, petro-chemical manufacturing & refining industries frameworks
- IT services and development frameworks
- Land-based services frameworks
- Rail transport engineering frameworks
- Security industry frameworks
- Automotive Industry frameworks

Table 19.2: Leading apprenticeship frameworks for selected SSCs – England
(Top five frameworks for each SSC, as measured by proportions of apprentices)

SSC	FRAMEWORK 1	2	3	4	5
Construction Skills	Construction (61%)	Engineering (10%)	Plumbing (7%)	Electrotechnical (6%)	Business administration (4%)
SummitSkills	Electrotechnical (64%)	Plumbing (24%)	Heating, ventilation, air conditioning and refrigeration (5%)	Engineering (3%)	Business administration (1%)
SEMTA	Engineering (50%)	Business administration (8%)	Vehicle maintenance (6%)	Customer service (6%)	Electrotechnical (5%)
Skillsmart Retail	Retail (51%)	Customer service (25%)	Management (7%)	Business administration (3%)	Engineering (2%)
Automotive Skills	Vehicle maintenance (59%)	Automotive industry (9%)	Vehicle body and paint operations (9%)	Vehicle fitting (7%)	Vehicle parts operations (3%)
Government Skills (inc. local govt)	Business administration (42%)	Engineering (13%)	Customer service (8%)	Accountancy (6%)	Construction (6%)
Skills for Logistics	Engineering (19%)	Business administration (13%)	Customer service (13%)	Public services (13%)	Vehicle maintenance (5%)
Cogent	Engineering (34%)	Retail (16%)	Business administration (12%)	Customer service (7%)	Chemical, pharmaceutical, petro-chemical manufacturing & refining industries (6%)
Improve	Engineering (35%)	Business Administration (10%)	Management (7%)	Customer service (7%)	Accountancy (6%)
e-Skills	UK customer service (34%)	Contact centres (13%)	Business administration (10%)	Sales and telesales (8%)	IT services and development (7%)
Lantra	Veterinary nursing (33%)	Animal care (15%)	Amenity horticulture (11%)	Agricultural crops (10%)	Land-based services (7%)
Skillfast-UK	Customer service (40%)	Retail (18%)	Business administration (14%)	Management (7%)	Engineering (4%)
GoSkills	Engineering (26%)	Vehicle maintenance (21%)	Customer service (10%)	Transport engineering and maintenance (9%)	Business administration (9%)
Energy and Utility Skills	Engineering (19%)	Business administration (19%)	Electrotechnical (14%)	Electricity industry (11%)	Customer service (10%)
Asset Skills	Business administration (23%)	Property services (20%)	Construction (19%)	Customer service (11%)	Plumbing (6%)
Proskills	Printing (25%)	Rail transport engineering (19%)	Engineering (15%)	Business administration (13%)	Customer service (7%)
Skills for Justice	Business administration (37%)	Customer service (34%)	Security industry (8%)	Rail transport engineering (4%)	Community justice (4%)
Skillset	Customer service (40%)	Retail (17%)	Business administration(11%)	Management (10%)	Construction (5%)

LSC Source: ILR 2007/8 W12.
Source: Adapted from LSC (2009) Figure 4.2: Leading apprenticeship frameworks for each SSC (Top five frameworks, as measured by number of apprentices).[108]

108 LSC (2009d). Identifying sectors with prospects for expanding the number of apprenticeships. Coventry:LSC Figure 4.2 Leading apprenticeship frameworks for each SSC. www.lsc.gov.uk/LSCGOVUK/Scripts/PublicationDownload.aspx?id=cb74013a-5a3e-4d30-b049-08b584b15e05`

The scale of apparent repetition in SSC provision illustrated in Table 19.2 may be countered by the fact that some frameworks are generic. However, *Working Futures 2007 – 2017* (UKCES 2008)[109] and LSC's *Research into Expanding Apprenticeships* (LSC, 2008c)[110] suggest an increasingly changing picture of demand – for example, towards broader mixes of disciplines and skills.

19.1 Wage returns to apprentices[111]

McIntosh (2004) reports that men who have completed an apprenticeship can expect to earn on average 7% more than those who have not when personal characteristics and other qualifications are held constant. However, for women, there appears to be no gain in wages from completing an apprenticeship (McIntosh, 2004:2 – summary).

109 UKCES (2008). Working Futures 2007 – 2017 Evidence Report 2. November 2008 (Produced by Institute for Employment Research and Cambridge Econometrics for the UK Commission for Employment and Skills. R. Wilson, K. Homenidou and L. Gambin Institute for Employment Research University of Warwick; Coventry: Wath-upon-Dearne: UKCES http://www.ukces.org.uk/Default.aspx?page=4729

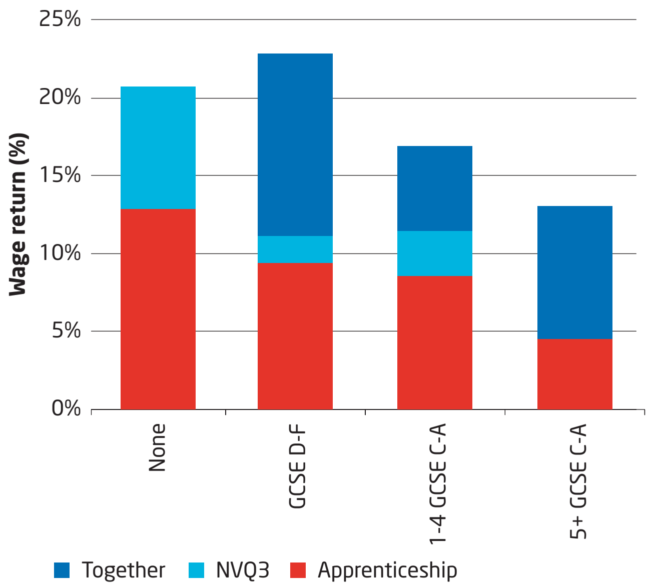
110 LSC (2008c). *Research into Expanding Apprenticeships.* Coventry:Learning and Skills Council. http://readingroom.lsc.gov.uk/lsc/National/Research_into_Expanding_Apprenticeships_for_release.pdf

111 Regarding wage returns also see, for example, Jenkins, A. et al, (2007) *The Returns to Qualifications in England: Updating the evidence base on level 2 and level 3 vocational qualifications*

McIntosh 2004

Figure 19.3 illustrates that: "those men who left school with no qualifications earn good returns from apprenticeship, even when no qualifications are obtained. Similarly, an NVQ 3 qualification yields high returns when obtained on its own. There is no additional gain from combining apprenticeship and NVQs for this group. However, as the level of success at school rises, so it becomes more important for this combination to be made. For those men who left school with five or more good GCSEs, the total height of their column reveals that acquiring an NVQ 3 qualification through an apprenticeship increases their earnings by 13%. However, most of this wage return is due to obtaining the NVQ 3 and apprenticeship in combination: if they had been received in isolation, they would have created much smaller wage returns (zero returns from the NVQ 3 qualification on its own, and only a 4% return from an apprenticeship without qualifications). Thus the importance of acquiring a level 3 qualification whilst on an apprenticeship... is particularly relevant to those who have left school with good qualifications, in order to stand out amongst their peers." (McIntosh, 2004:2 – summary[112]).

Fig. 19.3: Wage returns to apprenticeship, NVQ 3 qualifications and a combination of the two, males (1996-2002)



Source: McIntosh, S. (2004), summary, Figure 1

In a follow-up study (2007), McIntosh reports that wage returns from a level 3 apprenticeship are around 18% compared with those holding only level 2 qualifications. Significant wage returns for women are also observed (see box, McIntosh 2007).

112 McIntosh, S. (2004). *The Returns to Apprenticeship Training.* CEP, LSE. Summary, Figure 1. http://cep.lse.ac.uk/research/skills/Skills_Publications/default.asp

McIntosh 2007

"The estimates reveal substantial wage returns in 2004/5 to Modern Apprenticeships, of around 18% at level 3 and 16% at level 2, compared with individuals whose highest qualification is at level 2, or at level 1 or 2 respectively. It should be acknowledged, however, that the demand for Modern Apprenticeship places exceeds supply, so that employers may be able to choose the most able from the queue of applicants, meaning that a proportion of these wage returns may be due to ability differences, rather than the impact of the apprenticeship training itself.

When the analysis differentiates between men and women, significant wage returns are observed for women for the first time in the study of apprenticeships in the UK, specifically of 14% to a level 3 (Modern) Apprenticeship." (McIntosh, 2007:1)[113]

19.2 Benefits to employers of apprentices

Business benefits

"Apprenticeships deliver strong business benefits such as increased productivity and staff retention, reduced costs and a more diverse workforce. Other benefits include: increased profits (BT estimated they gained a higher annual net profit of over £1,300 per apprentice when compared with non-apprentices); higher quality of work (at BAE Systems apprentices fulfilled tasks correctly at a rate of 85% right first time after completing their training; external recruits had a rate of 60%); and career progression (over 90% of line managers in British Gas's engineering operations trained as apprentices)." (Kenyon, R. 2005 – abstract)[114]

113 McIntosh, S. (2007). *A Cost-Benefit Analysis of Apprenticeships And Other Vocational Qualifications*. DCSF. Brief No: RB834. www.dcsf.gov.uk/research/data/uploadfiles/RB834.pdf
Full report: http://www.dcsf.gov.uk/research/data/uploadfiles/RR834.pdf

114 Kenyon, R. (2005). The business benefits of apprenticeships: the English employers' perspective. *Education + Training*, Volume 47, Numbers 4–5, 2005, pp. 366–373(8). http://www.ingentaconnect.com/content/mcb/004/2005/00000047/F0020004/art00010?crawler=true

19.2.1 The value of apprentices to engineering employers

Case study from the Institute for Employment Research (IER)

Chris Hasluck and Terence Hogarth, University of Warwick

The IER net costs of training studies

Since the late 1990s the University of Warwick Institute for Employment Research (IER) has conducted a series of studies which have estimated the cost to the employer of training an apprentice.[115] These studies have consistently shown that the cost of apprenticeship training – which lasts for around three to four years and typically leads to a level 3 qualification (eg HNC, Advanced Apprenticeships) – is relatively high in engineering. Engineering employers, the studies repeatedly confirm, regard apprenticeship training as a necessary investment because of: (a) a shortage of fully experienced workers in the external labour market; (b) a need to continually replenish their stock of skilled workers; and (c) an on-going need to create a pool of workers steeped in the company's values from which supervisors and managers of the future will be selected. Though employers are able to provide a rationale for the investments in apprenticeship training, few employers carry out a cost-benefit appraisal of their investments, which begs the question whether they are able, in practice, to obtain a positive return from their training investment. The IER Net Costs of Training to Employers study, funded by the Apprenticeship Ambassadors Network (AAN), estimates the period over which the employer is able to recoup its investment in apprenticeship training using a standard discounted cash flow model.[116] As detailed below, it reveals that, while engineering employers invest relatively more in their apprentices than other employers, they are able to recoup that investment over a relatively short space of time provided they can retain the services of their apprentices once fully trained.

Engineering employers' investments in apprenticeship training

Detailed case studies were conducted in eleven engineering companies to ascertain the net cost of their apprenticeship training (typically over a three to four year period) and to gather information about the value of the apprentice's output while they were training. This was estimated by asking employers to assess the proportion of the fully experienced worker's job that their apprentices could complete at each stage of their training and then multiplying this by the wage of the typical fully experienced worker. Table 19.3 provides an average estimate of the net costs / benefits incurred by employers providing apprenticeship training. On average, the net costs of training a single apprentice (around £29,000) equates to around one and a quarter times the wage of a fully experienced worker. This was relatively high compared with the cost of apprenticeship training in sectors such as hospitality, business administration, IT, and social care, but similar to construction.

115 Hogarth, T., Siora, G., Briscoe, G. and Hasluck, C. (1996), *The Net Costs of Training to Employers*, Department for Employment Research Series, HMSO; Hogarth, T., and Hasluck, C. (2003) *The Net Costs of Training to Employers: Apprenticeships*, Department for Education and Employment Research Series, Sheffield; Hogarth, T., Hasluck, C. and Daniel, W.W. (2005) *Apprenticeships: The Business Case*, Modern Apprenticeship Task Force, London.

116 Hasluck, C., Hogarth, T., Baldauf, B. and Briscoe, C. (2008) The Net Benefit to Employer Investment in Apprenticeship Training, Report to the Apprenticeship Ambassadors Network, London. Available at: http://www.employersforapprentices.gov.uk/docs/research/Research_1_521.pdf

Table 19.3: Net costs of training to engineering employers

	Year 1	Year 2	Year of apprenticeship Year 3	Year 4	Total
Average wage of apprentice (£ p.a.)	8,876	11,556	13,139	17,314	-
NI of apprentice (£ p.a.)	548	870	1,073	1,341	-
Total wage cost of apprentice (p.a.)	7,790	10,499	12,284	14,354	-
Productive contribution of trainee (%)	9	39	51	82	-
Average wage of fully experienced worker (£ p.a.)	23,008	23,008	23,008	26,446 (a)	-
Employer costs					
Wage costs of apprentice (£)	9,424	10,963	12,607	14,688	51,963
Wage costs of supervision (£)	2,379	3,865	2,919	2,495	11,659
Training costs (£)	454	489	596	596	2,476
Other costs (£)	237	237	237	237	947
Total (£)	12,493	15,554	16,359	18,016	67,044
Employer benefits					
Productive contribution (£)	1,803	8,396	10,874	15,979	37,052
Other income (£)	56	56	56	208	377
Total (£)	1,859	8,452	10,930	16,187	37,429
Cost-benefit (£)	10,633	8,566	7,034	2,529	28,762

Source: IER Net Benefits of Training Study 2008

Note: The data in each cell is based on the average from all the case studies in engineering. For this reason the numbers in the table do not necessarily add up. For example, the cost-benefit estimate is the average cost-benefit reported by each employer rather than being the sum of all the benefits minus all the costs presented in the table. All data has been rounded

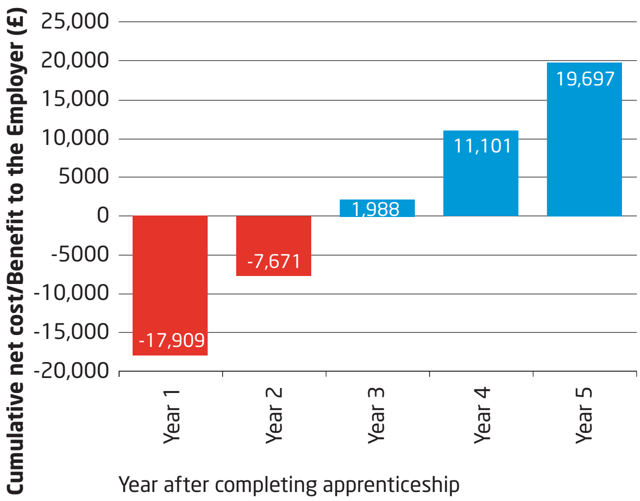
(a) In some engineering plants, apprentices divide into those who will fulfil a technician role and those who will not – this decision is made near the end of the apprenticeship. The wage here is the average for technicians and non-technicians

Recouping the investment

One way of assessing the benefits of training is to consider the time taken to pay back the investment. To give an indication of the payback period, a net present value (NPV) of an apprentice was calculated by summing the future benefits derived by the business from employing the apprentice once fully trained: the net cost of training apprentices was then deducted from that NPV. Since the benefits occur in the future, they must be discounted to a present value: a 6% discount rate has been used which was roughly equal to the retail interest rate at the time of the study in late 2008.[117] There is also a need to take into account the gain to employers from training someone (ie the mark-up on the employee's wage). Employers will recoup their investment in training by paying a wage to experienced workers that is somewhat less than their marginal productivity. It is this difference that enables employers to bear the cost of training and yield a return on their investment. The average productivity gap between apprentices and experienced workers provides a guide to the magnitude of the productivity gains. In the engineering case studies, the average productivity of an apprentice was estimated at around 45% of that of the experienced worker, while apprentice wages averaged around 49% of the wages of experienced workers.

Based on the assumptions above – and it must be acknowledged that these are very much indicative figures and based on the particular case studies undertaken – an estimate is provided in Figure 19.4 of the payback period for apprenticeship training. The results show that, despite the high net cost of apprenticeships in engineering, relative to other industries, the high value of added productivity once apprentices were fully trained means that the investment was recouped within two and three years. Whether or not these returns are obtained depends on the extent to which apprentices stay with the employer that trained them once their training is complete. In general, employers reported that they were able to retain most, if not all, of their apprentices once they were fully trained. In practice, employers recognised that they were making a substantial investment in their apprentices and had in place a range of measures to ensure that they stayed with the organisation, such as career development support, opportunities to continue training (eg to degree level) etc.

Fig. 19.4: Payback period for an apprenticeship in engineering



Source: IER Net Benefits of Training Study 2008

Final Comments

Historically, apprenticeship has proved to be one of the principal means by which engineering companies have equipped themselves with the craft and technician level skills they need, as well as providing a core group from which future managers will be selected. The evidence provided by IER's research suggests that there is a strong business case for engineering firms to invest in apprenticeships, so long as they are able to retain apprentices for the period over which training costs are recouped. The findings are also fitting given the current economic downturn and its impact on the engineering industry. Once the recovery begins there is a danger that skill shortages may emerge if, given the lead times in training apprentices, employers stop investing in apprenticeships. The evidence indicates that investing in apprentices now will reap benefits in the future.

117 The calculation can be expressed as follows:
formula is NPV of Apprenticeship =
$\Sigma[S_1/(1+r) + S_2/(1+r)^2 + S_3/(1+r)^3 ...+ S_n/(1+r)^n] - C_0$
t=1
where S_n is the value of the apprentice at time 1, 2, 3, ...n (n is the number of time periods), r is the discount rate and C_0 is the cost of the apprenticeship
t=n

19.2.2 Building Services Engineering sector

Preventing the perennial post-recession skills shortages and skills gaps, and improving the 'bottom line' through well-managed apprentices within the BSE sector

Summitskills CASE Study

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The views expressed in this paper are those of the author and are not necessarily those of SummitSkills or London SouthBank University.

Most professionals within building services engineering (BSE) think the sector will come out of recession towards the end of 2010 or beginning of 2011 (Hammond, 2009a,p20).[118, 119] When this happens, the demand for qualified and trained building services engineers, particularly at craft level, will increase for both the new build and the repair and maintenance sectors. The economic upturn at the end of previous recessions has invariably led to skills shortages and skills gaps appearing not just in the BSE sector, but right across the construction industry (Hammond, 2007).[120, 121]

In this paper, through examining published work for SummitSkills over the last two years, Dr Hammond suggests that this problem will emerge once again, preventing the sector from responding effectively to increased workloads and opportunities. It is suggested that many of the problems underpinning these emerging skills gaps and skills shortages relate to the current policies BSE companies are adopting during the recession towards craft apprentices.

In Hammond (2009a), using projections of workload for 2009 from the desks of BSE consultants, the potential job losses for the BSE sector within the English regions and devolved nations are projected. Table 19.4 below shows the total indicative UK job losses from the best case and worst case scenarios for the sector in 2009 for both full operatives and apprentices.

Table 19.4: Total indicative notional UK full operative and UK apprentice job losses from the best case and worst case scenarios by BSE industry

	Employment 2008	Indicative notional job losses best case scenario: full operative	Indicative notional job losses best case scenario: apprentices	Indicative notional job losses worst case scenario: full operative	Indicative notional job losses worst case scenario: apprentices
United Kingdom					
Electrical trades and installation	196,810	35,490	1,242	82,125	2,874
Plumbing	90,424	16,306	571	37,731	1,321
Heating and ventilation	55,645	10,034	351	23,222	813
Air conditioning and refrigeration	27,821	5,121	179	11,621	407

118 Hammond M. J. (2009a) *Potential impact of the recession on the building services engineering sector in 2009* Milton Keynes, SummitSkills

119 This piece of research was undertaken in November 2008 with professional building services engineering consultants seeking to identify the quantity of the reducing workload for the BSE sector in 2009, and the potential impact on jobs within the sector, and potential redundancies

120 Hammond, M. J. (2007) *The Sector Needs Analysis for the Building Services Engineering Sector* Milton Keynes, SummitSkills

121 This piece of research was undertaken as part of the Sector Skills Agreement for the building services engineering sector, and involved assessing the skills needs of the sector against Porter's theoretical model for business excellence

Since Hammond (2009a) was published in February 2009, anecdotal evidence from SummitSkills networks across the nations and regions – including from training providers and training managers working with apprentices in the sector – does not paint a positive picture. It suggests that, across all industries, the "indicative notional job losses best case scenario" for apprentices was passed some time ago. It also suggests that redundancies among apprentices are currently heading towards the worst case scenario and that job losses for apprentices may be higher as a percentage than those for full operatives.

One of the possible reasons for this phenomenon is that apprentices are currently viewed as a cost to a company rather than as a productive asset. Hammond (2007) cites numerous examples of employers in the sector giving philanthropic reasons for their employment of apprentices, which consequently are not seen as conducive to survival in a recession.

This misconception is challenged in Hammond (2009b).[123, 124] Using the SPONS mechanical and electrical pricing book, the author priced the cost of incorporating apprentices into standard twelve-man mechanical gangs, eight-man ductwork gangs and eleven-man electrical gangs. Those calculations suggest that 'smart' use of apprentices results in no skills deficit within the gang and even allows for apprentices undertaking college training. Ultimately, this leads to significant cost savings of the type shown in Table 19.5.

Table 19.5: SPONS M&E gang saving with apprentices compared with gangs without apprentices

Type of gang	Inclusive-man-hour rate without apprentices	Inclusive man-hour rate with apprentices	Saving
Twelve-man mechanical	£26.06	£23.41	10%
Eight-man ductwork	£30.41	£26.31	13.48%
Eleven-man electrical	£25.40	£21.38	15.83%

A considerable number of companies within the BSE sector are actually engaged in minor works, so Hammond (2009b) also looked at the cost savings here. Specifically, he looked at actual typical small works contracts in the mechanical and electrical trades based on one craftsman working with one apprentice. The savings on these typical minor works contracts are shown in Table 19.6.

Table 19.6: Savings on standard mechanical and electrical minor works contracts through using an apprentice

Type of contract	Saving on contract through using an apprentice	Additional displacement saving: time saved for the craftsman	Which equates to:
Electrical: typical upgrade of four-bedroom house	£117.65	30 hours 13 minutes	£359.57
Heating and ventilation Central heating: installation for two storey house	£106.39	31 hours 25 minutes	£387.77
Plumbing: fitting a domestic bathroom suite	£79.89	15 hours	£189.44

122 Hammond M.J. (2009b) *Apprentice Cost-Benefit Analysis for the Building Services Engineering Sector* Milton Keynes, SummitSkills

123 This piece of research was commissioned out of the Sector Skills Agreement for the BSE sector, and sought to quantify the actual cost benefits that accrue from the employment of apprentices, allowing for their training, both in relation to major works contracts, and minor works contracts. The report concludes that significant cost savings can be accrued through the effective management and maximum use of apprentices, as labour costs are lower for apprentices than fully qualified operatives

In Hammond (2009b), it was argued that these savings can be achieved if the apprentice is well managed and is not left unproductive for any significant period of time. The model created in Hammond (2009b) does allow for 10% unproductive time on each element of the work. The apprentice can use this time to observe the craftsman as part of the apprentice learning experience.

It is suggested that, in a climate of 'tight margins', a well-managed apprentice could be the differentiator that wins a contractor a tender.

In Hammond (2007) and Hammond (2008)[124 125] it was suggested that the BSE sector currently has problems with the quality and effectiveness of first line supervision and management. This may explain, but not justify, why apprentices are perceived, and in fact may be, a cost to the BSE sector. Because of this shortcoming, the potential savings Hammond identified are not being realised.

What is certain is that failing to retain or recruit apprentices is guaranteed to result in a skills shortage when the economy improves.

In the post-recession boom of the 1990s, the BSE sector turned in part to migrant labour to address the skills gaps and skills shortages. This was predominantly delivered through labour agencies, as can be seen from Table 19.7, taken from Hammond (2008, p101). This research was carried out during a time when the sector was very buoyant.

Table 19.7: Percentage of BSE companies who use the labour agencies to recruit migrant workers by company size

	Total	Single sites	Multi-sites	2-15	16-25	26-49	50-250	251+
Yes	56%	61%	37%	67%	25%	16%	58%	77%
No	41%	38%	55%	30%	75%	84%	35%	23%
Don't know	3%	1%	8%	3%	0%	0%	7%	0%

Table 19.7 is interesting as it suggests that bigger companies – those normally associated with prestigious high-tech specification contracts – used the highest percentage of migrant labour. It can be assumed that the current recession may have forced many of these migrant workers to return to their home country. If the value of the pound sterling against the workers' home currency (or, indeed, against the Euro) isn't sufficiently large, then there will be nothing to encourage them to return to the UK to work. If this happens, the UK BSE sector could suffer from an enhanced skills gap as well as a skills shortage.

The paper therefore concludes that the development of 'well managed' apprentices is essential both in preventing skills shortages and skills gaps after this recession, and in building a sustainable and highly skilled workforce. Companies in the BSE sector need to realise the benefits apprentices can bring to their bottom line.

124 Hammond, M.J. (2008) *Report on additional research into specific themes arising from the Sector Skills Agreement for Building Services Engineering* Milton Keynes, SummitSkills

125 This piece of research entitled 'Report on additional research into specific themes arising from the Sector Skills Agreement for building services engineering' arose out of the Sector Skills Agreement, and examined a range of issues impacting on the BSE sector including globalisation and economic performance and entrepreneurship, leadership and management, environmental Issues and technologies, and migrant workers. In total, 2004 companies of various sizes across the BSE sector took part in this research.

19.3 Young Apprenticeships

Young Apprenticeships[126] give 14–16-year-olds the opportunity to combine school-based national curriculum studies with college- or workplace-based vocational qualifications across a range of sectors. There were 9,000 Young Apprenticeship places in the 2009–11 cohort (Cohort 6). This includes 2,000 places for a new pilot Young Apprenticeship using 14–19 Diploma qualifications.[127] *Progression through Apprenticeships: the Final Report of the Skills Commission's Inquiry into Apprenticeships* (Skills Commission 2009)[128] notes that, since its launch in 2004, the Young Apprenticeship programme has become a highly valued and high achievement pathway for those aged 14 plus. An Ofsted evaluation (Ofsted 2007)[129] confirmed this view, as did a National Foundation for Educational Research unpublished evaluation of the first two Young Apprenticeship cohorts where, "the findings showed that around 90% of Young Apprentices continued onto Further Education or training, with around a quarter progressing onto a full apprenticeship," (Skills Commission, 2009:26).

The Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTA) told the Skills Commission inquiry that: "Young Apprenticeship starts in engineering nearly doubled between 2003 and 2007. Some 50% of those who enrol go on to an Advanced Apprenticeship with the same employer and 42% eventually progress on to Higher Education," (Skills Commission, 2009:26).[130] However, despite its success, the Young Apprenticeship programme has recently suffered policy and funding difficulties and pilots are under way to include it in the 14–19 Diploma model. This would risk losing the specific benefits of the Young Apprenticeships brand and its appeal to more able learners who want to engage in extended work-based learning (they have minimum entry level requirements and include around 50 days of work experience). The Skills Commission recommended that: "Government should protect against the further decline of Young Apprenticeship provision by ring-fencing funding for Young Apprenticeships ahead of the machinery of Government changes in 2010," (Skills Commission, 2009:26).[131]

126 "The Young Apprenticeship (YA) programme is a key stage 4 route. The programme allows motivated and able pupils to study for vocational qualifications, not just in the classroom, but also in college, with training providers and in the workplace. Pupils are based in school, and follow the core National Curriculum subjects – but for two days a week (or equivalent) they also work towards nationally recognised vocational qualifications delivered by their local YA Partnership. The programme was launched in September 2004, with 1,000 pupils embarking on YAs." http://www.excellencegateway.org.uk/VLSP6/

127 DCSF / Learning and Skills Council / Sector Skills Councils (2009). Young Apprenticeships Programme for 14 – 16-Year-Olds: Cohort 6: September 2009 – July 2011. http://www.skillsactive.com/training/apprenticeships/young-apprenticeships/FINAL%20v1%20-%20C6%20Processes%20for%20approval%20and%20commissioning%20with%20comments%20amendedfinal.doc/

128 Skills Commission (2009). *Progression through apprenticeships: The final report of the Skills Commission's inquiry into apprenticeships*; London: The Skills Commission pp 25–26. http://www.policyconnect.org.uk/docs/content/pc_apprenticeship_report-0.pdf

129 Ofsted (2007). *The Young Apprenticeships programme 2004–07: an evaluation.* London: Ofsted. http://www.ofsted.gov.uk/Ofsted-home/Publications-and-research/Browse-all-by/Education/Youth-services-and-careers/The-Young-Apprenticeships-programme-2004-07-an-evaluation

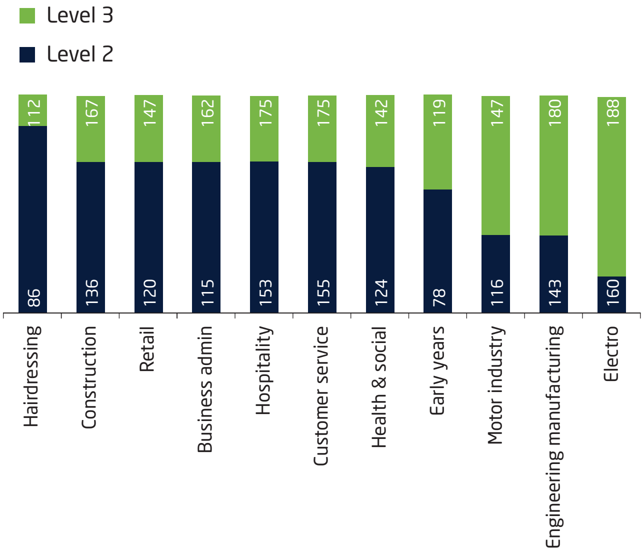
130 Skills Commission (2009). *Progression through apprenticeships: the final report of the Skills Commission's inquiry into apprenticeships;* London: The Skills Commission pp 25–26. http://www.policyconnect.org.uk/docs/content/pc_apprenticeship_report-0.pdf

131 Skills Commission (2009). *Progression through apprenticeships: the final report of the Skills Commission's inquiry into apprenticeships;* London: The Skills Commission pp 25-26. http://www.policyconnect.org.uk/docs/content/pc_apprenticeship_report-0.pdf

19.4 Apprenticeship pay and gender

Since the late 1990s, the Equal Opportunities Commission (EOC) and now the Equality and Human Rights Commission (EHRC) have been investigating education, training and occupational segregation, including in apprenticeships, from a gender perspective (EOC 1998,[132] EOC 2004,[133] EOC archive).[134] In June 2003, the EOC launched a 'general formal investigation into gender segregation in five occupational areas: construction, engineering, information and communication technologies (ICT) and plumbing (all male-dominated), and childcare (female dominated)' (Miller et al., 2005:iii).[135] Alongside many other variables such as class, family dwelling and ethnicity that impact on gender differentiated progression through school to work and to further and higher education and training, the issue of anomalies in apprenticeship pay became evident (Miller et al. 2005).[136] At this time, the pay rates for apprentices were not generally in the public domain and data about pay was not collected by the Learning and Skills Council (Miller et al. 2005). Furthermore the employment status of apprentices in different sectors was found to be variable (Miller et al. 2004).[137] Ullman and Deakin (2005) found an average pay gap of £40 a week between males and females, with the extremes in hairdressing (£90 per week) and the electrotechnical sector (£183) (Ullman and Deakin 2005).[138] Figure 19.5 (Ullman and Deakin 2005) illustrates average net pay during apprenticeship training by sector and by level 2 and 3 (Advanced Apprentices).

Fig. 19.5: Average net pay by apprenticeship sector and level



Source: Ullman & Deakin (2005)[139].

132 Equal Opportunities Commission (1998). Gender and differential achievement in education and training: a research review. Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/gender_and_differential_achievement_findings.pdf?page=16069

133 Equal Opportunities Commission (2004). Plugging Britain's skills gap: challenging gender segregation in training and work: Report of phase one of the EOC's investigation into gender segregation and Modern Apprenticeships. Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/phaseone.pdf?page=17444

134 EOC Archive: http://83.137.212.42/sitearchive/eoc/Defaultf1f1.html?page=15569

135 Miller, L., Pollard, E., Neathey, F., Hill, D. and Ritchie, H. Institute for Employment Studies (2005). Gender segregation in apprenticeships: occupational segregation, Working Paper Series No. 25. Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/gender_segregation_in_apprenticeships_wp25.pdf?page=17641

136 Miller, L., Pollard, E., Neathey, F., Hill, D. and Ritchie, H. Institute for Employment Studies (2005). Gender segregation in apprenticeships: occupational segregation Working Paper Series No. 25. Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/gender_segregation_in_apprenticeships_wp25.pdf?page=17641

137 Miller, L., Neathey, F., Pollard, E. and Hill, D. (2004). Occupational segregation, gender gaps and skill gaps. Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/occupational_segregation_ph1_report.pdf?page=16058

138 Ullman, A. & Deakin, G., (2005). Apprenticeship pay: a survey of earnings by sector Research Report RR674. BMRB Social Research. Department for Education and Skills. HMSO. http://www.dcsf.gov.uk/research/data/uploadfiles/RR674.pdf

139 Ullman, A. & Deakin, G. (2005). *Apprenticeship pay: a survey of earnings by sector* Research Report RR674. BMRB Social Research. Department for Education and Skills. HMSO. http://www.dcsf.gov.uk/research/data/uploadfiles/RR674.pdf

Fuller and colleagues (2005) emphasised that the male-dominated engineering and construction sectors are: "more likely [than female dominated sectors] to offer training in level 3 occupations ... leading to qualifications which are acceptable for entry to Higher Education and to pathways leading to professional status," (Fuller et al. 2005: unpaged source) through the effective management and maximum utilisation of apprentices, as labour costs are lower for apprentices than fully qualified operatives and that these sectors are also more likely to offer much higher rates of pay. If pay, employment status and details of training provision are not widely advertised by all sectors, young women may make choices about which apprenticeship to follow based on severely limited information.[140] The Equal Opportunities Commission (2005) emphasised that: "more employers must rid their workplaces of attitudes, practices and cultures that have for so long defined their businesses as 'male', so they can start to harness the essential skills that only more women can provide," (EOC, 2005: 5).[141]

In 2007, the Equality and Human Rights Commission (EHRC) and the Apprenticeship Ambassadors Network emphasised that (still): "only 2% of engineering apprentices are female, only 4% are from ethnic minority communities and 6% have a learning difficulty, disability or health problem," (EHRC 2007:3).[142]

In March 2008, the TUC published *Still More (Better Paid) Jobs for the Boys*,[143] followed by *Decent Pay for Apprentices*[144] in August 2008 – highlighting the gendered (and worsening) nature of apprenticeships in engineering-related sectors (Table 19.8) and calling for better apprentice pay, employment protection and for developing stronger enforcement mechanisms.

Table 19.8: Apprenticeship starts – proportion of women apprentices in top 10 frameworks (2002/03 and 2006/07)

	% Women Apprentices (Level 2 and Level 3)		
Apprenticeship Framework	**2002/03**	**2006/7**	**% change**
Construction	1.3	1.3	0
Hairdressing	92.6	91.7	-0.9
Business administration	78.6	79	0.4
Customer service	68.2	67	-1.2
Hospitality and catering	50.6	50.6	0
Children's care learning and development	97.3	97.1	-0.2
Engineering	4.6	2.6	-2
Health and social care	88.9	89.7	0.8
Retail	65.8	66.4	0.6
Vehicle maintenance and repair	2.9	1.4	-1.5

Source: TUC (2008a) *Still More (Better Paid) Jobs for the Boys: Apprenticeships and Gender Segregation* Table 1[145]

140 Fuller, A., Beck, V. and Unwin, L. (2005). *The gendered nature of apprenticeship.* Education & Training 47(4/5). In Emerald. Available at: http://www.emeraldinsight.com/Insight/ViewContentServlet?contentType=Article&Filename=Published/EmeraldFullTextArticle/Articles/0040470405.html

141 Equal Opportunities Commission (2005). *Free to choose: Tackling gender barriers to better jobs.* Manchester: EOC. http://www.equalityhumanrights.com/Documents/Gender/Formal%20investigations/Occupational%20segregation/Occupational%20segregation%20Free%20to%20choose%20England%20final%20report.pdf

142 Equality and Human Rights Commission and the Apprenticeship Ambassadors Network (2007). *Daring to be different: the business case for diversity on apprenticeships.* London: Equality and Human Rights Commission. http://www.equalityhumanrights.com/en/publicationsandresources/Pages/Daringtobedifferent.aspx

143 TUC (2008a). *Still more (better paid) jobs for the boys: apprenticeships and gender segregation.* http://www.tuc.org.uk/extras/genderreport.pdf

144 TUC (2008b). *Decent pay for apprentices.* http://www.tuc.org.uk/extras/apprenticepay.pdf

145 TUC (2008a). *Still more (better paid) jobs for the boys: apprenticeships and gender segregation.* http://www.tuc.org.uk/extras/genderreport.pdf

Despite this multi-agency, consistent and longstanding advice on the need to encourage more women into the engineering & technology sectors and how to do it, there is not much evidence of improvement. While there are pockets of change, little still seems to have been done, for example, to widely advertise apprenticeship wages by sector.[146] In May 2009, the apprenticeship website was offering no more than information on the minimum wage rate for apprentices (£80 a week) and stating that: "apprentices earn an average of £170 net pay per week. The highest paying sector is electrotechnical at £210 per week," (Apprenticeships website, 2009, unpaged source).[147] It is relevant that in 2002/03, only 0.4% of the 3,491 starters on the Electrotechnical Advanced Apprenticeship (level 3) were female.[148] By 2006/7, only 1.5% of starters at levels 2 and 3 in electrotechnical apprenticeships were female (TUC).[149]

The Learning and Skills Council (2008c) study into expansion of apprenticeships suggests: "there is a perception among FE learners that apprenticeships can close off future career choices and academic progression. A majority of FE learners highlighted that they would have been more likely to apply [for an apprenticeship place] if the apprenticeship provided a route to university. (This was particularly the case for non-white learners.) Almost 75% said they would be more likely to apply if an apprenticeship did not tie them down to a particular job in future," (LSC 2008c:18).[150] Whether perceptions are similar regarding undertaking a degree in engineering or technology would be an interesting question. And if not, why not? Furthermore, in order to expand the numbers of apprenticeships, we clearly need to do more to publicise real-life examples of the opportunities an apprenticeship pathway opens up.

146 For more recent pay rates see LSC (2008b). *Rapid review of research on apprenticeships. Coventry: LSC.* http://readingroom.lsc.gov.uk/lsc/National/Apprenticeships_Literature_Review_final.pdf

147 Apprenticeships website. Consulted 13 May 2009. In *Apprentice FAQs»Do apprentices get paid?* Accessible at: http://www.apprenticeships.org.uk/Be-An-Apprentice/Other-Questions/FAQDetails6.aspx

148 Miller, L., Pollard, E., Neathey, F., Hill, D. and Ritchie, H. (2005). *Gender segregation in apprenticeships – occupational segregation Working Paper Series No. 25.* Manchester: Equal Opportunities Commission. http://83.137.212.42/sitearchive/eoc/PDF/gender_segregation_in_apprenticeships_wp25.pdf?page=17641

149 TUC (2008a). *Still more (better paid) jobs for the boys: apprenticeships and gender segregation.* http://www.tuc.org.uk/extras/genderreport.pdf

150 LSC (2008c). *Research into expanding apprenticeships.* Coventry: Learning and Skills Council. http://readingroom.lsc.gov.uk/lsc/National/Research_into_Expanding_Apprenticeships_for_release.pdf

Part 2 Engineering in Education and Training

20.0 Other level 3 vocational qualifications

Figures provided to the STEM Higher Level Strategy Group in June 2009 provide an indication of combined total achievements in National Vocational Qualifications (NVQs) and Vocationally Related Qualifications (VRQs) by adults (age 19+) over a three year period (Table 20.0). The apparent spectacular rise in engineering achievements – more than doubling over the period and from a substantial base – is slightly offset by a reduction in manufacturing technologies achievements. However, we do not know what the engineering category includes, although the Key Performance Indicator (KPI) to which the data relates is concerned with level 3. Furthermore, there have been inconsistencies over time in recording and reporting level 3 vocational qualifications data (cf Lau, E. 2002).[151]

Table 20.0: Achievements in NVQs and VRQs by adults (age 19+) over a three year period

	2006	2007	2008
Engineering	40,360	50,380	87,450
Manufacturing technologies	3,270	2,400	2,190

Source: adapted from DCSF & DIUS, June 2009 (STEM HLSG (2009a); KPI 1.7 –"year on year increase in the number of adults aged 19+ achieving level 3 qualifications in STEM related areas".

151 Lau, E. (2002). Skills and productivity: developing new measures. Office for National Statistics. *Royal Economic Society Annual Conference March 2002.* http://www.statistics.gov.uk/about/methodology_by_theme/Productivity_methodology_papers/downloads/res_paper.pdf

20.1 National / Scottish Vocational Qualification (N/SVQ)

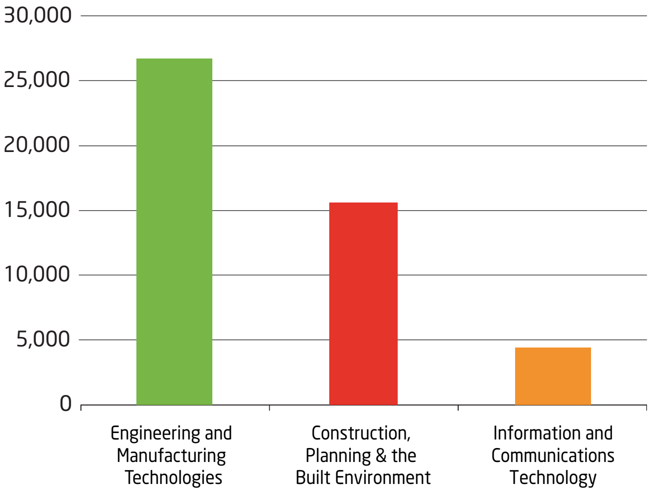
N/SVQ qualifications recognise the level of the skills and knowledge needed to show that a candidate is competent in the area of work the NVQ represents.[152] N/SVQs are awarded for successfully passing a performance-based assessment, normally undertaken in a working environment – N/SVQs are not related to a course of study. Over seven and a half million N/SVQs have been awarded in the UK since the mid 1990s.[153]

N/SVQ3 is a substantial element[154] of Advanced/Modern Apprenticeships which fulfils most of the competence requirements for professional registration with Engineering Council as an Engineering Technician (EngTech) or ICT Technician (ICT *Tech*). In 2008, N/SVQ4 was approved as an exemplifying qualification to meet the Enginering Council Incorporated Engineer (IEng) standard.[155]

Changes are underway in England, Wales and Northern Ireland regarding the use of NVQ in qualifications titles[156] and the English apprenticeship framework (SASE)[157] has also been revised.

Although, as noted earlier regarding qualifications more generally, not all N/SVQs recorded under engineering and manufacturing technologies (EMT), construction, planning and the built environment (CP&BE) and ICT will be directly related to engineering & technology. However, around 46,800 N/SVQ3 awards were made in the UK EMT, CP&BE and ICT sectors in 2007/08 (Figure 20.0).

Fig. 20.0: N/SVQ awards in selected sector subjects (2007/08) – UK



Source: The Data Service (2009a): Supplementary Release to Statistical First Release: DS/SFR2; Vocational Qualifications in the UK: 2007/08 commentary.[158]

Unsurprisingly perhaps, as learning in and through work may take time, in 2007/08 57% of all N/SVQ awards in the UK went to people over the age of 25. The higher the N/SVQ level, the more likely it is to be awarded to a learner over the age of 25. In 2007/08 (UK) 57% of level 3s and 87% of level 4/5s went to this age group (Figure 20.1).[159]

152 QCDA: http://www.qcda.gov.uk/6640.aspx.

153 The Data Service (2009c): Post-16 education & skills: learner participation, outcomes and level of highest qualification held DS/SFR2 England 26 March 2009. Table 9. http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000838/index.shtml

154 The Data Service: http://providers.lsc.gov.uk/LAD/aims/NewFrameworkMandKSsearch.asp

155 Engineering Council (2008a). *UK Standard for professional engineering competence* (UK-SPEC) http://www.engc.org.uk/documents/EC0006_UKSpecBrochure_MR.pdf

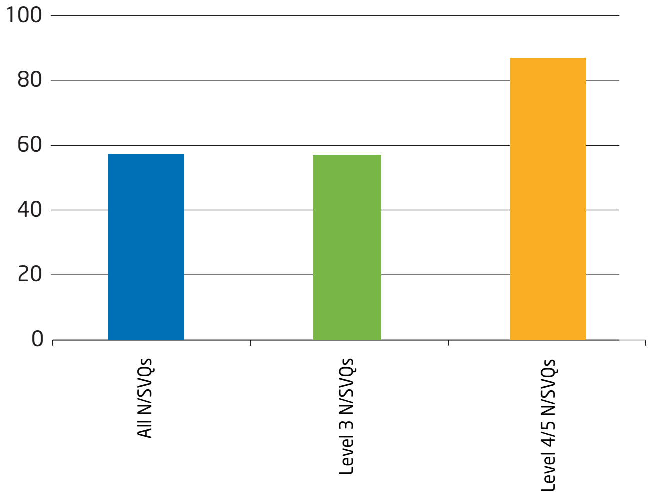
156 Ofqual: Operating rules for using the term 'NVQ' in a QCF qualification title (August 2008): http://www.ofqual.gov.uk/1947.aspx

157 DIUS: Specification of Apprenticeship Standards for England (SASE) consultation: http://www.dius.gov.uk/consultations/sase

158 The Data Service (2009a): Supplementary Release to Statistical First Release: DS/SFR2; Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009: Table 5; NVQ/SVQ awards by sector; 2007/08; UK. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

159 The Data Service (2009a).Supplementary Release to Statistical First Release: DS/SFR2 Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

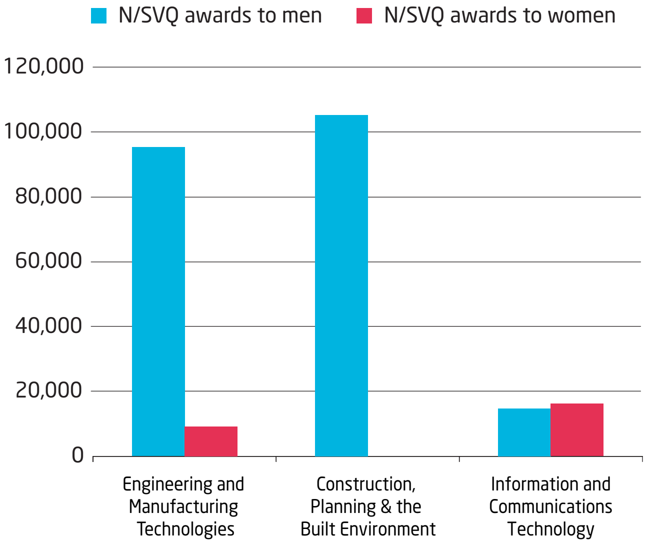
Fig. 20.1: Percentage of N/SVQ awards made to the 25 and over age group (2007/08) – UK



Source: National Statistics: The Data Service: Supplementary Release to Statistical First Release: DS/SFR2 Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009

It remains a concern that relatively few women gain N/SVQ awards in EMT or CP&BE. The gender split for ICT N/SVQ awards (UK, all levels) is more balanced. However, not all these awards will be for ICT *practitioner* skills – the area which falls under 'engineering and technology'.[160] Many may be for ICT user skills (Figure 20.2).

Fig. 20.2: N/SVQ awards (all levels) by selected sector subjects and gender (2007/08) – UK



Note – where none shown = less than 1,000

Source: The Data Service (2009a). Supplementary Release to Statistical First Release: DS/SFR2 Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009

160 For example, see the Engineering Council ICT Technician Standard website: http://www.icttech.org.uk/about-icttechs/roles-and-levels.aspx

20.2 Wage returns of NVQs

In recent years, a number of substantial studies have investigated the lifetime 'wage returns' of vocational and occupational qualifications to individuals (Table 20.1), employers and the State, compared with general qualifications, and the possible impacts of this difference on social stratification.[161]

Table 20.1: Wage returns to an individual by selected qualifications

Qualification	Wage returns to an individual of around:
First degree	26%
Two or more A levels	16%
5 or more grade C or above GCSEs	28%
HND	11% for men 8% for women
HNC	14% for men 8% for women
NVQ1 and NVQ2	No positive effect on earnings
NVQ3*	3% for men 5% for women*

Source: McIntosh, 2002[162]

* Source: Jenkins et al., 2007[163]

"The returns to each qualification are estimated on the basis of the earnings of all individuals who acquire them, rather than just individuals who acquire that qualification and progress no further. ... the interpretation of the estimated coefficient on any particular qualification is the estimated difference in earnings between someone who holds that qualification and someone who does not, holding all other education achievements constant. The estimated returns should be viewed as cumulative across qualifications, and so can be summed to obtain the total returns to a combination of qualifications." (McIntosh, 2002:2)

The Returns to Qualifications in England: Updating the Evidence Base on Level 2 and Level 3 Vocational Qualifications (Jenkins, Greenwood and Vignoles, 2007)[164] added to this evidence, through exploring the value of level 3 vocational qualifications to a restricted sample of: "individuals who leave school, generally at age 16, with a good set of GCSEs at best and ... do not go on to higher level vocational study," (Jenkins et al. 2007:6). The analysis suggests that there are positive returns to a range of level 3 vocational qualifications for this restricted sample but that this varies by sector, occupation and gender. Whilst, generally, NVQ3 holders can expect a wage return of a little under 5% (women) and 3% (men), in the restricted sample the marginal wage return to NVQ3 increases substantially – to 10% for women and 13% for men (from around 5% for women and 3% for men NVQ3 holders generally) (Jenkins et al. 2007:6). However, we still need to put this in context of the far greater wage returns to those who accumulate general qualifications.

161 For further discussion, including relationship with increased social stratification see: Engineering and Technology Board and Engineering Council (2005). *Engineering UK 2005*: A Statistical Guide to Labour Supply and Demand in Engineering and Technology section 2.4. http://www.etechb.co.uk/research/engineering_uk.cfm

162 McIntosh, S.(2002).Further Analysis of the Returns to Academic and Vocational Qualifications. Nottingham: DfES. http://www.dcsf.gov.uk/research/data/uploadfiles/RR370.pdf

163 Jenkins, A, Greenwood, C and Vignoles, A. (2007). *The Returns to Qualifications in England: Updating the Evidence Base on Level 2 and Level 3 Vocational Qualifications* London: Centre for the Economics of Education London School of Economics http://eprints.lse.ac.uk/19378/

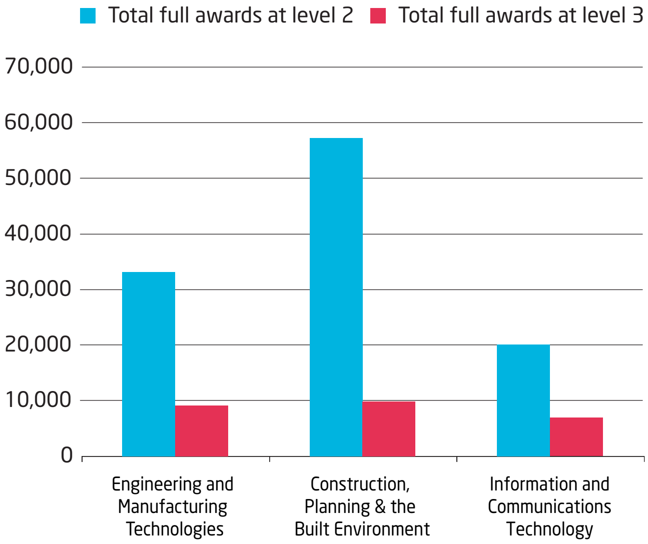
164 Jenkins, A, Greenwood, C and Vignoles, A (September 2007). *The returns to qualifications in England: Updating the evidence base on level 2 and level 3 vocational qualifications* London: Centre for the Economics of Education London School of Economics http://eprints.lse.ac.uk/19378/consultation: http://www.dius.gov.uk/consultations/sase

20.3 Vocationally related qualifications (VRQs)

Nearly six million vocationally related qualifications (VRQs)[165] have been awarded in the UK since the mid 1990s.[166] Vocationally related qualifications (VRQs), such as National Certificates and Diplomas, provide an indication of a 'theoretical learning' level within the sector to which they relate. VRQ courses are usually run at colleges or similar centres and may involve some work experience. As well as being stand alone, VRQs are often, but not necessarily, an element of apprenticeships. VRQ achievements at level 3 (6 in Scotland) are also of direct interest to the engineering & technology community. Level 3 VRQs are a further component of most engineering & technology Advanced/ Modern Apprenticeships and data about level 2 and 3 (4 to 6 in Scotland) achievements can help to provide a picture of progression. In 2007/08, 46% of all UK VRQ awards at levels 1–3 were achieved through Further Education/Tertiary Colleges (around 778,400 awards), 19% through schools and 17% through private training providers.[167]

Figure 20.3: provides a picture of UK level 2 and 3 achievements in EMT, CP&BE and ICT in 2007/08.

Fig. 20.3: VRQ full awards[168]; all ages; all centres (2007/08) - UK



Source: The Data Service (2009a). Supplementary Release to Statistical First Release: DS/SFR2; Vocational Qualifications in the UK: 2007/08 commentary[169]

Whilst, as with N/SVQs, not all VRQs in the sector subjects in Figures 20.3 or 20.4 will be directly related to engineering & technology, in 2007/08 CP&BE was the most popular of all sector subjects according to its share of all UK recorded full VRQ awards Figure 20.5.

165 "Vocationally related qualifications (VRQs) serve a range of purposes in different sectors and at different levels, and consequently vary in terms of size, level and assessments. VRQs generally provide the knowledge and practical skills required for particular job roles through a structured learning programme – usually delivered off-site. As such, they provide a learning pathway for those not yet in employment or who prefer a more traditional study-based training programme. VRQs are particularly suited to less confident learners who may benefit from the support offered by mediated learning experiences and tutor guidance. Although VRQs are closely related to occupational roles and include some work-based experience, they are usually assessed by assignments, projects and sometimes short written tests. The assessments will often relate to activities carried out during work-based practice and may include an element of assessment in the workplace." http://www.tda.gov.uk/support/qualificationsandtraining/vrqs.aspx

166 The Data Service (2009c): Post-16 Education & Skills: Learner Participation, Outcomes and Level of Highest Qualification Held DS/SFR2 England 26th March 2009. Table 9. http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000838/index.shtml

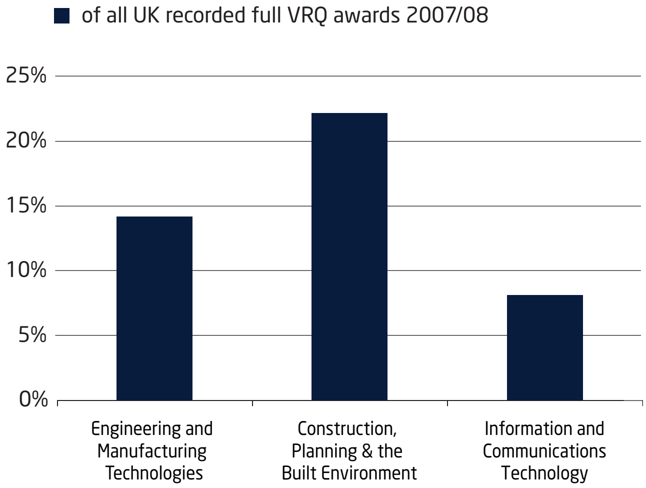
167 The Data Service (2009a): Supplementary Release to Statistical First Release: DS/SFR2. Vocational Qualifications in the UK: 2007/08 commentary, published on 26th March 2009. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

168 Full VRQs – where Guided Learning Hours were at least 80% of hours recommended.

169 The Data Service (2009a). Supplementary Release to Statistical First Release: DS/SFR2; Vocational Qualifications in the UK: 2007/08 commentary, published on 26th March 2009: Table 7; VRQ awards by sector subject area; 2007/08; UK http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

20.0 Other level 3 vocational qualifications

Fig. 20.4: Percentage of all recorded full VRQ awards by selected sector subjects (2007/08) – UK

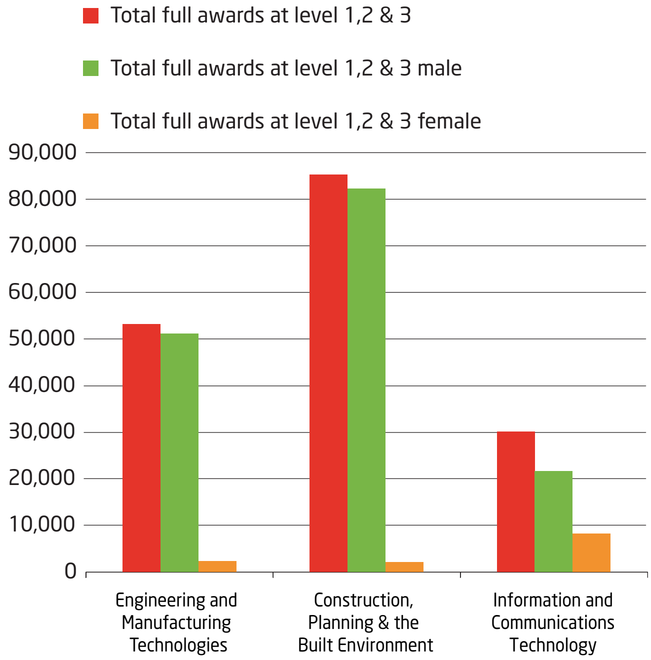


Source: The Data Service (2009a). Supplementary Release to Statistical First Release: DS/SFR2. Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009

However, a quarter of all full level 2 VRQ awards were in CP&BE.[170] The relatively low numbers achieving level 3 VRQs in engineering & technology sectors may be a progression concern, particularly in that a level 3 VRQ is often necessary to complete an Advanced Apprenticeship.

As with N/SVQs, the gender split (all levels, UK) in EMT and CP&BE also remains a substantial concern (Figure 20.5).

Fig. 20.5: VRQ full awards[171] by total and by gender in selected sector subjects (2007/08) – UK



Note: Numbers may not add up due to rounding

Source: The Data Service (2009a). DS/SFR2 Supplementary Release to Statistical First Release: Vocational Qualifications in the UK: 2007/08 commentary[172]

In 2007/08, 34% and 21% of all UK recorded full VRQ awards to males were in CP&BE and EMT respectively.[173]

Of the 391,000 awards of full VRQs recorded in 2007/08, 58% were at level 2 and 31% were at level 3. Of the level 2 awards, 49% were to those aged 16 and under whilst 84% of level 3 awards were to those aged 17–19.[174] The latter is in some contrast to the majority (57%) achievement of N/SVQ3s by the 25+ age group.

As the Qualifications and Credit Framework (QCF)[175] rolls out, credit will be awarded at each level. The Scottish framework (SCQF)[176] already includes credit arrangements.

170 The Data Service (2009a): DS/SFR2 Supplementary Release to Statistical First Release: Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

171 Full VRQs – where Guided Learning Hours were at least 80% of hours recommended.

172 The Data Service (2009a): DS/SFR2 Supplementary Release to Statistical First Release: Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009: Table 7; VRQ awards by sector subject area; 2007/08; UK. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

173 The Data Service (2009a): Supplementary Release to Statistical First Release: DS/SFR2. Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

174 The Data Service (2009a): Supplementary Release to Statistical First Release: DS/SFR2. Vocational Qualifications in the UK: 2007/08 commentary, published on 26 March 2009. http://www.thedataservice.org.uk/statistics/sfrmar09/summary.htm

175 The QCF: a framework for recognising and accrediting qualifications in England, Wales and Northern Ireland. The framework is central to the major reform of the vocational qualifications system. The framework is a way of recognising skills and qualifications through awarding credit for qualifications and units; enables individuals to transfer credit points between qualifications and to plan their learning; utilises two measures – the level of a qualification and the number of Credit Points awarded for that qualification: http://www.qca.org.uk/qca_8150.aspx

176 The SCQF: similar purposes to QCF: http://www.scqf.org.uk/

Part 2 Engineering in Education and Training
21.0 Further Education teaching workforce

A paper presented to the STEM Higher Level Strategy Group in February 2009 noted that teaching staff in colleges may teach across a range of areas. "For example, in teaching automotive curriculum, there may be an element of science and maths that is delivered by a teacher with industrial automotive skills who is not primarily identified as a STEM teacher," (STEM HLSG, 2009b:1). The paper goes on to note that, "it can be difficult therefore to be absolutely certain about the true picture of FE STEM teacher numbers. This is compounded by the fact that FE providers are independent organisations responsible for their own recruitment and deployment of staff, and organisation of provision, to meet employer business needs," (STEM HLSG, 2009b:1). According to this paper, analysis by main subject taught shows a steep decline from 2003/04 to 2006/07 in the numbers teaching engineering, technology and manufacturing (Fig 21.0 & Table 21.0). However this data does not include those teaching construction and the built environment or computing aspects of engineering.

Fig. 21.0: FE teaching staff by selected disciplines – number in workforce (2002/03-2007/08) - England

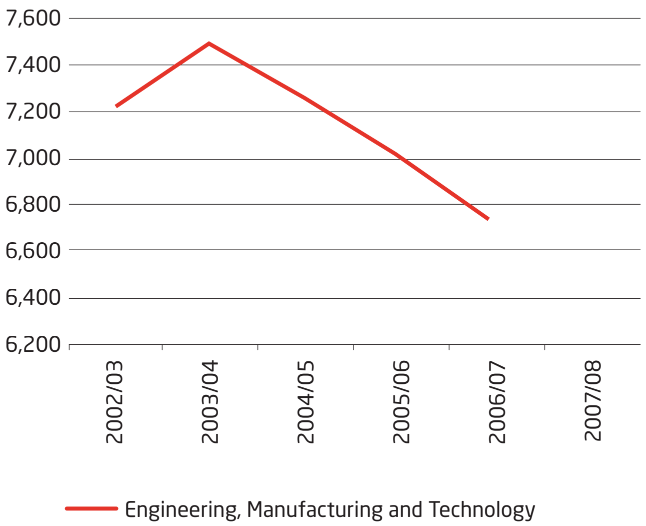


Table 21.0: Area of learning of main subject taught (2002/03) - England

	Number of FE teachers				
	2002/03	**2003/04**	**2004/05**	**2005/06**	**2006/07**
Engineering, Manufacturing and Technology	7,245	7,492	7,287	7,023	6,743

Source: Adapted from STEM HLSG February 2009:2

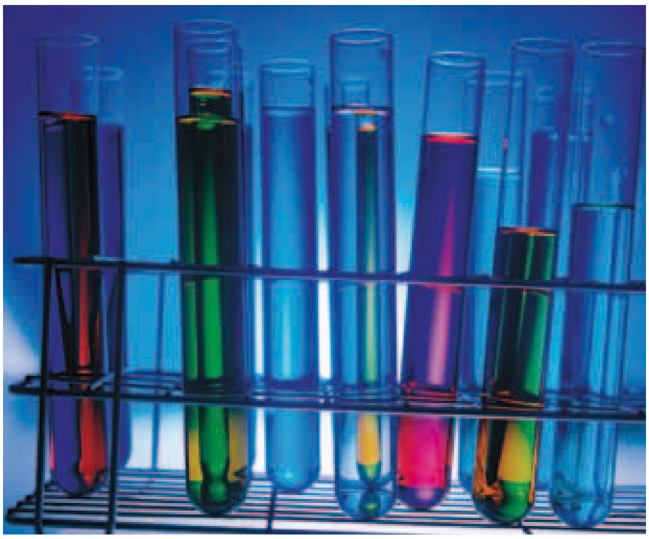
Albeit faced with similar issues about categorising main subject specialism and the independent nature of the sector, Lifelong Learning UK (LLUK) produces a regular analysis of the Staff Individualised Record (SIR) data. This provides a broader picture than the data in Figure 21.0 and Table 21.0. For example, it suggests that there is more than double the number of teaching staff in 2006/07 (England), indicated by the HLSG calculation, with main subject taught falling within engineering related areas (Table 21.1). However there also appears to be a fall in staffing numbers over the two-year period 2004 – 2007.

Table 21.1: Subject areas taught by FE teaching staff during (2004/05 and 2006/07) - England

	Number 2004/05	**Number 2006/07**
Engineering, Manufacturing and Technology	7,159	5,016
Construction	5,257	4,399
Information and Communication Technology	8,124	5,024
Total	20,540	14,439

Source: Adapted from LLUK (2008). *Further Education Workforce Data for England 2006/07* Table 20 and LLUK (2006) *Further Education Workforce Data For England: An Analysis Of Staff Individualised Record (SIR) Data 2004/2005* table 3.4[177]

However, the LLUK 2008 analysis also provides figures that indicate the percentage of all FE staff teaching general subjects over the 2002/03 to 2006/07 period by subject area (Figure 21.1 and Table 21.2). This data suggests (other than for ICT) a *rise* in the proportion of staff teaching in the engineering-related areas over time.



177 LLUK (2006). *Further Education workforce data for England: an analysis of staff individualised record (SIR) Data 2004/2005* http://www.lluk.org/research-reports-staff-individualised-record.htm
LLUK (2008). *Further Education workforce data for England 2006/07* http://www.lluk.org/research-reports-staff-individualised-record.htm

Fig. 21.1: Percentage of FE staff teaching in selected subject areas (2002/03-2006/07) - England

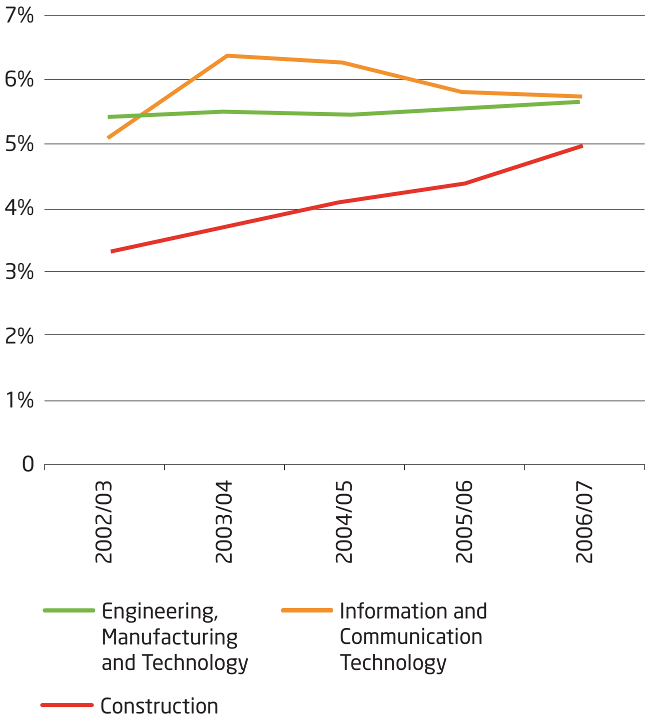


Table 21.2: Percentage of FE staff teaching in selected subject areas (2002/03-2006/07) - England

	2002/03	**2003/04**	**2004/05**	**2005/06**	**2006/07**
Engineering, Manufacturing and Technology	5.4	5.5	5.5	5.6	5.7
Construction	3.3	3.7	4.1	4.4	5.0
Information and Communication Technology	5.1	6.4	6.3	5.8	5.7

Source: Adapted from (LLUK, 2008). *Further Education Workforce Data for England 2006/07* Table 21[178].

LLUK (2009)[179] provides an indication of relative staffing shortages across subject areas (Table 21.3). Although it's not necessarily the case, given the range of current vacancies reported, the table can be read to indicate that construction reports the highest proportion of vacancies of all FE subject areas (43 respondents reporting up to seven current vacancies). Similarly, engineering, technology and manufacturing report the second highest proportion (31 respondents reporting up to three vacancies). In comparison, ICT reports relatively few vacancies (four respondents reporting one vacancy). LLUK (2009) notes that: "engineering, technology and manufacturing covers a wide range of distinct, specialist provision. It may not be meaningful to describe a general shortage here," (LLUK, 2009:9). However, illustrating the difficulty in establishing staff shortages, LLUK (2009) also reports that: "[t]he three sectors experiencing both a high volume and high density of skills shortages according to the most recent NESS (National Employer Skills Survey) are construction, engineering and ICT," (LLUK, 2009:10).

Table 21.3: LLUK data from ORC survey: has your college had any hard-to-fill vacancies for skilled teachers/tutors in any of the following subject areas? (2009)

	Number of respondents who found area hard-to-fill	**Number of current vacancies within the hard-to-fill area**
Engineering, Manufacturing and Technology	31	0-3
Construction	43	0-7
Information and Communication Technology	4	0-1

Source: Adapted from: LLUK (2009) *FE Sector Gap Analysis: Final Report*. Table 2.1.

178 LLUK (2008). *Further Education workforce data for England 2006/07* http://www.lluk.org/research-reports-staff-individualised-record.htm

179 LLUK (2009). *FE Sector Gap Analysis: Final Report*: http://www.lluk.org/2960.htm

LLUK (2009) reports that shortages vary by region and, perhaps linked, demand from learners in those regions. For example, there appear to be more shortages in engineering in areas with a higher level of engineering business and industry. LLUK also suggests that:

"There was an important trend in relation to vocational subjects in which there was a high emphasis on recruiting staff from industry with professional experience, particularly construction, planning and the built environment and engineering and manufacturing technologies, and to a lesser extent health, public services and care and ICT," (LLUK, 2009:18).

Providers in engineering and construction and the built environment sectors suggested that when industry salaries were high and industry jobs were plentiful it was harder to recruit teaching staff (LLUK, 2009).

However, LLUK (2007)[180] identifies particular aspects of shortages, not all of which are engineering-related:

- Engineering: electrical; mechanical; refrigeration
- Construction: advanced plumbing; joinery; carpentry
- ICT: specialised areas rather than basic/general ICT

FE sector teaching staff are now required to gain teaching qualifications and to engage in continuing professional development (alongside entering the sector with discipline knowledge and experience). As a consequence, LLUK notes that:

"Providers are being required to apply a more consistent and, in some cases, higher set of standards when recruiting for teaching roles as part of the professionalisation of the FE workforce. It is therefore logical that when providers who did not previously require staff to be qualified are recruiting teaching staff, they may find it harder to fill vacancies than they previously did, even though the pool of potential candidates is no less qualified or skilled," (LLUK, 2009:11).

21.1 Gender of FE teaching workforce

Whilst total numbers appear to vary from those provided above, Table 21.4 (adapted from LLUK 2008) provides a picture of the gender breakdown of FE teaching staff within engineering-related disciplines. Engineering, technology and manufacturing, and construction, at 93% and above male staffing, are by far the most male-dominated areas of FE. The closest are hospitality, sports, leisure and travel with 48.4% male staff (under half). Hairdressing and beauty therapy, with 88.8% female staff, is the most female-dominated area. Such skews in staffing may well result from the gender bias of those coming through the system but it may also be that a 'chicken and egg' situation is continuingly underpinned by gender (role models) of staff.

Table 21.4: Subject area taught by FE teaching staff by gender (2006/07) – England

		Female	**Male**	**Total**
Engineering, Manufacturing and Technology	Number	453	6,102	6,555
	%	6.9	93.1	100
Construction	Number	389	5,160	5,549
	%	7.0	93.0	100
Information and Communication Technology	Number	3468	3,160	6,628
	%	52.3	47.7	100

Source: Adapted from LLUK (2008). *Further Education Workforce Data for England 2006/07* Table 22.

180 LLUK paper to ACER Engineering, Manufacturing and Technology Forum October 2007.

Part 2 Engineering in Education and Training

22.0 Higher Education

The UK's Higher Education (HE) sector is evolving and growing year on year. It remains the major route into engineering and technology employment and Higher Education institutions remain the key supplier for the UK science base and knowledge based society. The Government set a target for 50% of young people to be educated to degree in HE by 2010. There has been a lot of attention given to the ever growing number of non-UK domicile students, particularly in engineering and technology, and how this will affect the UK economy and skills base. In 2006/07 £1,713m was raised in fees from these students, compared with £445m in 1994/95. While the revenue raised is welcome, as yet, we are unsure of the overall effect on UK global competitiveness should most of these UK-trained non-domiciled graduates return to their home countries.

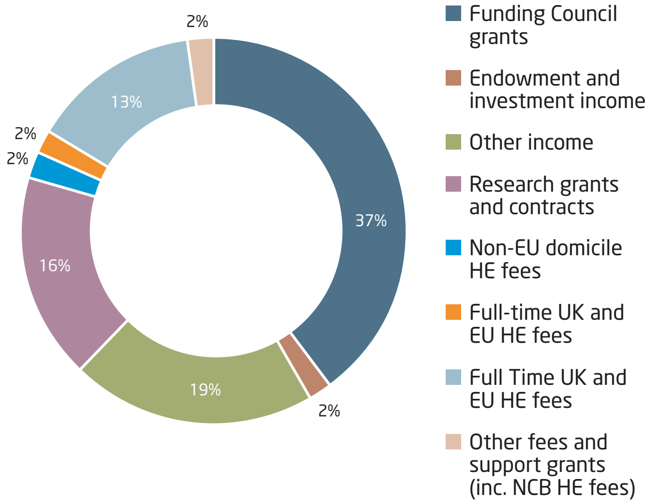
Table 22.0: Overview of HE sector (2006/07) – UK

	Higher Education institutions	Universities
England	133	90
Scotland	20	14
Wales	12	3
Northern Ireland	4	2
United Kingdom	169	109

Source: Universities UK (HESA data)

The sector is a major contributor to the UK economy in its own right, with an income stream of £23.4 billion in 2006/07 (Figure 22.0), 57.4% of which is spent on staffing costs (Figure 22.1). "The sector contributes £45 billion pa to the UK economy,[181] generating export earnings worth £3.6 billion and generating, directly and indirectly, 580,000 jobs". [182]

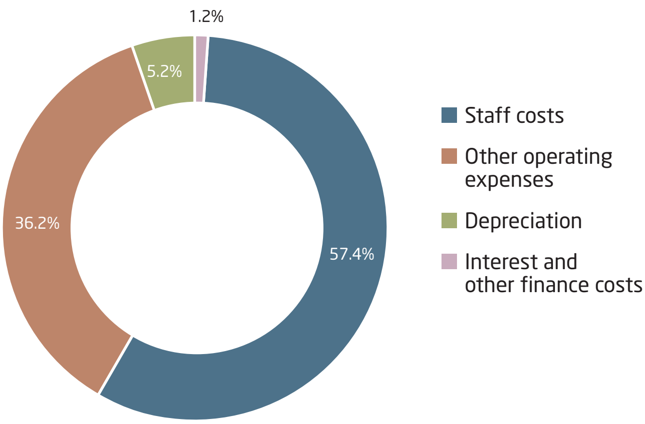
Fig. 22.0: Income £23.4 billion (2006/07)



Source: UUK's HESA breakdown

181 UUK
182 www.universitiesuk.ac.uk/publications/pages/publication-237.aspx

Fig. 22.1: Expenditure £22.9 billion (2006/07)



Source: UUK's HESA breakdown

The UK comes mid way amongst Organisation for Economic Co-operation and Development (OECD) and partner countries, spending only 1.2% of GDP on tertiary education compared with 2.4% for Denmark (Table 22.1). It is on a par with the US which spends 1.3%.

Table 22.1: Higher Education spend as a proportion of GDP by OECD and partner countries

OECD/ partner countries	Denmark[3]	Norway	Finland	Sweden	Canada[2, 3]	New Zealand	Austria	Switzerland4	Iceland[3]	Greece[3]	Netherlands	United States	Belgium	Slovenia	United Kingdom	France	Poland[4]	Australia	Germany	Ireland	Israel	Hungary[4]	Portugal[4]	Mexico	Spain	Estonia	Czech Republic	Brazil[4]	Slovak Republic[3]	Russian Federation[4]	Italy	Japan[3]	Korea	Chile
HE spend as % GDP 2005 tertiary education	2.4	2.3	2.0	1.9	1.7	1.5	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.6	0.6	0.5

1. Year of reference 2004 instead of 2005
2. Some levels of education are included with others
3. Public expenditure only
4. Year of reference 2006 instead of 2005

Source: UUK

22.1 Participation rates

In 2007/08 the provisional HE Initial Participation Rate (HEIPR) in England was 43%, up from the final 2006/07 figure of 42%, as shown in Table 22.2. The provisional figures for females and males were both up one percentage point from the final 2006/07 ones, to 49% and 38% respectively, indicating a 29% greater participation by females compared with males.

The 2007/08 figures were calculated using a new methodology, which means they cannot be compared to a historical time series. The 2006/07 figures were reproduced in the table using this new technique for comparison.

Table 22.2: Higher Education initial participation rate (new methodology) for first time participants in Higher Education institutions (2006/07 and 2007/08) – England

Academic Year	2006/07	2007/08 (Provisional)
HEIPR (male and female) %	42 (42.1)	43 (43.3)
Initial entrants (thousands)	285	296
HEIPR (male) %	37 (36.6)	38 (37.8)
Initial entrants (thousands)	127	133
HEIPR (female) %	48 (47.8)	49 (49.2)
Initial entrants (thousands)	158	163

Source: DIUS, SFR 02/2009

Different methodologies to calculate the HEIPR are used in Scotland, Wales and Northern Ireland, which means comparisons between nations should not be made. All nations measure and compare different cohorts and many are based upon regional breakdowns. In Scotland, in 2006/07[183] the full time equivalent (FTE) participation rate, excluding the Open University, was 36.3[184] (the overall headcount rate was 52.1) for those aged 16 and over. In 2007/08 the participation rate in Ireland was 49.6% for the 18-year-old population. In Wales in 2006/07, the participation rate for 18–19-year-olds was 22.4% for males and 29.9% for females.

183 The 2007/08 figures are due to be released at the end of October 2009
184 Scottish Funding Council (SFC)

22.2 Student and graduate numbers

22.2.1 Applicants[185] to STEM HE courses

Applicant numbers to Higher Education have risen by 28% since 2001/02, with an 8.8%[186] rise in applications to UK universities and colleges in 2009 alone (UCAS, March 2009). In 2001/02 STEM[187] subjects accounted for 22% of all applicants but by 2007/08 this proportion had dropped to 18%. On the surface, this seems to be a negative trend. However, the Social Work Admission Service (SWAS) was incorporated into UCAS in 2003 and the Nursing and Midwifery Admissions Service (NMAS) followed in 2007, significantly increasing the number of applicants for non-STEM subjects. This means that true comparisons cannot be made from this data.

Examination of the overall number of applicants to STEM subjects reveals a positive trend, both in the last year and over the six year period, as illustrated in Figure 22.2. In both comparisons, there has been an increase in UK and overseas students across all STEM subjects – with the exception of mathematical and computer science, which is discussed later in this section. The increasing number of non-UK students studying STEM subjects – particularly engineering – is interesting. Non-EU students pay higher fees which bring a welcome additional income to some university departments, but global market changes could have a considerable impact on course viability.

Table 22.3 illustrates that engineering and technology has attracted the greatest proportion of international students, with around 24% coming from outside the EU in 2007/08. If students from other EU countries are included, then the proportion has hovered around the 33% after reaching a peak of 35% in 2006/07. Overall, applications in engineering and technology are up 16% since 2007. Encouragingly, this includes an 11% increase in UK-domiciled students.

Applicant numbers to both biological sciences and physical sciences have increased by a steady 20% since 2001/02. Biological sciences applicants exceeded 38,000 last year, making it the most popular STEM subject, whereas physical sciences had the lowest overall number of applicants within the group. Over 90% of applicants for both areas were UK-domiciled – a figure that remained fairly consistent over the period.

Further breakdown of the figure for biological sciences, however, shows that psychology and sports science accounts for a large proportion of the applicants (Figure 22.4) and, in turn, students.[188]

185 UCAS applicants are those who apply to full-time, undergraduate higher education courses (first degrees, HNC/HNDs etc) offered by universities or colleges in membership of the UCAS scheme.

186 Based on a snapshot taken 24 March 2009 and compared with the same date in 2008.

187 Biological sciences, physical sciences, mathematical and computer sciences and engineering and technology subject areas.

188 See pg 52 *Engineering UK 2008* for breakdown from 2002/03 to 2006/07 of biological sciences applicant numbers

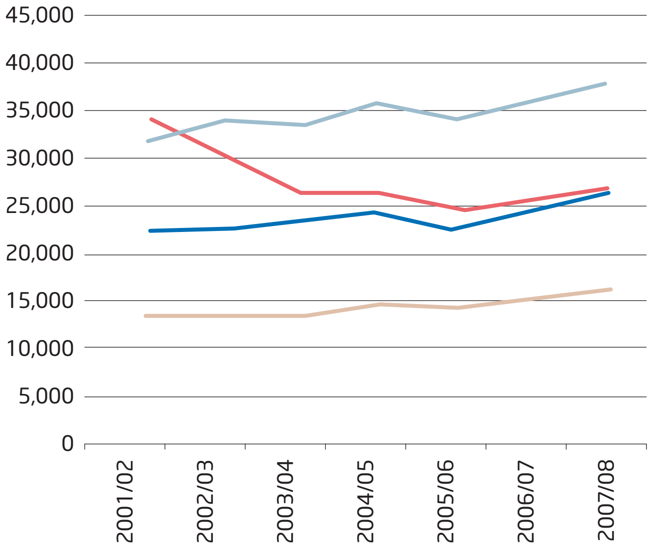
Table 22.3: Applicants to STEM HE courses by domicile (2001/02-2007/08)[189]

		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	one year change	change over period
Biological sciences	UK	29,788	31,734	30,654	32,537	31,172	32,923	34,903	6.0%	17.2%
	EU	1,011	1,046	1,355	1,510	1,727	1,784	1,752	-1.8%	73.3%
	Non EU	1,075	1,362	1,492	1,567	1,383	1,421	1,454	2.3%	35.3%
	Total	**31,874**	**28,982**	**29,262**	**32,446**	**30,916**	**31,769**	**38,109**	**20.0%**	**19.6%**
	% non UK	6.5%	8.3%	9.7%	9.5%	10.1%	10.1%	8.4%	-1.7%	1.9%
	% non -EU	3.4%	4.7%	5.1%	4.8%	4.5%	4.5%	3.8%	-0.7%	0.4%
Physical sciences	UK	12,797	12,642	12,200	13,159	13,246	14,168	14,826	4.6%	15.9%
	EU	335	416	432	479	561	692	708	2.3%	111.3%
	Non EU	503	608	649	746	692	707	880	24.5%	75.0%
	Total	**13,635**	**13,666**	**13,878**	**14,980**	**14,927**	**15,572**	**16,414**	**5.4%**	**20.4%**
	% non UK	6.1%	7.5%	7.8%	8.2%	8.4%	9.0%	9.7%	24.5%	75.0%
	% non -EU	3.7%	4.4%	4.7%	5.0%	4.6%	4.5%	5.4%	5.4%	20.4%
Mathematical & computer sciences	UK	29,511	26,473	22,107	21,929	21,086	20,967	22,373	6.7%	-24.2%
	EU	776	752	996	1,093	1,143	1,441	1,444	0.2%	86.1%
	Non EU	3,849	3,307	3,152	3,228	2,493	2,694	2,683	-0.4%	-30.3%
	Total	**34,136**	**25,597**	**23,273**	**23,886**	**23,031**	**22,033**	**26,500**	**20.3%**	**-22.4%**
	% non UK	13.5%	15.9%	17.8%	18.1%	15.8%	18.8%	15.6%	-3.2%	2.0%
	% non -EU	11.3%	12.9%	13.5%	13.5%	10.8%	12.2%	10.1%	-2.1%	-1.2%
Engineering and technology	UK	16,372	15,851	15,812	16,132	15,218	16,250	18,044	11.0%	10.2%
	EU	1,598	1,552	1,946	2,001	2,180	2,514	2,434	-3.2%	52.3%
	Non EU	4,764	5,414	6,016	6,237	5,370	5,672	6,332	11.6%	32.9%
	Total	**22,734**	**23,616**	**23,380**	**23,653**	**22,852**	**23,141**	**26,810**	**15.9%**	**17.9%**
	% non UK	28.0%	29.5%	34.1%	34.8%	33.0%	35.4%	32.7%	-2.7%	4.7%
	% non -EU	21.0%	22.9%	25.7%	26.4%	23.5%	24.5%	23.6%	-0.9%	2.7%

Source: UCAS

189 Changes in proportion are percentage point increases/decreases

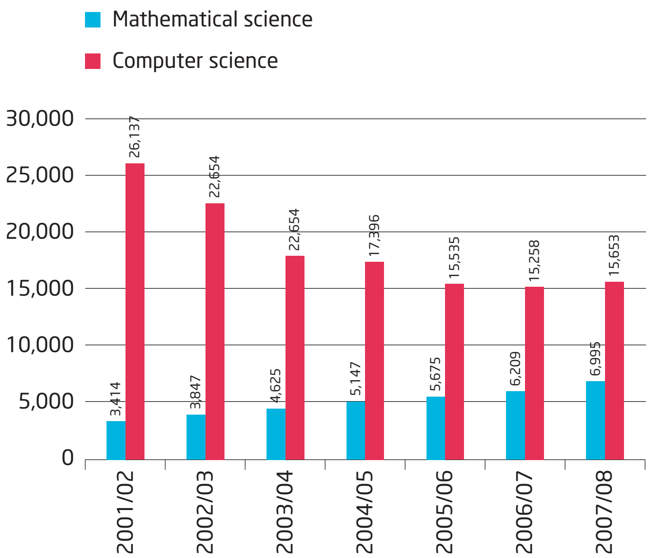
Fig 22.2: Trends in applicants to STEM HE courses (2001/02-2007/08) - all domiciles



Source: UCAS

Mathematical and computer sciences are the only STEM areas where applicant numbers have dropped since 2002, though a breakdown of the figures, shown in Figure 22.3, reveals that the drop is actually confined to computer science and follows a boom in 2001. Applications are now on the rise again, with a 6% increase since 2007. Applications to mathematics courses, however, have been steadily rising across the period, more than doubling since 2001/02.

Fig. 22.3: Applicant numbers in mathematical and computer sciences (2001/02-2007/08) - all domiciles



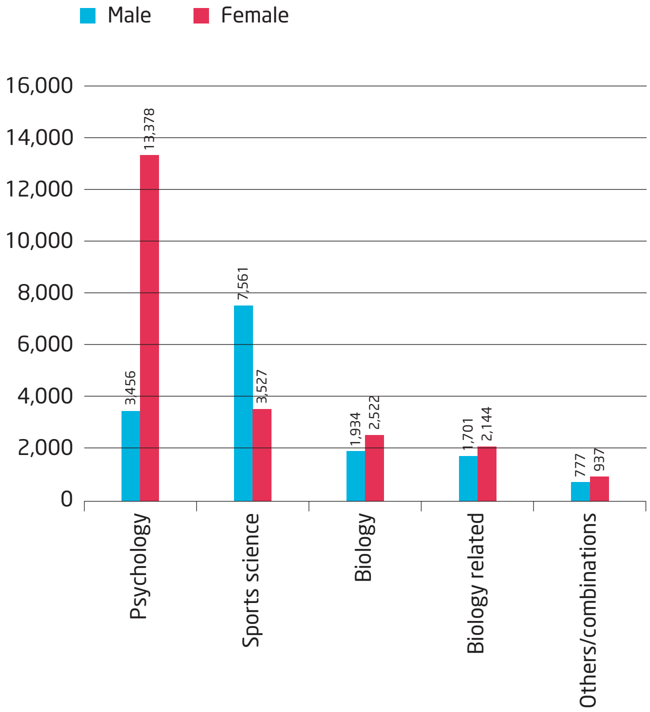
Source: UCAS

22.2.2 Applicants to STEM by gender

The gender balance varies greatly, not only between STEM subject areas, but within them. Biological sciences is often cited as appealing more to females, as shown in Figure 22.4. Interestingly, however, the chart also shows that, within biological sciences, a clear majority of sports science students are male while the majority of psychology students are female.

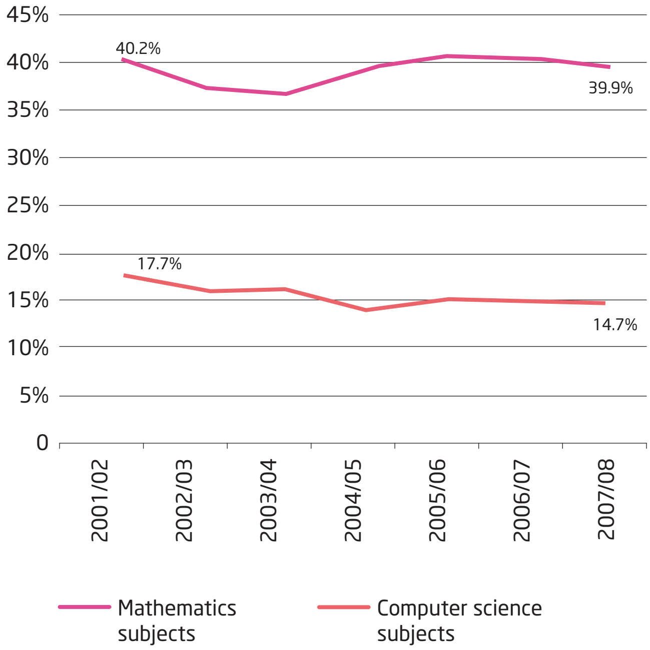
Within physical sciences, the gender imbalance is far more prominent in physics (Figure 22.5) – where only 20% of 2007/08 applicants were female – than chemistry, with a near 50–50 gender split. Breaking down the mathematical and computer science group (Figure 22.6) again proves revealing: across the six year period, the proportion of female applicants has consistently been around 40% for mathematics subjects but only 15% for computer science subjects. The gender imbalance within engineering and technology is the greatest within STEM (Figure 22.7), with female applicants remaining at around 12% over the period (see Section 22.2.4).

Fig. 22.4: Applicant numbers in biological sciences by subject and gender (2007/08) – all domiciles



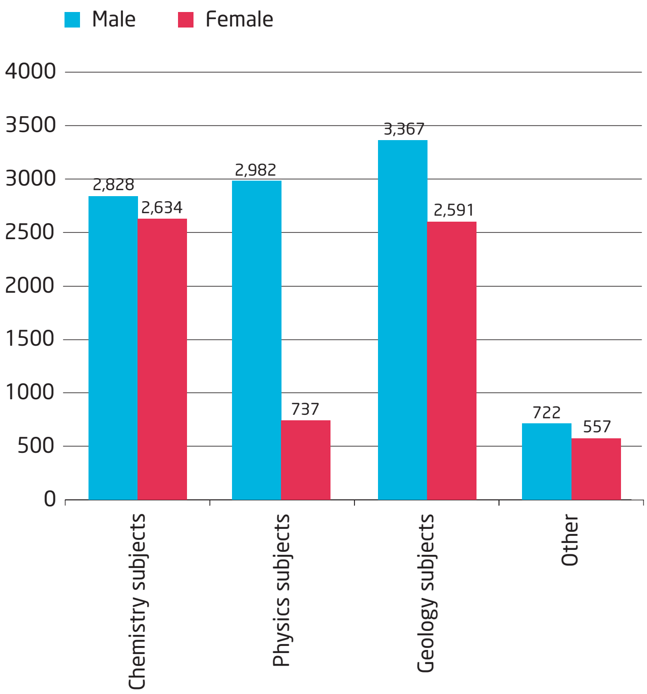
Source: UCAS

Fig. 22.6: Proportion of female applicants in mathematics and computer science subjects (2001/02-2007/08) – all domiciles



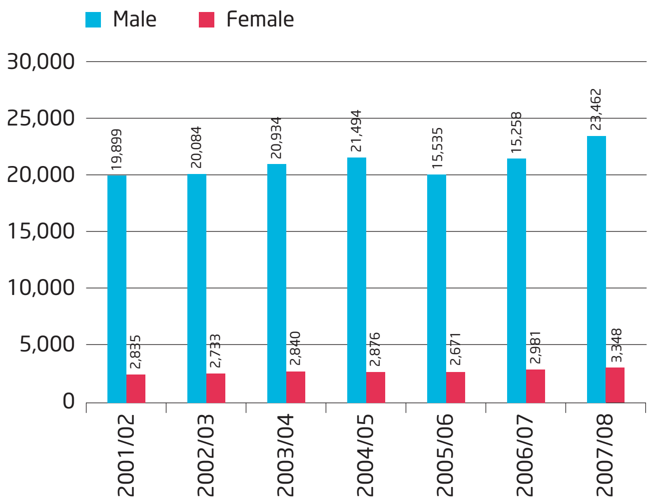
Source: UCAS

Fig. 22.5: Applicant numbers in physical sciences by gender and subject type (2007/08) – all domiciles



Source: UCAS

Fig 22.7: Applicant numbers in engineering and technology by gender (2001/02-2007/08) – all domiciles



Source: UCAS

22.2.3 Applicants to engineering by sub-discipline

As with the other STEM areas, the trends within engineering also vary between fields: Tables 22.4 to 22.10 show how applicant numbers contrast within the sub-disciplines. Applicant numbers are up for most disciplines, with the exception of production and manufacturing engineering, where they continue to fall – this year by another 17%.

Applications to electronics and electrical engineering have risen 5% in the last year after a period of steady decline. Encouragingly, this rise is from UK-domiciled students, although this subject area still attracts the highest proportion of non-EU applications – 38% in 2008.

The figures suggest a surge in the popularity of engineering courses by UK-domiciled prospective students over the six year period. In particular, applications to chemical, process and energy engineering courses have nearly doubled. Interestingly, females account for 26% of these applicants – the highest proportion within the subject area. Civil engineering enjoyed a further 32% increase in UK-domiciled applicants this year, contributing to a 42% increase since 2003.

There has also been a rise in applications to mechanical engineering courses, again particularly from UK-domiciled students. However, applications from females remain low, hovering around 7% throughout the period. Applicant numbers continue to rise steadily in aerospace engineering, overall numbers increasing by almost a third in the last six years. There has also been a rise in applications to general engineering courses, particularly in the last year (33%).

Table 22.4: Applicants to general engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	755	754	853	855	824	1,070	32.6%	41.7%
EU (excluding UK)	103	84	118	183	176	151	-24.3%	46.6%
Non EU	146	147	185	229	215	246	21.2%	68.5%
Total non UK	249	231	303	412	391	397	2.4%	59.4%
Female	141	143	164	172	168	208	28.4%	47.5%
Total	1,004	985	1,156	1,267	1,215	1,467	25.1%	46.1%
Percentage of non EU	14.5%	14.9%	16.0%	18.1%	17.7%	16.8%	-0.9%	2.2%
Proportion of female students	14.0%	14.5%	14.2%	13.6%	13.8%	14.2%	0.4%	0.1%

Source: UCAS

Table 22.5: Applicants to civil engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	1,894	2,205	2,557	2,453	2,924	3,479	19.0%	83.7%
EU (excluding UK)	378	607	626	698	831	879	5.8%	132.5%
Non EU	619	739	714	616	760	863	13.6%	39.4%
Total non UK	997	1,346	1,340	1,314	1,591	1,742	9.5%	74.7%
Female	416	488	561	514	627	838	33.7%	101.4%
Total	2,891	3,551	3,897	3,767	4,515	5,221	15.6%	80.6%
Percentage of non EU	21.4%	20.8%	18.3%	16.4%	16.8%	16.5%	-0.3%	-22.8%
Proportion of female students	14.4%	13.7%	14.4%	13.6%	13.9%	16.1%	2.2%	11.5%

Source: UCAS

Table 22.6: Applicants to mechanical engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	3,700	3,797	3,839	3,560	3,888	4,515	16.1%	22.0%
EU (excluding UK)	283	386	449	412	483	447	-7.5%	58.0%
Non EU	939	1,174	1,265	1,149	1,307	1,460	11.7%	55.5%
Total non UK	1,222	1,560	1,714	1,561	1,790	1,907	6.5%	56.1%
Female	338	386	378	339	427	450	5.4%	33.1%
Total	**4,922**	**5,357**	**5,553**	**5,121**	**5,678**	**6,422**	**13.1%**	**30.5%**
Percentage of non EU	19.1%	21.9%	22.8%	22.4%	23.0%	22.7%	-0.3%	3.7%
Proportion of female students	6.9%	7.2%	6.8%	6.6%	7.5%	7.0%	-0.5%	0.1%

Source: UCAS

Table 22.7: Applicants to aerospace engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	1,459	1,628	1,673	1,647	1,714	1,760	2.7%	20.6%
EU (excluding UK)	102	112	113	151	146	145	-0.7%	42.2%
Non EU	306	379	472	447	465	493	6.0%	61.1%
Total non UK	408	491	585	598	611	638	4.4%	56.4%
Female	162	204	205	170	236	252	6.8%	55.6%
Total	**1,867**	**2,119**	**2,258**	**2,245**	**2,325**	**2,398**	**3.1%**	**28.4%**
Percentage of non EU	16.39%	17.89%	20.90%	19.91%	20.00%	20.56%	0.6%	4.2%
Proportion of female students	8.68%	9.63%	9.08%	7.57%	10.15%	10.51%	0.4%	1.8%

Source: UCAS

Table 22.8: Applicants to electronic and electrical engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	3,729	3,146	2,934	2,462	2,381	2,504	5.2%	-32.9%
EU (excluding UK)	367	376	335	336	397	339	-14.6%	-7.6%
Non EU	2,280	2,330	2,190	1,696	1,621	1,773	9.4%	-22.2%
Total non UK	2,647	2,706	2,525	2,032	2,018	2,112	4.7%	-20.2%
Female	670	630	527	424	425	422	-0.7%	-37.0%
Total	6,376	5,852	5,459	4,494	4,399	4,616	4.9%	-27.6%
Percentage of non EU	35.8%	39.8%	40.1%	37.7%	36.8%	38.4%	1.6%	2.7%
Proportion of female students	10.5%	10.8%	9.7%	9.4%	9.7%	9.1%	-0.5%	-1.4%

Source: UCAS

Table 22.9: Applicants to production and manufacturing engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	904	801	721	467	424	376	-11.3%	-58.4%
EU (excluding UK)	29	31	29	13	31	12	-61.3%	-58.6%
Non EU	102	91	96	68	65	44	-32.3%	-56.9%
Total non UK	131	122	125	81	96	56	-41.7%	-57.3%
Female	162	125	138	103	121	98	-19.0%	-39.5%
Total	1,035	923	846	548	520	432	-16.9%	-58.3%
Percentage of non EU	9.9%	9.9%	11.3%	12.4%	12.5%	10.2%	-2.3%	0.3%
Proportion of female students	15.7%	13.5%	16.3%	18.8%	23.3%	22.7%	-0.6%	7.0%

Source: UCAS

Table 22.10: Applicants to chemical, process and energy engineering (2002/03-2007/08)

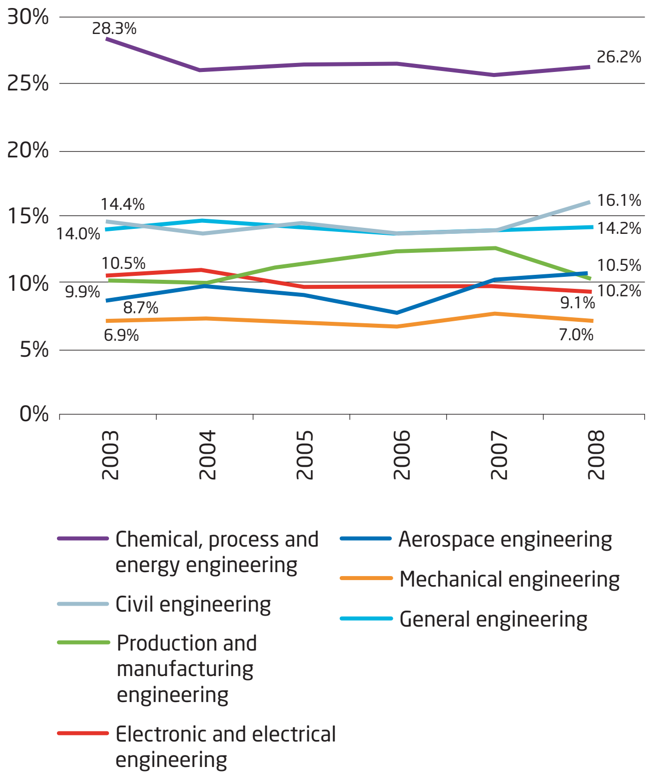
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	559	561	683	713	877	1,042	15.8%	86.4%
EU (excluding UK)	31	48	51	62	84	91	7.7%	193.5%
Non EU	338	420	494	493	553	681	18.8%	101.5%
Total non UK	369	468	545	555	637	772	17.5%	109.2%
Female	263	267	323	335	388	475	18.3%	80.6%
Total	928	1,029	1,228	1,268	1,514	1,814	16.5%	95.5%
Percentage of non EU	36.4%	40.8%	40.2%	38.9%	36.5%	37.5%	1.0%	1.1%
Proportion of female students	28.3%	25.9%	26.3%	26.4%	25.6%	26.2%	0.6%	-2.2%

Source: UCAS

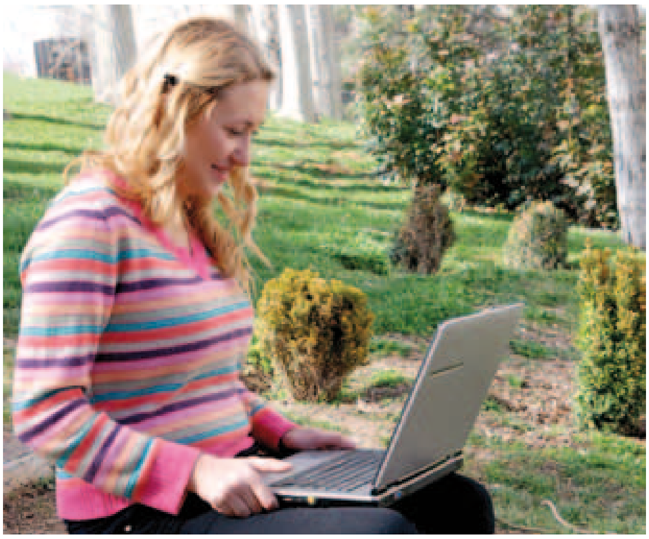
22.2.4 Female applicants to engineering subjects

The level of female participation varies between specialisms in engineering: Figure 22.8 shows the proportion of female applicants for each discipline. With the exception of chemical, process and energy engineering, females account for around 10–15% of applicants. What is clear from the chart is that this proportion is fairly static across the six-year period. The exception is civil engineering which attracted a third more applications in one year from females: applications in 2008 rose to 16%, albeit from a low base.

Fig. 22.8: Proportion of female applicants by sub discipline (2002/03–2007/08) – all domiciles



Source: UCAS

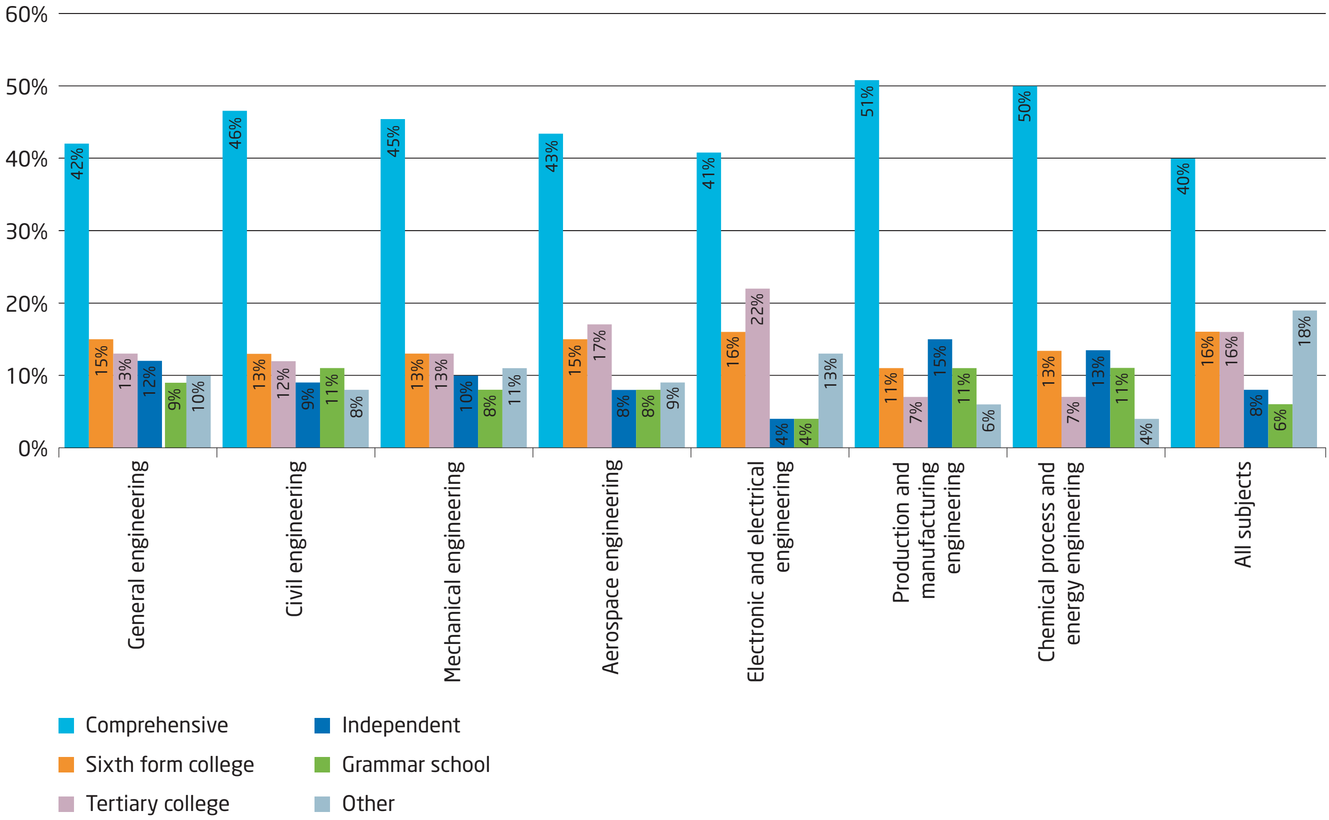


22.2.5 Educational background of applicants to engineering HE undergraduate courses

When looking at the educational background of those applying to study engineering degrees, it is clear that there is variation across sub-disciplines. Figure 22.9 shows the breakdown within engineering.

Interestingly, production and manufacturing engineering, chemical, process and energy engineering and general engineering courses have a significantly higher proportion of applicants from independent schools than HE overall. Most disciplines, with the exception of electrical and electronic engineering, have more students from grammar schools applying than the average. Electrical and electronic engineering stands out from other disciplines when applicants are broken down by educational background, as more people from an FE background and only a minority from independent and grammar schools choose to apply to this area. This is, however, a clear demonstration of the point made by the Cabinet Office's Panel on Fair Access to the Professions: that engineering does have a greater variety of routes into the profession than other established professions. Degrees which allow progression from Further Education to Higher Education are key in this regard.

Fig. 22.9: Educational background of UK domiciled applicants to engineering undergraduate level HE courses by sub-discipline (2007/08)



Source: UCAS

22.2.6 Ethnicity of applicants

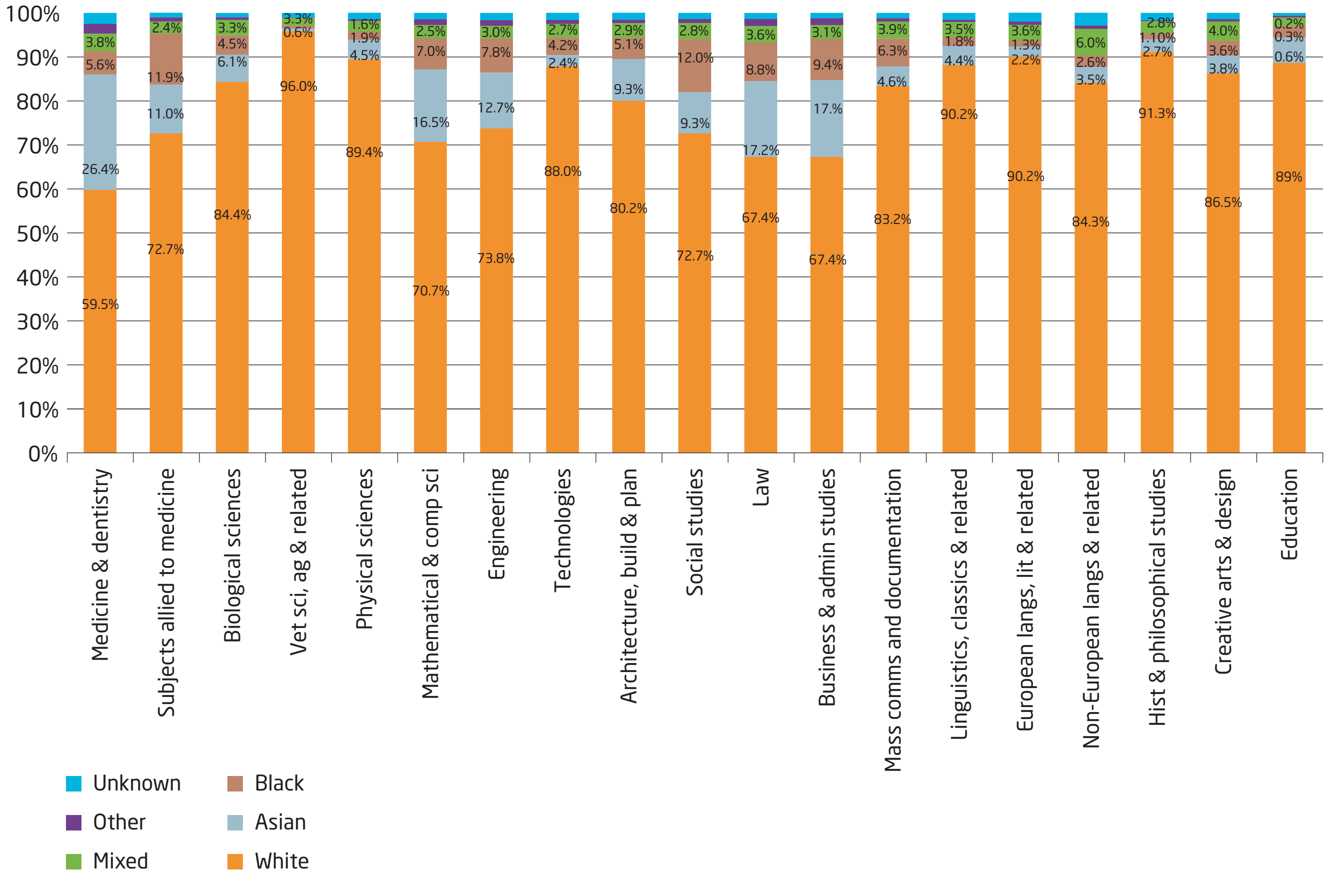
Figure 22.10 gives a breakdown by ethnicity across HE subject areas in 2007/08. This can be compared with the breakdown of the population at large, as shown in Table 22.11. There is clearly some variation between subject areas, particular groups being more prominent across different areas. For example, medicine attracts a greater number of applicants of Asian origin.

Table 22.11: Estimated 15-24-year-old population estimates by ethnic group – experimental[190] (mid-2007)

Ethnic group	Estimated populations (thousands)	Estimated proportion
Asian	683.0	10%
Black	236.8	3%
Mixed	271.8	4%
White	5,707.4	83%

Source: Office for National Statistics (ONS)

Fig. 22.10: Breakdown by ethnicity of applicants across HE subject areas (2007/08) – UK domiciled



Source: UCAS

190 http://www.statistics.gov.uk/statbase/product.asp?vlnk=14238

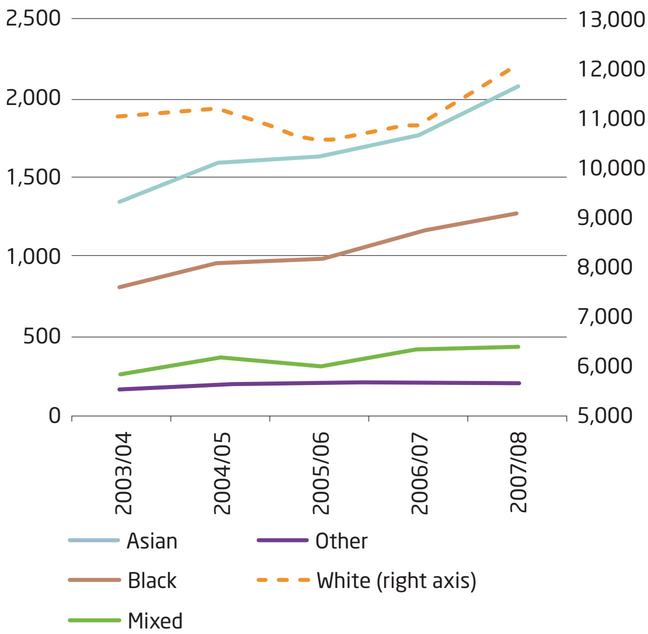
Ethnicity of applicants to engineering

The trend in the number of applicants to engineering HE courses appears positive amongst most ethnic groups, as illustrated in Figure 22.11. The sharpest rate of increase came from Asian applicants, and the rise in black students applying continues steadily across the period.

On numbers alone, it appears obvious that engineering is dominated by white applicants. Examination of the population statistics (Table 22.11) suggests that the subject is representative of the population as a whole, or even appeals more to students from different ethnic backgrounds. However, these assumptions are crude and are given for context only. Table 22.11 only covers 15–24-year-old applicants in England in 2007, and whereas the UCAS statistics (Figure 22.11) do cover the whole of the UK, not all applicants are from the 15–24 age group (although most are). Nevertheless, the figures do give some indication of the ethnic mix of the population at large.

Table 22.14 breaks down the applicants to engineering and technology by ethnic origin and shows the ONS estimates for context. It would appear that applicants of Indian and African origin are attracted to engineering HE courses.

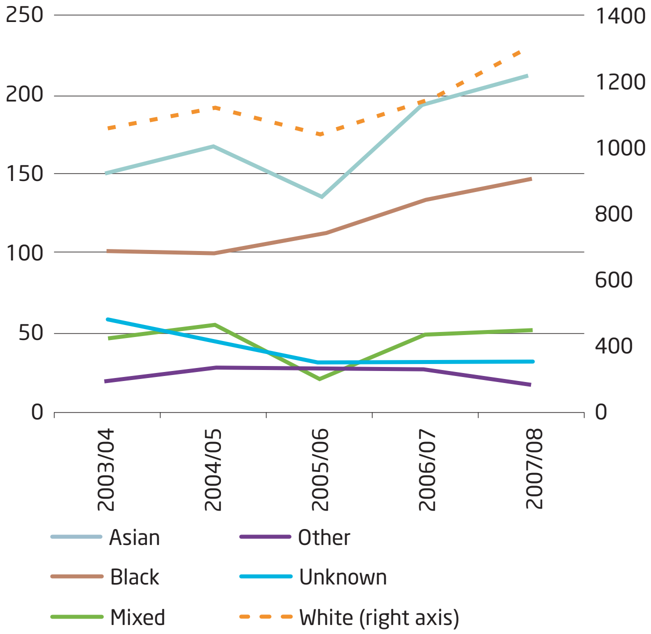
Fig. 22.11: Applicants to engineering by ethnic group (2003/04-2007/08) - UK domiciled



Source: UCAS

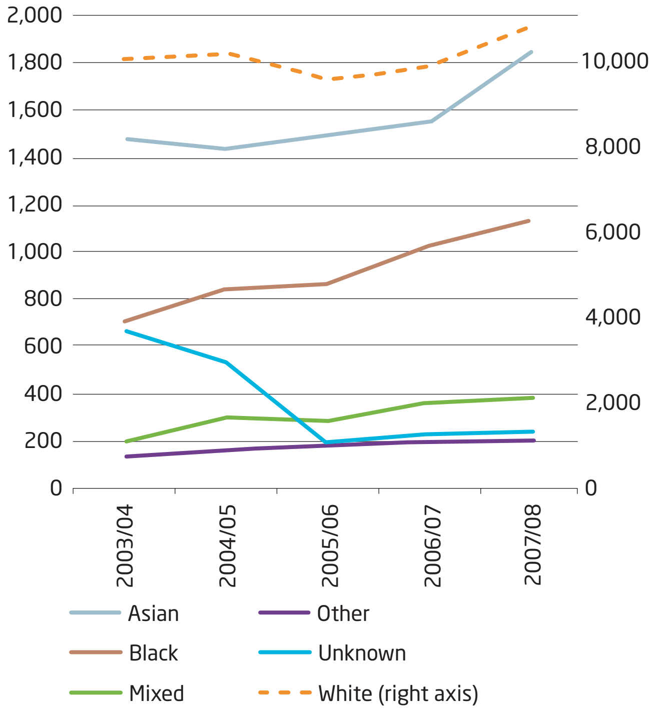
Figures 22.12 and 22.13 show that the ethnicity trends are largely similar for male and female applicants. The number of female students in non-white ethnic groups is pitifully small. However, the proportions mirror those of male students, which suggests that it is females of all ethnicities that need to somehow be engaged.

Fig. 22.12: Female applicants to engineering by ethnic group (2003/04-2007/08) - UK domiciled



Source: UCAS

Fig. 22.13: Male applicants to engineering by ethnic group (2003/04–2007/08) – UK domiciled



Source: UCAS

Table 22.12 shows the percentage split of applicants by ethnic group since 2004, illustrating that the proportion of black and Asian students is increasing over time. Tables 22.13 and 22.14 break these figures down by gender and show that the breakdown by ethnic group is similar for male and female applicants. Please note, however, that the actual numbers for the non-white female applicants remain low.

Table 22.12: Percentage split of engineering applicants by ethnic group (2003/04–2007/08) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08
Asian	11.2%	10.7%	11.7%	12.0%	12.7%
Black	5.6%	6.4%	7.1%	7.8%	7.8%
Mixed	1.7%	2.5%	2.3%	2.8%	2.7%
Other	1.1%	1.3%	1.5%	1.5%	1.3%
Unknown	4.9%	3.9%	1.6%	1.8%	1.7%
White	75.6%	75.2%	75.8%	74.1%	73.8%

Source: UCAS

Table 22.13: Percentage split of female engineering applicants by ethnic group (2003/04–2007/08) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08
Asian	10.9%	11.5%	10.5%	12.8%	12.2%
Black	7.3%	6.8%	8.7%	8.8%	8.4%
Mixed	3.4%	3.8%	1.6%	3.2%	2.9%
Other	1.3%	2.0%	1.9%	1.7%	1.0%
Unknown	4.2%	3.2%	2.2%	2.0%	1.8%
White	72.9%	72.8%	75.0%	71.6%	73.8%

Source: UCAS

Table 22.14: Percentage split of male engineering applicants by ethnic group (2003/04–2007/08) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08
Asian	11.2%	10.7%	11.8%	11.9%	12.7%
Black	5.4%	6.4%	6.9%	7.7%	7.7%
Mixed	1.6%	2.3%	2.3%	2.8%	2.7%
Other	1.1%	1.2%	1.5%	1.5%	1.4%
Unknown	5.0%	3.9%	1.5%	1.7%	1.7%
White	75.8%	75.5%	75.9%	74.4%	73.8%

Source: UCAS

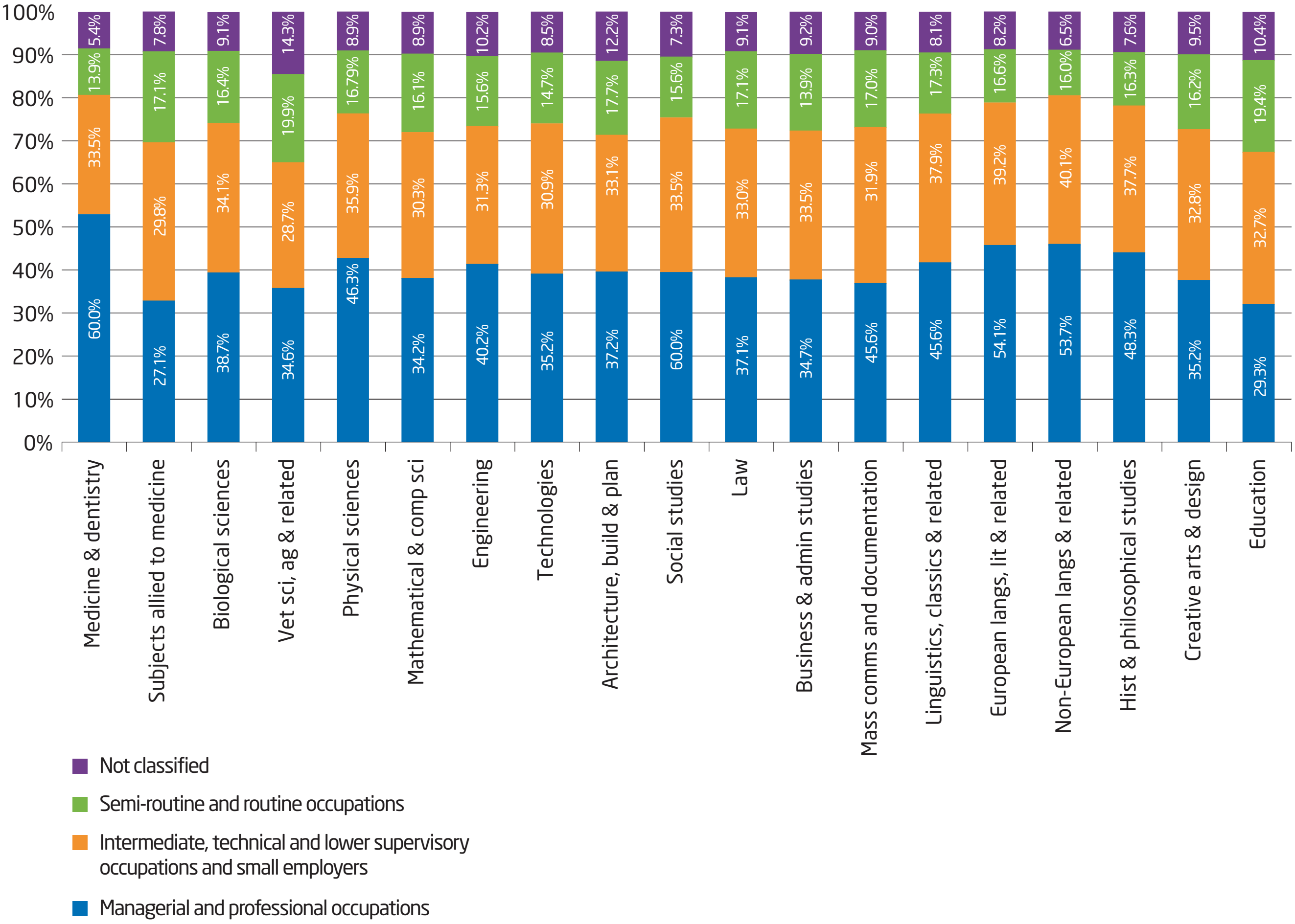
Table 22.15: Ethnic origin of UK domiciled engineering and technology applicants in 2007/08 and estimated ethnic origin of the 15-24-year-old population in England (2007 midyear)

	White	Mixed: White and Black Caribbean	Mixed: White and Black African	Mixed: White and Asian	Mixed: Other Mixed	Asian or Asian British: Indian	Asian or Asian British: Pakistani	Asian or Asian British: Bangla-deshi	Asian or Asian British: Other Asian	Black or Black British: Black Caribbean	Black or Black British: Black African	Black or Black British: Other Black	Chinese or Other Ethnic Group: Chinese
Estimated population (England 15–24-year-olds)	83.8%	1.0%	0.3%	0.8%	0.6%	3.3%	2.6%	1.1%	0.8%	1.2%	1.9%	0.3%	1.3%
Engineering and technology applicants	69.1%	0.4%	0.4%	1.1%	0.9%	4.1%	3.3%	1.1%	2.8%	0.7%	6.0%	0.2%	1.5%

22.2.7 Socio-economic grouping of applicants to engineering

Figure 22.14 shows the socio-economic group of applicants to HE. The classification is based on the employment type of the applicant's parent or guardian (or themselves if they are over 25). The graph shows that the number of applicants in each socio-economic group varies greatly between subject areas. For example, most applicants to medicine and dentistry are from the 'managerial and professional occupations' group (60%). However, students in this group are also less likely to apply for subjects allied to medicine (27%), and education (29%). In the 'subjects allied to medicine' category, most applicants are for nursing. Engineering applicants are more likely to come from the 'managerial and professional occupations' category (40%) with 16% coming from the 'semi-routine and routine occupations' group.

Fig. 22.14: Socio-economic grouping of applicants to engineering (2007/08) – UK domiciled



Source: UCAS

22.2.8 Accepted applicants to STEM first degrees[191]

The data on 'accepted applicants' is the clearest indication available of actual 'starts'. The data collected is not as comprehensive, with many students 'not classified' by ethnicity or socio economic group. Also, it would not be appropriate to map 'applicants' to 'accepted applicants' for comparison, as both categories include different groups of people. For example, 'accepted applicants' includes those who have not entered university through the main UCAS scheme along with those applying to HNDs and other undergraduate degrees.

Table 22.16 details the number of accepted applicants onto degree courses in STEM areas. Unsurprisingly, the trends mirror applicant numbers. All areas have experienced significant increases both in the last year and over the six-year period, with the exception of mathematical and computer sciences, which, despite increasing by 15% since 2006/07, has still dropped by 5% overall. As with the applicant numbers, it is the decrease in accepted applicants for Computer Sciences since the dot com boom which accounts for the fall. In the long run, therefore, we can expect these numbers to resume their upward trend.

191 Successful UCAS applicants. The numbers of accepted applicants are close, but not necessarily identical, to the numbers who actually enrol.

Table 22.16: Number of accepted applicants to STEM degrees by subject area and domicile (2001/02-2007/08)

		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	one year change	change over period
Biological sciences	UK	26,112	27,179	27,133	30,155	28,654	29,451	32,726	11.1%	25.3%
	EU	759	822	1,089	1,178	1,292	1,354	1,370	1.2%	80.5%
	Non EU	786	981	1,040	1,113	970	964	1,031	7.0%	31.2%
	Total	**27,657**	**28,982**	**29,262**	**32,446**	**30,916**	**31,769**	**35,127**	**10.6%**	**27.0%**
	% non UK	5.6%	6.2%	7.3%	7.1%	7.3%	7.3%	6.8%	-0.5%	1.2%
	% non -EU	2.8%	3.4%	3.6%	3.4%	3.1%	3.0%	2.9%	-0.1%	0.1%
Physical sciences	UK	13,414	13,336	12,933	13,973	13,849	14,356	15,075	5.0%	12.4%
	EU	303	381	376	405	461	608	601	-1.2%	98.3%
	Non EU	428	588	569	602	617	608	736	21.1%	72.0%
	Total	**14,145**	**14,305**	**13,878**	**14,980**	**14,927**	**15,572**	**16,412**	**5.4%**	**16.0%**
	% non UK	5.2%	6.8%	6.8%	6.7%	7.2%	7.8%	8.1%	21.1%	72.0%
	% non -EU	3.0%	4.1%	4.1%	4.0%	4.1%	3.9%	4.5%	5.4%	16.0%
Mathematical & computer sciences	UK	23,709	22,167	19,984	20,542	19,963	18,786	22,042	17.3%	-7.0%
	EU	642	674	848	913	990	1,106	1,185	7.1%	84.6%
	Non EU	2,627	2,756	2,441	2,431	2,078	2,141	2,193	2.4%	-16.5%
	Total	**26,978**	**25,597**	**23,273**	**23,886**	**23,031**	**22,033**	**25,420**	**15.4%**	**-5.8%**
	% non UK	12.1%	13.4%	14.1%	14.0%	13.3%	14.7%	13.3%	-1.4%	1.2%
	% non -EU	9.7%	10.8%	10.5%	10.2%	9.0%	9.7%	8.6%	-1.1%	-1.1%
Engineering and technology	UK	17,566	16,995	16,622	17,240	16,387	16,156	18,648	15.4%	6.2%
	EU	1,451	1,423	1,713	1,698	1,959	2,159	2,034	-5.8%	40.2%
	Non EU	4,013	4,431	5,045	4,715	4,506	4,826	5,017	4.0%	25.0%
	Total	**23,030**	**22,849**	**23,380**	**23,653**	**22,852**	**23,141**	**25,699**	**11.1%**	**11.6%**
	% non UK	23.7%	25.6%	28.9%	27.1%	28.3%	30.2%	27.4%	-2.7%	3.7%
	% non -EU	17.4%	19.4%	21.6%	19.9%	19.7%	20.9%	19.5%	-1.3%	2.1%

22.2.9 Accepted applicants by engineering discipline

Tables 22.17 and 22.18 show the number of accepted applicants for each of the individual engineering disciplines. The trends are, as expected, similar to those of applicant numbers, with all subject areas experiencing healthy growth except for electronic and electrical engineering and production and manufacturing engineering. Civil engineering and chemical, process and energy engineering have seen a rise of two thirds in accepted applications since 2002. There has been a 30% rise in the number of accepted applicants onto mechanical engineering degree courses over the last six years, with a rise of 18% since last year. Aerospace engineering has enjoyed stable growth in levels of accepted applicants since 2002. Although numbers did drop in this field from 2006 to 2007, the 2008 figures showed a 15% rise. Accepted applicant numbers for general engineering degrees continue to rise steadily, with an 8% increase since last year which amounts to growth of 25% since 2002. The decline in the proportion of females accepted in a number of fields is particularly disappointing, especially given the low starting base.

Table 22.17: Accepted applicants onto first degrees in general engineering (2002/03–2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	2,056	2,016	2,245	2,176	2,269	2,553	12.5%	24.2%
EU (excluding UK)	130	169	186	249	272	211	-22.4%	62.3%
Non EU	375	432	456	438	438	440	0.5%	17.3%
Total non UK	505	601	642	687	710	651	-8.3%	28.9%
Female	356	395	397	363	389	437	12.3%	22.8%
Total	**2,561**	**2,617**	**2,887**	**2,863**	**2,979**	**3,204**	**7.6%**	**25.1%**
Percentage of non EU	14.6%	16.5%	15.8%	15.3%	14.7%	13.7%	-1.0%	-0.9%
Proportion of female students	13.9%	15.1%	13.8%	12.7%	13.1%	13.6%	0.6%	-0.3%

Source: UCAS

Table 22.18: Accepted applicants onto first degrees in civil engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	1,871	2,267	2,469	2,458	2,607	3,151	20.9%	68.4%
EU (excluding UK)	294	426	423	494	583	685	17.5%	133.0%
Non EU	507	619	563	502	564	601	6.6%	18.5%
Total non UK	801	1,045	986	996	1,147	1,286	12.1%	60.5%
Female	382	447	518	500	563	707	25.6%	85.1%
Total	**2,672**	**3,312**	**3,455**	**3,454**	**3,754**	**4,437**	**18.2%**	**66.1%**
Percentage of non EU	19.0%	18.7%	16.3%	14.5%	15.0%	13.5%	-1.5%	-5.4%
Proportion of female students	14.3%	13.5%	15.0%	14.5%	15.0%	15.9%	0.9%	1.6%

Source: UCAS

Table 22.19: Accepted applicants onto first degrees in mechanical engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	3,157	3,387	3,515	3,311	3,193	4,032	26.3%	27.7%
EU (excluding UK)	283	314	334	365	383	360	-6.0%	27.2%
Non EU	716	846	885	874	1,016	1,020	0.4%	42.5%
Total non UK	999	1,160	1,219	1,239	1,399	1,380	-1.4%	38.1%
Female	297	326	318	292	359	377	5.0%	26.9%
Total	**4,156**	**4,547**	**4,734**	**4,550**	**4,592**	**5,412**	**17.9%**	**30.2%**
Percentage of non EU	17.2%	18.6%	18.7%	19.2%	22.1%	18.8%	-3.3%	1.6%
Proportion of female students	7.1%	7.2%	6.7%	6.4%	7.8%	7.0%	-0.9%	-0.2%

Source: UCAS

Table 22.20: Accepted applicants onto first degrees in aerospace engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	1,397	1,412	1,522	1,483	1,289	1,489	15.5%	6.6%
EU (excluding UK)	71	87	80	120	99	95	-4.0%	33.8%
Non EU	232	256	300	302	273	325	19.0%	40.1%
Total non UK	303	343	380	422	372	420	12.9%	38.6%
Female	146	166	176	162	193	202	4.7%	38.4%
Total	**1,700**	**1,755**	**1,902**	**1,905**	**1,661**	**1,909**	**14.9%**	**12.3%**
Percentage of non EU	13.6%	14.6%	15.8%	15.9%	16.4%	17.0%	0.6%	3.4%
Proportion of female students	8.6%	9.5%	9.3%	8.5%	11.6%	10.6%	-1.0%	2.0%

Source: UCAS

Table 22.21: Accepted applicants on to first degrees in electronic and electrical engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	4,272	3,469	3,336	2,824	2,699	2,689	-0.4%	-37.1%
EU (excluding UK)	333	329	325	311	389	304	-21.9%	-8.7%
Non EU	1,770	1,969	1,620	1,495	1,549	1,538	-0.7%	-13.1%
Total non UK	2,103	2,298	1,945	1,806	1,938	1,842	-5.0%	-12.4%
Female	760	742	588	521	532	498	-6.4%	-34.5%
Total	**6,375**	**5,767**	**5,281**	**4,630**	**4,637**	**4,531**	**-2.3%**	**-28.9%**
Percentage of non EU	27.8%	34.1%	30.7%	32.3%	33.4%	33.9%	0.5%	6.2%
Proportion of female students	11.9%	12.9%	11.1%	11.3%	11.5%	11.0%	-0.5%	-0.9%

Source: UCAS

Table 22.22: Accepted applicants onto first degrees in production and manufacturing engineering (2002/03-2007/08)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	1,177	980	899	677	618	603	-2.5%	-48.8%
EU (excluding UK)	48	44	37	36	49	44	-11.4%	-8.3%
Non EU	122	114	106	109	103	101	-2.0%	-17.2%
Total non UK	170	158	143	145	152	145	-4.8%	-14.7%
Female	246	204	201	165	189	175	-8.0%	-28.9%
Total	**1,347**	**1,138**	**1,042**	**822**	**770**	**748**	**-2.9%**	**-44.5%**
Percentage of non EU	9.1%	10.0%	10.2%	13.3%	13.4%	19.4%	6.0%	10.3%
Proportion of female students	18.3%	17.9%	19.3%	20.1%	24.5%	23.4%	-1.1%	5.1%

Source: UCAS

Table 22.23: Accepted applicants onto first degrees in chemical, process and energy engineering (2002/03-2007/08)

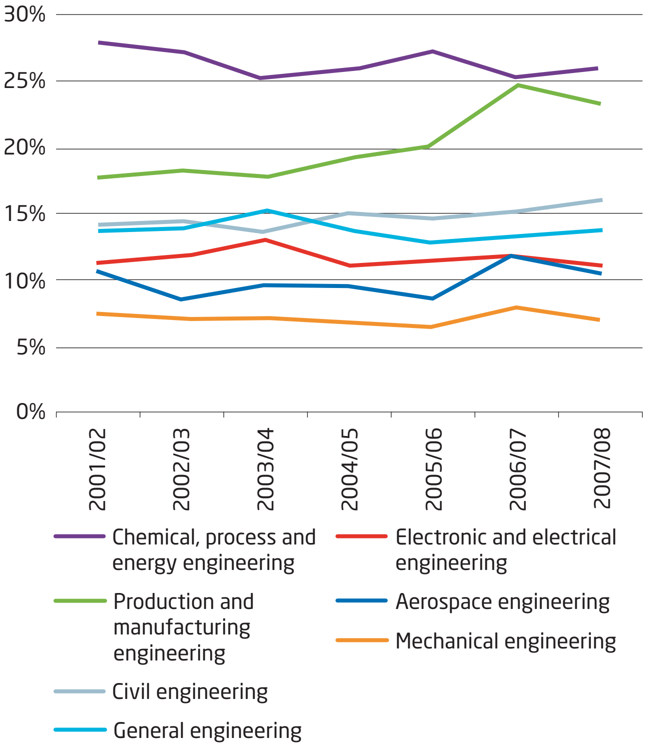
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	One year change	Percentage change over six year period
UK	676	689	768	855	953	1,084	14%	60.4%
EU (excluding UK)	42	47	46	58	80	62	-23%	47.6%
Non EU	282	362	389	393	422	494	17%	75.2%
Total non UK	324	409	435	451	502	556	11%	71.6%
Female	272	275	311	356	368	428	16%	57.4%
Total	**1,000**	**1,098**	**1,203**	**1,306**	**1,455**	**1,640**	**13%**	**64.0%**
Percentage of non EU	28.2%	33.0%	32.3%	30.1%	29.0%	30.1%	1.9%	1.9%
Proportion of female students	27.2%	25.0%	25.9%	27.3%	25.3%	26.1%	-1.1%	-1.1%

Source: UCAS

22.2.10 Gender of accepted applicants to engineering first degrees

Figure 22.15 illustrates the proportion of female accepted applicants onto degrees in engineering subjects since 2001/02. Once again, most of the trends show that levels are static in most areas. However, females are increasingly present among production and manufacturing engineering acceptances, with numbers up from 18% in 2001/02 to 23% in 2007/08. Mechanical engineering remains the discipline with the lowest level of female accepted applicants at 7% in 2007/08. Females make up 11% of accepted applicants within aerospace engineering and electronic and electrical engineering. Civil engineering courses had a slightly higher level at 16% last year. Chemical, process and energy engineering appears to be the most popular discipline among female students, accounting for 26% of accepted applicants. The extent of the ongoing gender issue in engineering is well recognised and was once again brought to the public's attention by the Cabinet Office's Panel on Fair Access to the Profession's final report. A number of initiatives are in place to address this.

Fig. 22.15: Proportion of female accepted applicants to degree courses by engineering discipline (2001/02-2007/08) - all domiciles



Source: UCAS

22.3 Qualifications achieved[192]

The Higher Education Statistics Agency (HESA) gathers statistics on the HE student population. Table 22.24 details the growth in first degrees across HE, particularly in STEM areas. It also shows that STEM degrees account for a quarter of all first degrees. However, its overall share is decreasing: STEM subjects only grew by 8% while there was an 18% increase across all subjects. This is due to the increasing number of subjects on offer at HE level. Numbers of students achieving first degrees in all STEM subjects, bar computer science, have grown. Figure 22.15 illustrates the percentage year-on-year growth in first degrees in all subjects, STEM subjects and in engineering and technology. The last year has proved particularly positive for STEM and engineering and technology and the positive trends in applicant and acceptance numbers suggest that this growth will continue.

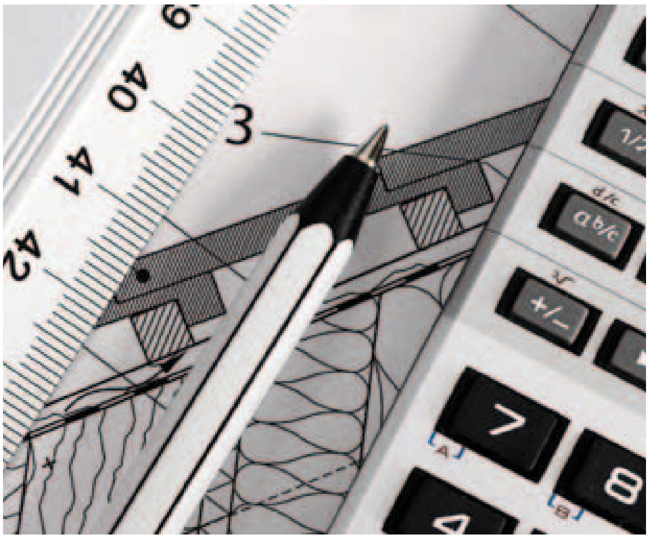


Table 22.24: Number of first degrees achieved in STEM (2002/03-2007/08) – all domiciles

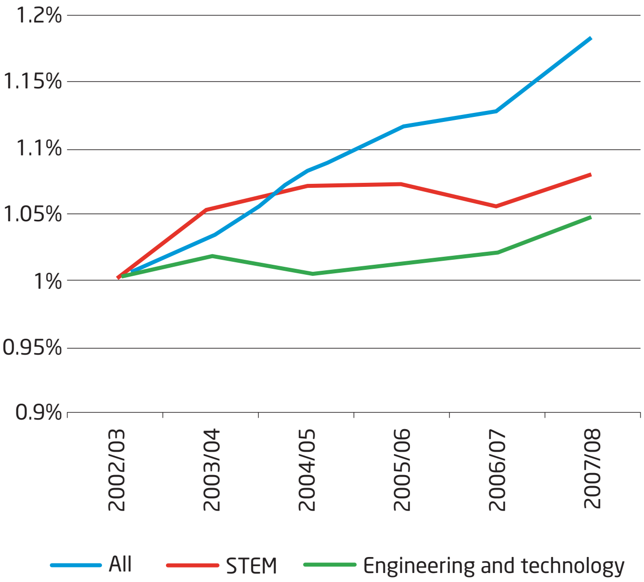
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	Percentage change
Biological sciences	23,725	25,955	27,200	27,840	29,095	31,185	31.4%
Physical sciences	12,480	11,995	12,530	12,900	12,480	13,015	4.3%
Mathematical sciences	5,100	5,395	5,270	5,500	5,645	5,815	14.0%
Computer science	18,240	20,205	20,095	18,840	16,445	14,915	-18.2%
Engineering & technology	19,455	19,780	19,575	19,765	19,900	20,420	5.0%
Total STEM	79,000	83,330	84,670	84,845	83,565	85,350	8.0%
All subjects	283,280	292,090	306,365	315,985	319,260	334,890	18.2%
STEM proportion of all degrees	27.9%	28.5%	27.6%	26.9%	26.2%	25.5%	-2.4%[193]

Source:HESA

192 The HESA qualifications obtained population is a count of student instances associated with the award of an HE qualification (excluding HE institutional credits) This includes qualifications awarded from dormant, writing-up and sabbatical status. Incoming visiting and exchange students are excluded from this population.

193 Change in percentage points

Fig. 22.16: Percentage year-on-year growth in first degrees achieved (2002/03–2007/08) – all domiciles



Source:HESA

22.3.1 Degrees achieved in engineering subjects

Although the overall number of engineering and technology degrees[194] achieved is rising, further analysis by sub-discipline reveals that the modest 5% rise masks large rises and falls within individual disciplines.[195] Table 22.25 details the numbers of first degrees achieved within engineering and focuses on UK-domiciled graduates only. The number of first degrees attained in civil engineering has risen by 44% since 2003/04 and numbers for mechanical engineering and chemical, process and energy engineering have both risen by 6%. Aerospace engineering degree numbers fell by 4% over the five year period. However, as detailed earlier in this section, there has been a recent surge in applicant numbers to this area which implies that this trend will be reversed.

The greatest falls in the number of first degrees achieved were for electronic and electrical engineering (25%) and production and manufacturing engineering (35%): mirroring the trend for applicants and accepted applicants. Degrees in general engineering are also falling, with a drop of 15% in five years.

194 Includes doctorate, other higher degree, PGCE, other postgraduate, first degree, first degree equivalent, foundation degree, HND/DipHE and 'other HE' qualifications.

195 NB. The 5% overall is for a six year period whereas the sub discipline breakdown only goes back five years.

Table 22.25: Number of first degrees achieved in engineering subjects (2003/04–2007/08) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	one year change	five year change
General engineering	Female	284	226	261	244	229	-6%	-19%
	Male	1,431	1,454	1,421	1,500	1,235	-18%	-14%
	Total	1,714	1,679	1,682	1,743	1,464	-16%	-15%
Civil engineering	Female	241	235	223	277	310	12%	29%
	Male	1,311	1,502	1,382	1,622	1,918	18%	46%
	Total	1,551	1,737	1,604	1,898	2,228	17%	44%
Mechanical engineering	Female	236	204	206	211	225	7%	-5%
	Male	2,402	2,431	2,445	2,554	2,572	1%	7%
	Total	2,638	2,635	2,651	2,765	2,796	1%	6%
Aerospace engineering	Female	109	93	105	107	89	-16%	-18%
	Male	903	944	926	895	877	-2%	-3%
	Total	1,012	1,037	1,032	1,002	966	-4%	-4%
Electronic & electrical engineering	Female	431	358	310	283	317	12%	-27%
	Male	3,510	3,209	2,913	2,777	2,654	-4%	-24%
	Total	3,941	3,567	3,223	3,060	2,970	-3%	-25%
Production & manufacturing engineering	Female	162	154	139	144	115	-20%	-29%
	Male	1,089	953	869	730	692	-5%	-36%
	Total	1,252	1,107	1,008	874	807	-8%	-35%
Chemical, process & energy engineering	Female	128	126	139	119	141	19%	10%
	Male	411	407	383	382	428	12%	4%
	Total	539	533	523	501	569	14%	6%

Source: HESA

The number of postgraduate degrees achieved by UK domiciles is shown in Table 22.26. Because the numbers are relatively small, it would be inappropriate to talk about percentage growth or decline. The largest number of these qualifications is in civil engineering with 752 in 2008. This is interesting, as it is only the third most popular discipline in terms of first degree numbers. The number of doctorates awarded is detailed by subject area in Table 22.26. Electronic and electrical engineering was the most awarded by far, with 189 in 2008. There were 145 doctorates awarded in general engineering and 106 in mechanical engineering. The number achieved in each area tends to vary from year to year but these three remain the most popular disciplines at this level. The relatively low numbers of postgraduate degrees can be partially attributed to the fact that many undergraduates study the four year MEng degree which is classified as an undergraduate degree.

Table 22.26: Number of postgraduate degrees (excluding doctorates and PGCE) achieved in engineering subjects (2003/04–2007/08) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08
General engineering	Female	61	112	108	86	79
	Male	362	624	612	535	498
	Total	**422**	**736**	**720**	**622**	**577**
Civil engineering	Female	160	162	143	198	206
	Male	388	389	413	472	546
	Total	**548**	**551**	**556**	**670**	**752**
Mechanical engineering	Female	34	33	26	22	69
	Male	263	266	227	234	311
	Total	**296**	**299**	**253**	**255**	**380**
Aerospace engineering	Female	22	21	22	18	7
	Male	83	105	114	92	116
	Total	**104**	**125**	**136**	**110**	**124**
Electronic & electrical engineering	Female	131	148	107	100	81
	Male	591	553	527	507	443
	Total	**721**	**702**	**634**	**607**	**524**
Production & manufacturing engineering	Female	43	50	52	33	47
	Male	307	251	230	219	185
	Total	**350**	**301**	**282**	**252**	**232**
Chemical, process & energy engineering	Female	58	61	62	38	30
	Male	114	128	126	123	113
	Total	**172**	**189**	**187**	**162**	**143**
Total		**2,614**	**2,902**	**2,766**	**2,678**	**2,731**

Source: HESA

Table 22.27: Number of doctorates achieved in engineering subjects (2003/04-2007/08) - UK domiciled

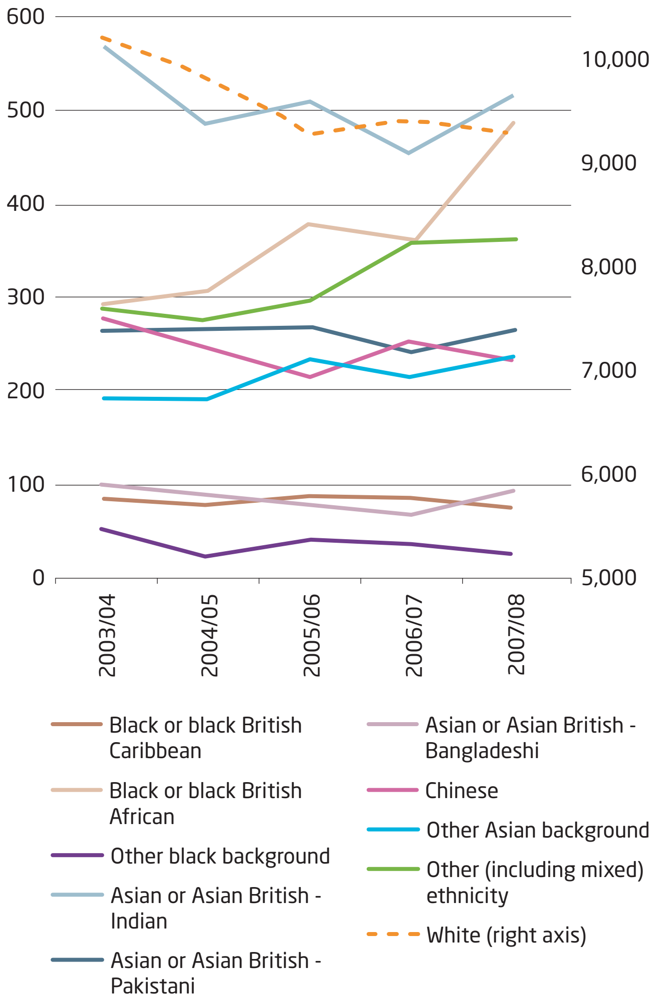
		2003/04	2004/05	2005/06	2006/07	2007/08
General engineering	Female	33	26	38	27	19
	Male	157	142	136	148	125
	Total	190	168	174	174	145
Civil engineering	Female	20	25	27	31	28
	Male	74	70	77	73	63
	Total	94	95	104	104	92
Mechanical engineering	Female	25	17	20	27	16
	Male	114	109	114	152	90
	Total	139	126	133	179	106
Aerospace engineering	Female	3	5	2	10	7
	Male	20	21	24	39	23
	Total	23	26	26	49	29
Electronic & electrical engineering	Female	27	26	30	32	25
	Male	161	176	144	205	164
	Total	188	201	174	236	189
Production & manufacturing engineering	Female	9	14	16	7	11
	Male	34	24	29	22	33
	Total	43	37	44	29	44
Chemical, process & energy engineering	Female	30	21	24	21	28
	Male	60	59	64	54	58
	Total	89	80	88	74	85
Total		**764**	**732**	**743**	**844**	**689**

Source: HESA

22.3.2 Ethnicity of engineering graduates

As discussed earlier in this section, engineering is considered to have an over-representation of white males. But whilst gender is an issue, it seems that the ethnic mix of engineering students and graduates is more diverse than generally believed. Figure 22.17 illustrates trends in the number of first degrees achieved by ethnic origin. It shows that the number of white students is declining and that there has been a strong upward trend in graduates from different ethnic backgrounds – namely black or black British African, Asian backgrounds and those of mixed ethnicity. Black or black British-Caribbean students are under-represented as are those of Asian or British Asian-Bangladeshi ethnic origin.

Fig. 22.17: First degrees achieved in engineering by ethnic origin (2003/04–2007/08) – UK domiciled



Source: HESA

The ethnic origin of graduates in engineering is detailed in Tables 22.27 and 22.29, broken down into first and higher degrees, respectively. The estimated ethnic breakdown of 15–24-year-olds in England (Table 22.11) was detailed earlier in this section as a rough comparator. Figure 22.10 showed that there was a strong upward trend in participation in engineering by black African students and graduates, and this breakdown shows that these students tend to study chemical, process and energy engineering and electronic and electrical engineering, accounting for 8.6% and 4.5% respectively of all first degree graduates in 2007/08. Graduates of Asian Indian origin are represented particularly well in electronic and electrical engineering, aerospace engineering and chemical, process and energy engineering. Interestingly, chemical, process and energy engineering, electronic and electrical engineering and aerospace engineering have the most diverse graduates within the group. In 2007, nearly 3% of first degrees in civil engineering and chemical, process and energy engineering were achieved by graduates of Chinese origin. The ONS estimates that only 1.3% of 15–24-year-olds in England come from this ethnic background. Interestingly, 4% of postgraduate qualifications were achieved by students of Chinese ethnic origin.

The pattern of first degrees achieved is reflected in postgraduate qualifications, though there is unfortunately a much larger unknown proportion which makes comparison difficult.

Table 22.28: Percentage breakdown of first degrees achieved by ethnic origin in engineering subjects (2007/08) – UK domiciled

	White	Black or Black British - Caribbean	Black or Black British - African	Other Black Back-ground	Asian or Asian British: Indian	Asian or Asian British: Pakistani	Asian or Asian British: Bangla-deshi	Chinese	Other Asian Back-ground	Other (Incl. mixed) Ethnicity	Un-known
General engineering	81.8%	0.5%	1.8%	0.2%	3.5%	1.4%	0.5%	1.6%	1.4%	2.2%	5.1%
Civil engineering	83.1%	0.5%	2.2%	0.3%	2.1%	1.2%	0.5%	2.5%	1.6%	2.1%	3.9%
Mechanical engineering	84.5%	0.3%	2.0%	0.2%	2.9%	1.2%	0.4%	1.5%	1.2%	2.2%	3.6%
Aerospace engineering	75.7%	0.6%	2.6%	0.2%	5.8%	3.2%	0.9%	2.4%	2.0%	3.5%	3.2%
Electronic & electrical engineering	70.2%	1.1%	4.5%	0.5%	6.0%	3.4%	1.1%	2.3%	2.4%	3.1%	5.5%
Production & manufacturing engineering	82.5%	0.7%	1.5%	0.2%	3.7%	1.4%	0.5%	1.5%	1.2%	2.3%	4.5%
Chemical, process & energy engineering	68.1%	0.5%	8.6%	0.6%	5.5%	3.8%	0.7%	2.8%	2.3%	3.4%	3.9%

Source: HESA

Table 22.28 shows the ethnic mix of the first degrees achieved by male and female students, which does highlight some differences. When looking at the percentage split for each sub-division, it is important to consider how small the pool of female graduates is (Table 22.26). Among Chinese students, engineering subjects seem to appeal more relatively to females than males – in particular with civil engineering. The most mixed subject for female students is electronic and electrical engineering, where over one in ten first degrees awarded to females in 2008 was to graduates of black African origin. Females of Indian and Pakistani origin both accounted for 6% of awarded degrees in electronic and electrical engineering – far exceeding the ONS population estimates. This breakdown certainly suggests that engineering is inclusive where ethnicity is concerned.

Table 22.29: Percentage breakdown by gender of first degrees achieved by ethnic origin in engineering subjects (2007/08) – UK domiciled

		White	Black or Black British - Caribbean	Black or Black British - African	Other Black Back-ground	Asian or Asian British: Indian	Asian or Asian British: Pakistani	Asian or Asian British: Bangla-deshi	Chinese	Other Asian Back-ground	Other (Incl. mixed) Ethnicity	Un-known
General engineering	Male	83.8%	0.6%	2.9%	0.0%	2.9%	1.5%	0.3%	1.1%	1.4%	1.9%	3.5%
	Female	80.3%	0.4%	1.7%	0.1%	3.6%	0.4%	0.0%	4.4%	2.4%	3.5%	3.1%
Civil engineering	Male	82.1%	0.4%	3.3%	0.3%	3.0%	1.5%	0.5%	1.4%	1.8%	2.4%	3.4%
	Female	77.2%	0.6%	1.2%	0.0%	4.1%	1.0%	0.0%	4.1%	3.5%	5.5%	2.7%
Mechanical engineering	Male	82.3%	0.5%	2.9%	0.2%	3.4%	1.6%	0.5%	1.6%	1.8%	2.5%	2.7%
	Female	79.4%	0.4%	3.2%	0.0%	5.7%	1.4%	0.4%	2.4%	1.3%	3.9%	1.8%
Aerospace engineering	Male	72.5%	0.6%	4.1%	0.0%	7.4%	3.8%	1.3%	2.3%	2.1%	3.5%	2.4%
	Female	79.6%	0.0%	2.8%	0.0%	3.9%	2.2%	1.1%	1.1%	3.4%	3.4%	2.8%
Electronic & electrical engineering	Male	71.8%	0.8%	5.9%	0.4%	5.0%	2.9%	1.1%	2.0%	2.2%	3.6%	4.2%
	Female	54.0%	3.2%	11.6%	0.3%	6.2%	6.0%	2.8%	4.2%	3.6%	4.3%	3.6%
Production & manufacturing engineering	Male	82.7%	0.6%	1.1%	0.0%	3.9%	2.1%	0.7%	1.8%	0.8%	2.8%	3.5%
	Female	83.6%	0.9%	0.0%	0.3%	4.8%	1.7%	0.0%	1.3%	2.6%	2.9%	1.7%
Chemical, process & energy engineering	Male	66.6%	0.0%	9.1%	0.5%	6.9%	3.3%	1.4%	3.0%	1.9%	4.9%	2.3%
	Female	53.8%	1.4%	14.2%	0.7%	11.4%	1.4%	0.0%	5.7%	3.5%	3.3%	4.7%

Source: HESA

Table 22.30: Percentage breakdown by ethnic origin of higher degrees achieved in engineering subjects (2007/08) - UK domiciled

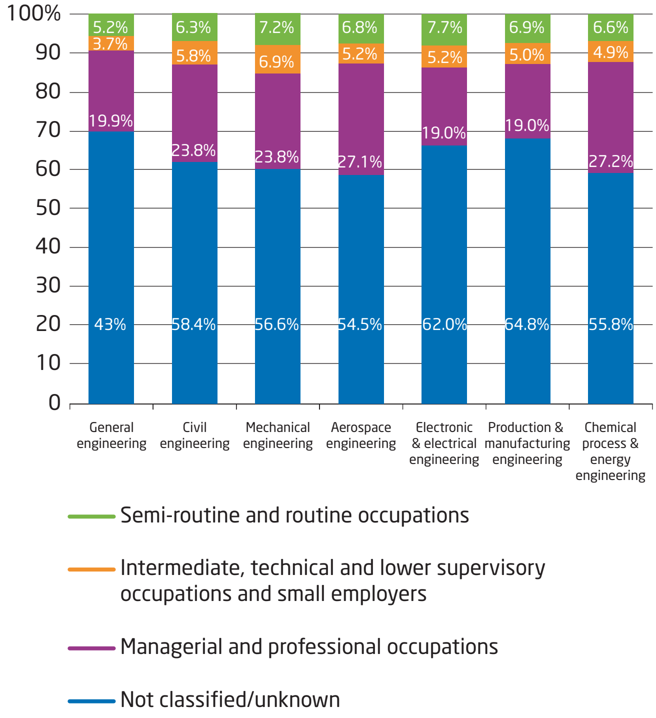
	White	Black or Black British - Caribbean	Black or Black British - African	Other Black Back-ground	Asian or Asian British: Indian	Asian or Asian British: Pakistani	Asian or Asian British: Bangla-deshi	Chinese	Other Asian Back-ground	Other (Incl. mixed) Ethnicity	Un-known
General engineering	73.4%	0.4%	2.6%	0.2%	2.6%	1.2%	0.3%	2.1%	1.5%	2.0%	5.2%
Civil engineering	66.1%	0.4%	3.0%	0.2%	1.2%	0.8%	0.3%	2.2%	1.9%	2.6%	7.1%
Mechanical engineering	68.4%	0.3%	2.2%	0.2%	2.7%	1.2%	0.3%	2.9%	1.5%	3.1%	2.4%
Aerospace engineering	73.2%	0.5%	1.7%	0.0%	3.4%	1.8%	0.5%	1.0%	2.2%	2.5%	13.2%
Electronic & electrical engineering	49.6%	0.7%	4.1%	0.5%	4.4%	3.6%	0.8%	4.0%	3.2%	4.2%	24.8%
Production & manufacturing engineering	67.7%	0.7%	4.1%	0.4%	3.4%	2.6%	0.7%	2.8%	2.3%	2.8%	12.4%
Chemical, process & energy engineering	50.9%	0.6%	3.9%	0.3%	3.4%	2.9%	0.5%	2.4%	1.9%	3.5%	29.6%

Source: HESA

22.3.3 Socio-economic group of engineering graduates

Across all engineering disciplines, the majority of known graduates come from backgrounds in which their parent(s) or guardian(s) (or themselves if over 25) had managerial or professional occupations. This reflects the general trend across HE. Unfortunately, there is a huge 'unknown' quantity in this breakdown, which is immediately apparent when looking at Figure 22.18. Of those that did declare their parents' occupation, only a small percentage came from backgrounds where the socio-economic group is 'semi-routine or routine occupation'. There is some variation between disciplines: aerospace engineering and chemical, process and energy engineering having a greater proportion of graduates from the 'managerial and professional occupations' category. Interestingly, the percentage of graduates from the 'semi-routine and routine occupations' group is fairly consistent across disciplines, fluctuating between 5% and 8%. However, there is an argument that suggests that students in this group are less likely to state their parents' occupations.

Fig. 22.18: Percentage breakdown by socio-economic group of first degrees achieved in engineering subjects (2007/08) – UK domiciled



Source: HESA

22.4 BTEC Higher National Certificate (HNC) and Higher National Diploma (HND)

HNCs and HNDs are highly flexible and can be studied part-time, full-time, as a sandwich course or through distance learning. They are assessed through projects and practical tasks rather than formal written exams and all involve work-related experience. They provide a recognised route to related degree courses and HNC/D holders may move on to the second or third year of a related degree course. Table 22.31 portrays the total number of STEM-related HNC/HNDs achieved over the latest three-year period.

Table 22.31: Total number of STEM HNC/HNDs achieved (2006/07-2008/09) - England, Wales and Northern Ireland

		2006/07	2007/08	2008/09
Applied biology	HNC	8	4	12
	HND	38	23	23
Applied chemistry	HNC	33	48	46
	HND	8	28	11
Biomedical science	HNC	2	9	0
	HND	2	0	0
Electrical/electronic engineering	HNC	885	720	859
	HND	250	301	261
Electrical/electronic engineering (communications)	HNC	4	5	1
	HND	18	42	73
Electrical/electronic engineering (electrical)	HNC	20	1	2
	HND	6	6	7
Electrical/electronic engineering (electronic)	HNC	48	42	49
	HND	16	17	19
Mechanical engineering	HNC	573	496	684
	HND	196	214	172
Operations engineering (instrumentation and control)	HNC	12	22	19
	HND	24	25	25
Operations engineering	HNC	131	169	186
	HND	33	14	7
Vehicle operations management	HNC	42	47	33
	HND	47	64	74
Manufacturing engineering	HNC	338	343	467
	HND	108	74	117
Marine engineering	HNC	99	132	149
	HND	67	65	105
Aerospace engineering	HND	56	29	24
Nautical science	HND	612	605	578

Source: Edexcel

22.5 Foundation degrees

Higher level skills are crucial to the economic competitiveness of all nations. In 1997 an enquiry into the future of Higher Education[196] recommended that future growth in UK HE provision should specifically address a recognised shortfall in the number of adults with knowledge and skills at the associate professional level (levels 4 and 5 on the National Qualifications Framework (NQF)) rather than just facilitating further expansion of honours degree (level 6) provision. Foundation degrees were subsequently introduced in 2000 with the aim of addressing the projected requirements of the UK economy, while offering a new and accessible route into Higher Education, particularly for individuals already in the workforce.

i. What are Foundation degrees?

Foundation degrees are Higher Education qualifications (at level 5 on the NQF) that integrate academic and work-based learning. They are designed in partnership with employers to ensure that they deliver the knowledge and skills relevant to industry and businesses. Foundation degrees are awarded by universities but can be delivered in flexible ways across a range of institutions and settings, including Further Education colleges and private training providers.

Existing in-house training programmes can be accredited[197] and incorporated into a Foundation degree and a number of major employers have found this a particularly attractive option when selecting programmes for workforce development.

ii. How do employers use Foundation degrees?

Foundation degrees are used by businesses for a number of different purposes:

- To enhance the knowledge and skills of existing employees (with the aim, for example, of increasing productivity and competitiveness)
- To change the skill set of existing employees (for example, when adaptation to new technology is required)
- To move employees on within the business (for example, to move employees to management level)
- To train new recruits

iii. How do employers use Foundation degrees?

Example case studies

Electrical power engineering

National Grid, E.ON and Scottish and Southern Electricity have employees undertaking a foundation degree in electrical power engineering[198] at Aston University. The programme is modular with employees typically undertaking one to two week blocks of intensive study. These blocks of study are separated by periods of 4–6 weeks in their normal employment within industry, during which they undertake work-based learning and independent study.

For National Grid,[199] the Foundation degree is part of their Electricity Development Programme that prepares employees for a career in designing, operating or maintaining their high-voltage electricity transmission system.

Aircraft maintenance

The aircraft maintenance industry is using foundation degrees to address recognised skills shortages within the sector.[200] Marshall Aerospace is working with HE partners to develop a Foundation degree/CPD framework that will support the training of its workforce and include accreditation of its in-house training within the qualification. Marshall Aerospace also plans to offer the Foundation degree to the wider workforce within the sector, and particularly to new entrants, via its AeroAcademy.

iv. The development of engineering and technology Foundation degrees

In 2004–05 there were just 77 Foundation degree courses in engineering and technology running in England. By 2008–09, provision had more than doubled, with students enrolled on 187 courses (see Figure 22.19).

196 The final report of the National Committee of Enquiry into Higher Education *Higher Education in the learning society* is available at: http://www.leeds.ac.uk/educol/ncihe/

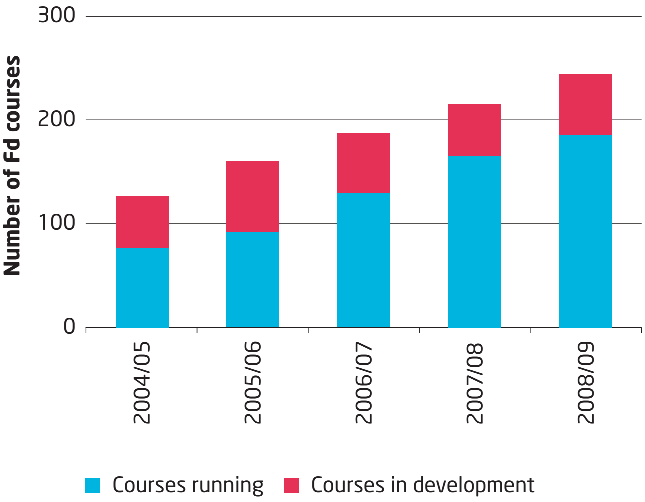
197 See the *fdf* website at: www.fdf.ac.uk for details of the Employer Based Training Accreditation (EBTA) service

198 For further details see: www1.aston.ac.uk/eas/foundation-study/foundation-degrees/foundation-degrees-list/

199 For further details see: www.nationalgrid.com/freshtalent/FoundationEngineer/

200 Thomas, H. and Marshall, B. (2009). *Approaching the challenge of higher level skills needs in the aircraft maintenance sector.* Forward. 18, 26-30. Available at: www.fdf.ac.uk

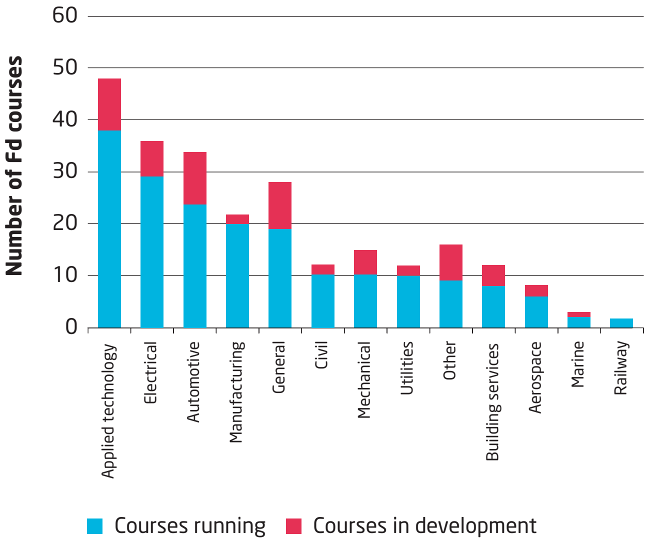
Fig. 22.19: Growth in engineering and technology Foundation degree courses (2004/05-2008/09) - England



Source: *fdf* course database

Engineering and technology Foundation degrees can be general programmes covering a broad subject base and probably offering a route into initial employment within the sector. There are also some very specific programmes, which are developed to suit the needs of a particular industry or company and are more likely to be aimed at improving the skills of the existing workforce. Figure 22.20 shows a subject profile for the engineering and technology Foundation degrees that were available in 2008–09. Courses in applied technology, electrical engineering and automotive engineering dominate the profile and account for 45% of provision. Specialist programmes in aerospace, marine and railway engineering account for just over 5% of provision.

Fig. 22.20: Subject profile of engineering and technology degrees (2008/09) - England

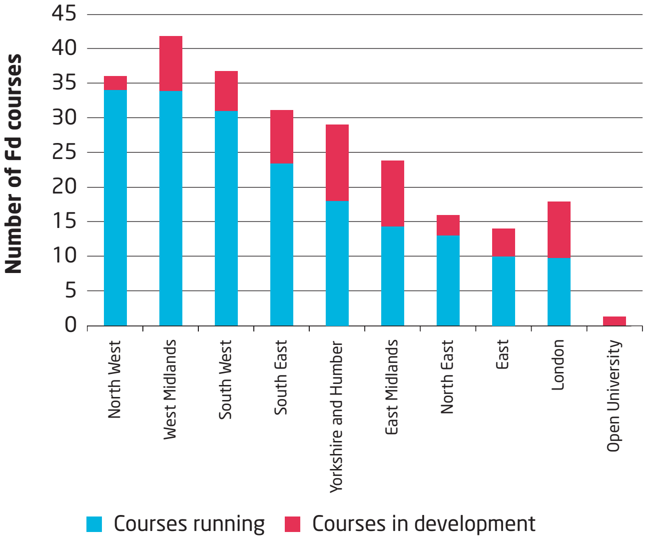


Source: *fdf* course database

The distribution of programmes is uneven in terms of the number of courses offered within each of the English regions (see Figure 22.21). Just over 18% of the courses running in 2008–09 were in the North West. In contrast, just over 5% of provision was in London.

The majority of engineering and technology foundation degrees are delivered by Further Education colleges (78%), 19% are delivered by universities and 3% delivered by other organisations such as private training providers or employers.

Fig. 22.21: Location of engineering and technology Foundation degrees (2008/09) – England



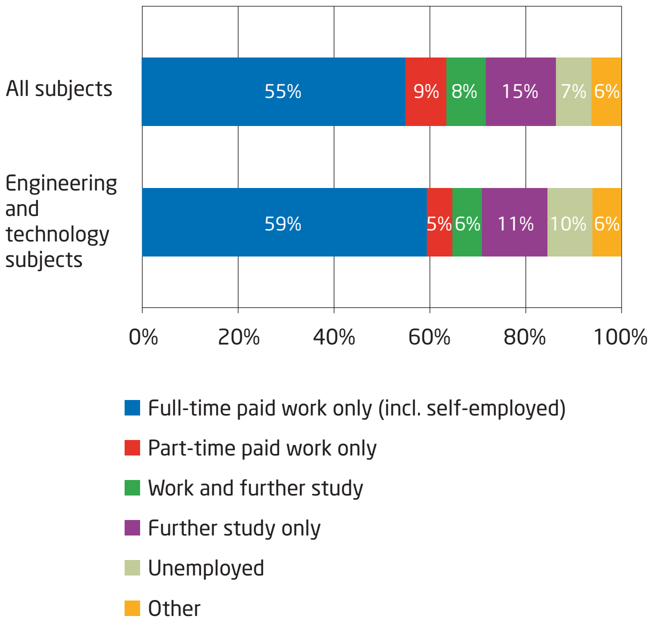
Source: *fdf* course database

Part 3 Engineering in Employment
23.0 Graduate destinations

This section explores the destinations of engineering and technology (E&T) graduates six months after graduation, using data from HESA's *Destination of Leavers of Higher Education* (DLHE) survey. The 2007/08 survey had 344,715 valid responses from 474,455 qualifiers.

The latest data (Figure 23.0) shows that in 2007/08, 59% of E&T graduates entered full-time paid employment, which was higher than the 55% for all subjects. E&T graduates are also less likely than average to pursue further study, at 20% (full and part-time study) compared with 23%. The unemployment rate in 2007/08 for both engineering and technology graduates (10%) and all subjects (7%) was higher than in 2006/07 where it was 6% and 5% respectively.

Fig. 23.0: Destination of leavers of HE (all qualifications) in all subjects and engineering and technology, who obtained qualifications by full time study (2007/08) – UK-domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

Figure 23.1 shows that the destination of engineering and technology graduates varies depending on the type of qualification. Those graduates obtaining 'other undergraduate' qualifications are the most likely to progress to further study, with nearly half of them remaining in education. Postgraduates are most likely to enter full-time employment, with 74% in 2007/08. Of those obtaining first degree qualifications, 18% stay in education, a third of whom combine work and study.

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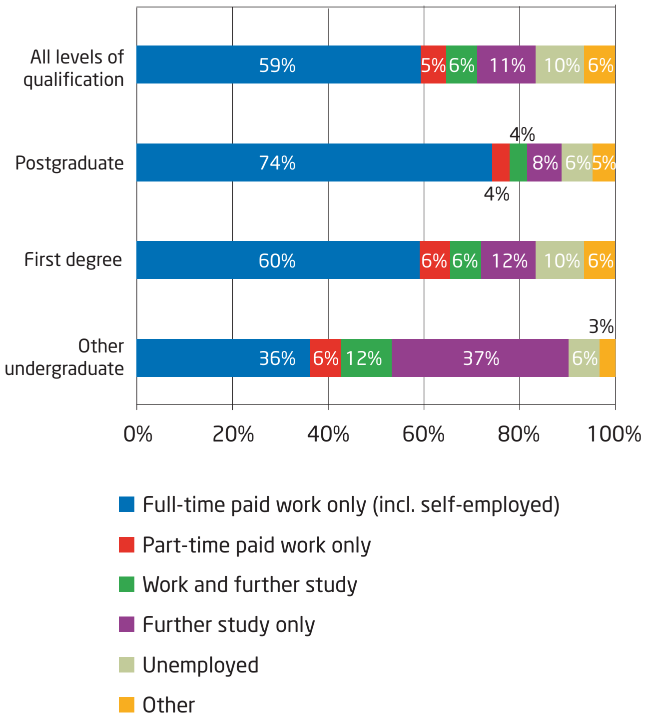
Fig. 23.1: Destinations of engineering and technology graduates who obtained qualifications through full-time study (2007/08) – UK domiciled

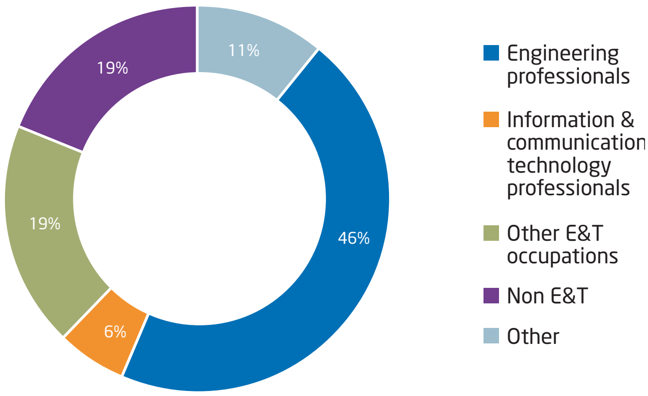


Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

23.1 Occupations of engineering and technology graduates

The HESA destinations data also details the type of occupation[201] of graduates who entered employment: Figure 23.2 shows that, contrary to some opinion, the vast majority of E&T graduates go into related occupations. In 2007/08, 71% of graduates went to work in E&T occupations, as engineering professionals (46%), ICT professionals (6%) or in other E&T occupations (19%). This figure may in fact be higher, as the 'other' category contains occupation types where there was insufficient detail within the definition to categorise them: for example, some sales occupations – though not all – involve technical expertise. SOC code group 212 'engineering professionals', (which includes civil engineer, mechanical engineer and electrical engineer) is by far the most popular destination for E&T graduates.

Fig. 23.2: Occupation of leavers of HE who obtained a first degree in the E&T subject area (2007/08) – UK domiciled

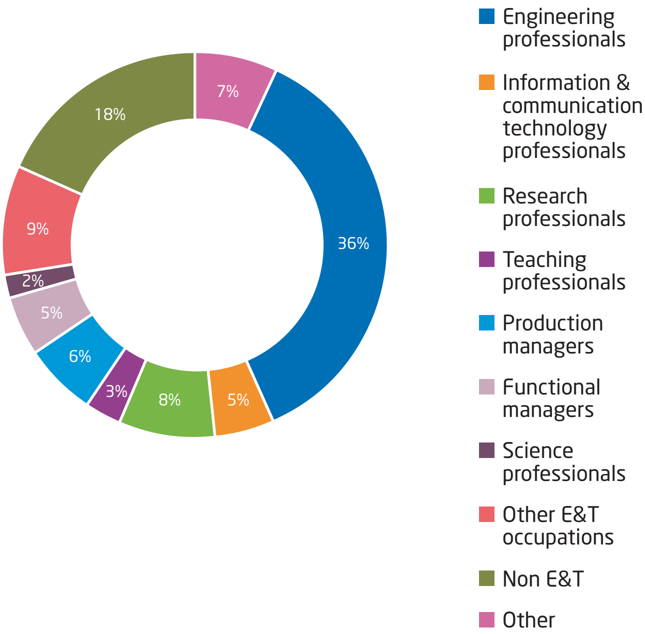


Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

201 By Standard Occupational Classification (SOC) code. See annex 33.3

The majority of E&T postgraduates enter a related professional occupation (Figure 23.3), with 57% entering direct employment in E&T. There were 11% employed in E&T management roles, 5% working as functional managers and 6% as production managers. A further 9% were employed in E&T roles, which results in three-quarters of postgraduates going into E&T occupations.[202]

Fig. 23.3: Occupation type of qualifiers who obtained a postgraduate qualification in E&T (2007/08) – UK domiciled

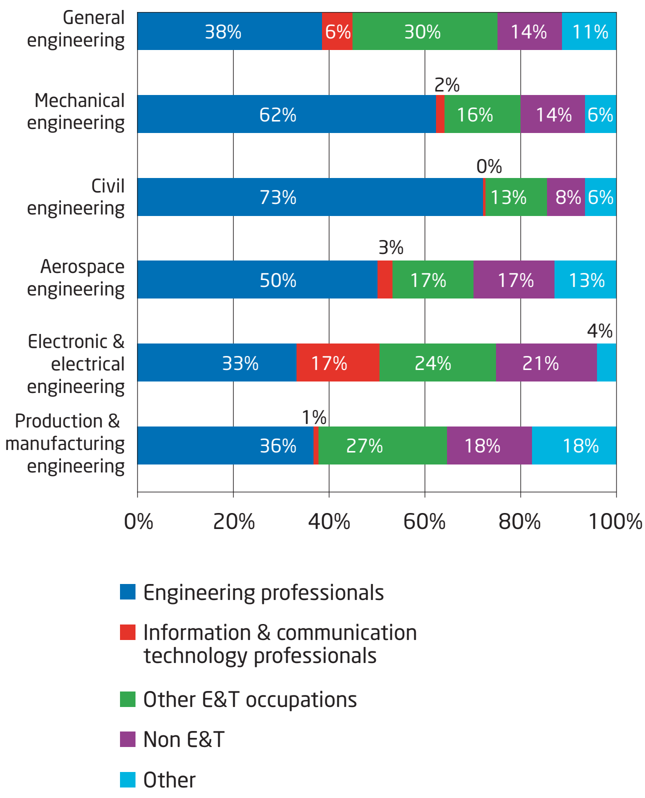


Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

23.2 Occupations by discipline

The occupation choice of engineering first degree graduates varies between individual disciplines, as illustrated in Figure 23.4. Our analysis shows that civil engineering graduates are most likely to work as engineering professionals (73%) around six months after completion[203] and are least likely to work in non-E&T occupations (8%). Electronic and electrical engineering graduates are most likely to take a non-E&T occupation, with a fifth[204] working outside of the field. They are also most likely to work as ICT professionals: 17% of those qualifying with electronic and electrical engineering first degrees in 2007/08 chose this area.

Fig. 23.4: Occupation type of qualifiers who obtained first degrees in engineering by sub-discipline (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

202 Up to a potential 82%, as 7% were not classifiable.

203 When the survey is completed.

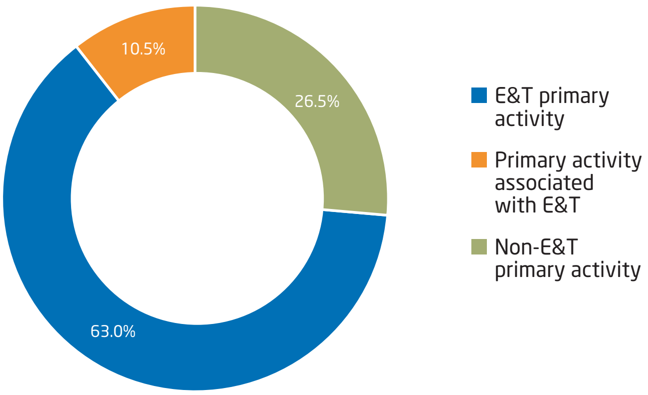
204 Subject to the limitations of SOC analysis as discussed.

23.3 Types of industry

The destination of graduates is also classified by Standard Industrial Classification (SIC) code in the HESA DLHE survey. These codes reflect the primary activity of the employer and do not indicate the graduate's role – a graduate may be working in an engineering role in a company whose main activity is not E&T.

Of the respondents to the survey who achieved first degrees in E&T, 63% gained employment with employers whose primary activity is E&T, as shown in Figure 23.5. A further 11% went into industries where the primary activity was associated with E&T.

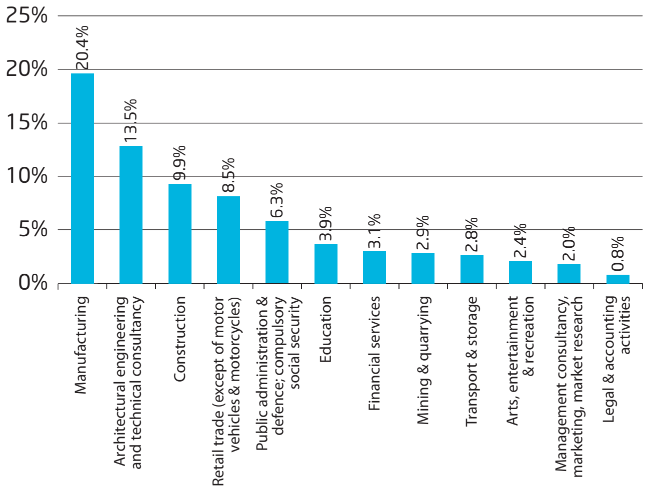
Fig. 23.5: Employer destinations for E&T subject area leavers who obtained first degrees and entered employment by primary activity of employer (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

Figure 23.6 breaks down the industries E&T graduates go into. Manufacturing is the biggest employer of those with E&T first degrees. This is perhaps unsurprising given the size of the sector: this sector accounts for 1/7th of total UK output and 75% of industrial research and development. Consultancy companies are the second largest employer of E&T graduates. The financial services sector only employed 3.1% of leavers with first degrees in 2007/08 – the same proportion as in 2006/07. Some further analysis found that, of the 3.1% that do go to work in financial services, 18% actually work in an E&T related role – generally in the computing/software engineering field. The proportion for 'all subjects' who find employment within the financial services sector is 5.5%. E&T graduates remain considerably less likely than the average to work in this sector. A continuing challenge within graduate engineering employment lies in accurately predicting jobs in STEM: a task only several sectors earnestly research.

Fig. 23.6: Employer destinations for E&T leavers who obtained first degree qualifications (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

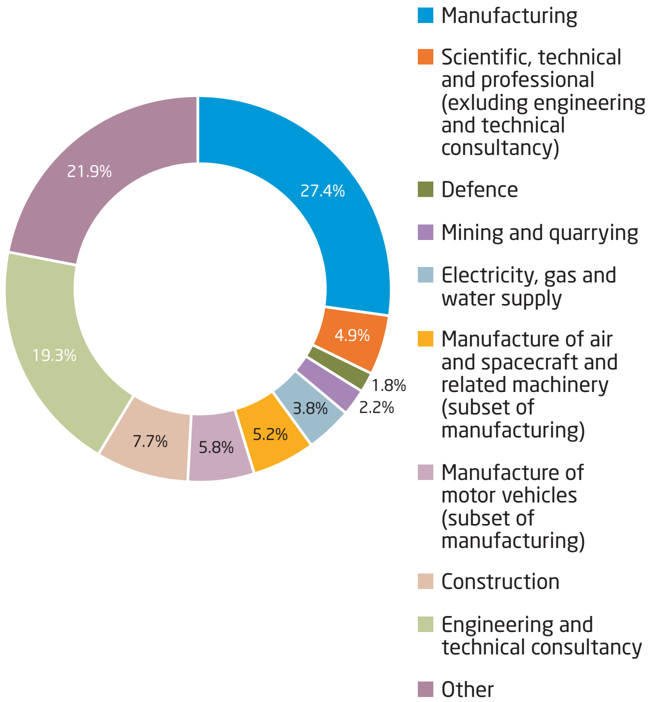
23.4 Industry type by engineering discipline

The industry engineering graduates go into on graduation varies between sub-disciplines. Figures 23.7 to 23.12 break down the sectors where engineering graduates are employed in E&T occupations.

Figure 23.7 shows, unsurprisingly perhaps, that general engineering graduates work in a range of areas. Manufacturing and consultancy firms are the most popular choices – in 2007/08, 27% and 22% of graduates worked in E&T occupations in these businesses.

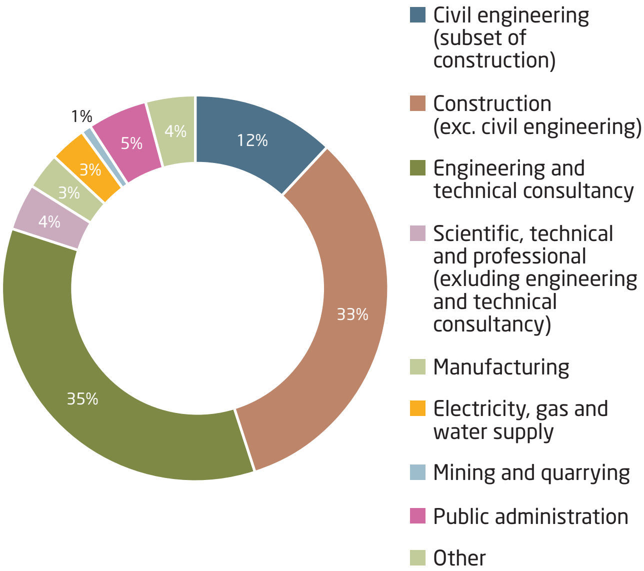
Figure 23.8 shows that civil engineers, as might be expected, are largely employed in construction (45% in total) and, in particular, in civil engineering companies (12%). In 2007/08, 35% of those achieving a first degree or postgraduate qualification in civil engineering worked for consultancy companies.

Fig. 23.7: Employer type of general engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

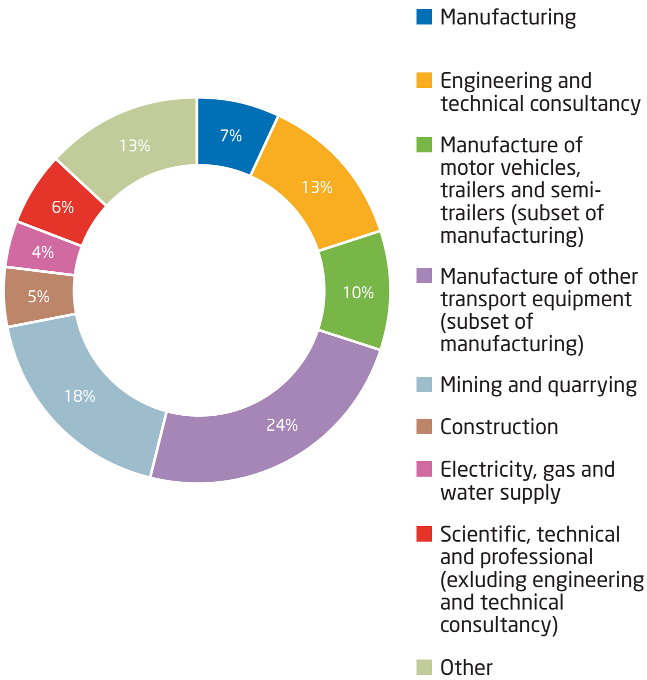
Fig. 23.8: Employer type of civil engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

As shown in Figure 23.9, mechanical engineering graduates are most likely to work in manufacturing – particularly within vehicle-related disciplines. These comprise motor vehicles and related (10%) and 'other transport', including manufacture of boats and aircraft, which combined account for 34% in total. Mining and quarrying is also a popular sector for mechanical engineers, with 18% of graduates working in a relevant occupation within this industry.

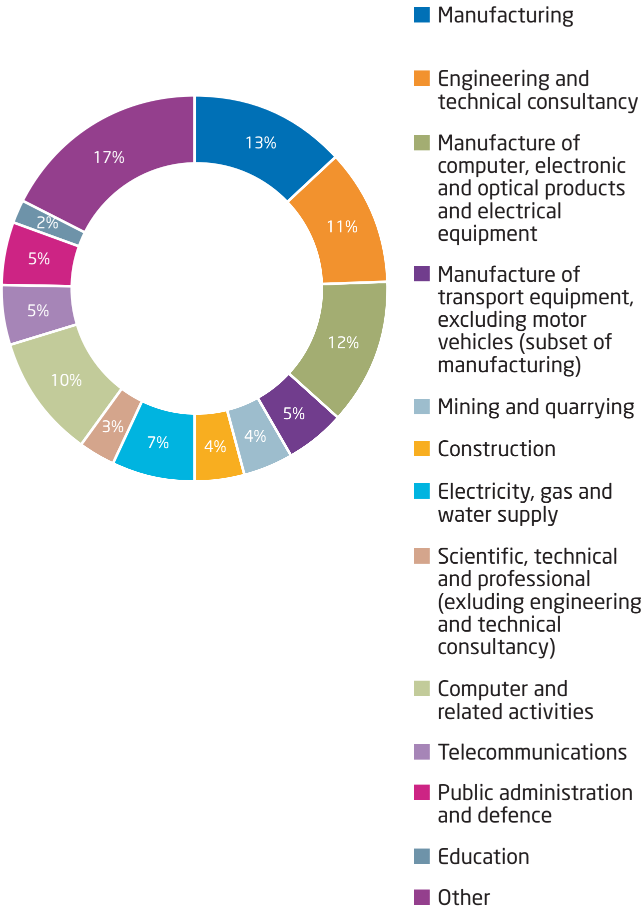
Fig. 23.9: Employer type of mechanical engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

Reflecting trends for general engineering graduates, electronic and electrical engineers are employed across a wide range of industries, as illustrated in Figure 23.10. Manufacturing is again a popular sector, attracting 36% of graduates. More specifically, they tend to work in manufacture of computer, electronic and optical products and in electrical equipment companies (13%). One in ten of this group went into the computing sector.

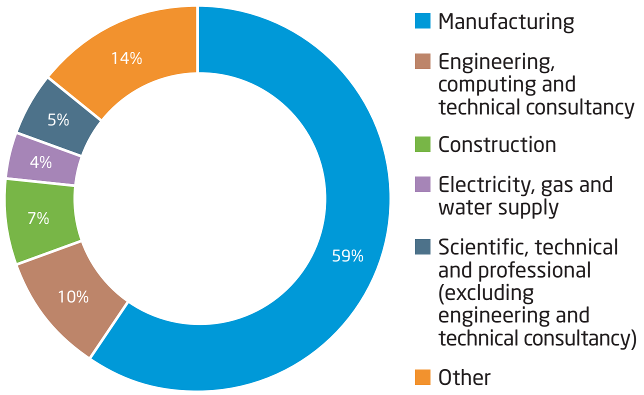
Fig. 23.10: Employer type of electronic and electrical engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

As the number of graduate production and manufacturing engineers working in E&T occupations was relatively low, wider groupings were used and the breakdown is less detailed (Figure 23.11). The manufacturing sector accounts for the majority of leavers with HE qualifications in production and manufacturing engineering. A tenth go to work for consultancy firms.

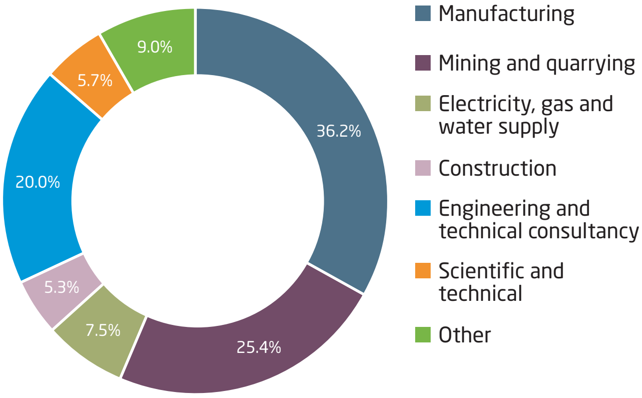
Fig. 23.11: Employer type of production and manufacturing engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

A quarter of leavers with HE qualifications in chemical, process and energy engineering, working in E&T occupations, were employed in the mining and quarrying sector (Figure 23.12). One in five of this group went to work for technical consultancy firms. However, manufacturing was by far the most common industry for these graduates with 36% taking E&T roles in this sector.

Fig. 23.12: Employer type of chemical, process and energy engineering graduates (all levels) in E&T occupations (2007/08) – UK domiciled



Source: HESA/ Destinations of Leavers from Higher Education Institutions 2007/08

23.5 Conclusion

Analysis of the destinations data shows a positive picture for engineering, with 79% of graduates going into full-time employment or further study six months after graduation.[205] Of those with first degrees that went into full-time employment, 74% went to work for employers whose primary activity was E&T.

The manufacturing sector was the largest employer of E&T graduates in 2007/08, with many also going to work in construction, mining and quarrying, and electricity, water and gas supply. Engineering and technical consultancy companies were also a popular choice for graduates in this area, with the choice of industry varying between engineering sub-disciplines.

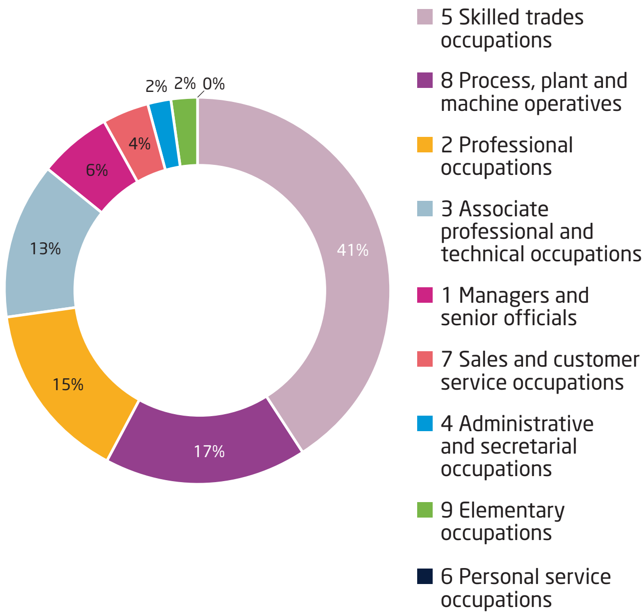
205 All levels of HE qualification.

Part 3 Engineering in Employment
24.0 Skills Shortage vacancies

This short section, originally published in *Engineering UK 2008*, has been included for ease of reference: the National Employers Skills Survey (NESS) 2007, published in May 2008, is the most recent data. The 2009 survey results are due to be published in 2010.

Although the vast majority of E&T employers claim that they do not face skills shortages, an analysis of the Skills Shortage Vacancies (SSVs) by SOC Code gives an indication of where the major issues lie (Figure 24.0). This shows a significant skew towards certain 'problem' occupations.

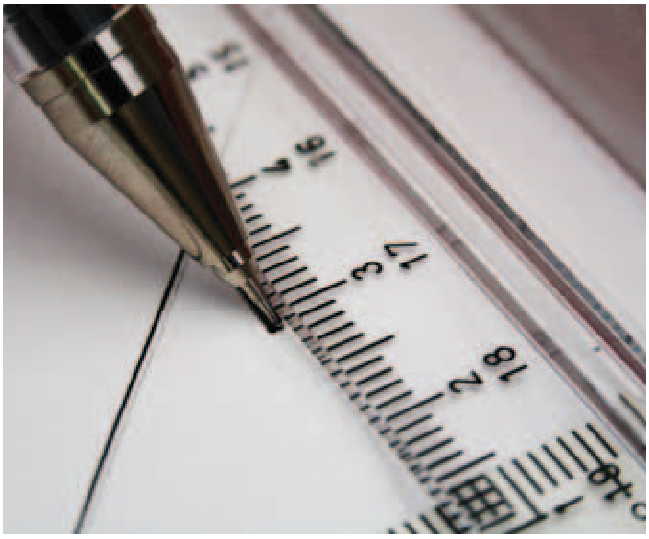
Fig. 24.0: Share of skills shortage vacancies at employers covered by the SEMTA footprint by SOC major group occupation codes (2007) – England



Source: National Employers Skills Survey (England) 2007

To put this in context, the greatest area of skills shortages, accounting for just over two-fifths of SSVs, is in the skilled trades occupations. These include metal working production and maintenance fitters, motor mechanics, auto engineers, electricians, electrical fitters and steel erectors.

The next largest category (17%) is process, plant and machine operatives, which includes chemical and related process operatives, quarry workers, energy plant operatives, routine laboratory testers and rail construction and maintenance operatives.



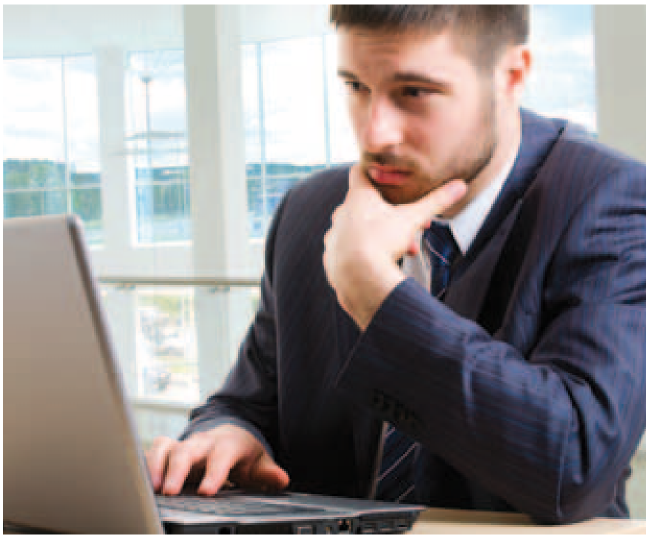
These two largest groups, combined with associate professional and technical occupations (eg engineering technicians, architectural technologists and laboratory technicians) account for 71% of SSVs, but only 21% of first degree HE E&T leaver occupations.

Professional occupations (eg chemical, civil, mechanical or electrical engineers, or ICT professionals) account for 55% of first-degree HE E&T leavers' employment but for just 15% of SSVs.

Engineering UK 2008

Part 3 Engineering in Employment

25.0 Graduate recruitment and salaries



This section looks at graduate vacancies and starting salaries, focusing primarily on the Association of Graduate Recruiters' (AGR) recent Summer Survey of Members.

25.1 Earnings in engineering

The AGR Summer Review[206] found that the current economic climate has had an unprecedented effect on graduate vacancy levels – among those surveyed, there is a 24% slump. The perennial recruitment shortfall is all but eradicated, with nine tenths of all employers surveyed expecting all their 2009 vacancies to be filled this season.

As shown in Table 25.0, vacancies in the engineering and industrial sector, construction and IT have dropped by 40.5%, 40.6% and 44.5% respectively. These falls are even slightly greater than those in investment banking (40.2%) which was predicted to be the hardest hit sector. On a more positive note, the energy, water and utilities sector, which employs a significant number of engineering and technology graduates,[207] has reported a 7.1% increase in vacancies.

Table 25.0: Percentage change in vacancies (2008-2009) by sector

		% change
Energy, water or utilities	↑	7.1%
Retail	↓	-1.2%
Public Sector	↓	-8.1%
Consulting or business services	↓	-9.8%
Transport or logistics	↓	-12.4%
Insurance	↓	-18.5%
Law firm	↓	-19.1%
Accountancy or professional services	↓	-20.6%
Banking or financial services	↓	-23.1%
Chemical or pharmaceutical	↓	-25.6%
FMCG	↓	-30.6%
Investment bank or fund managers	↓	-40.2%
Engineering or industrial	↓	-40.5%
Construction company or consultancy	↓	-40.6%
IT	↓	-44.5%

Source: AGR Summer Survey 2009

206 AGR employee members are surveyed twice a year on recruitment practices http://www.agr.org.uk/Content/AGR-Graduate-Recruitment-Survey-2009-Summer-Review

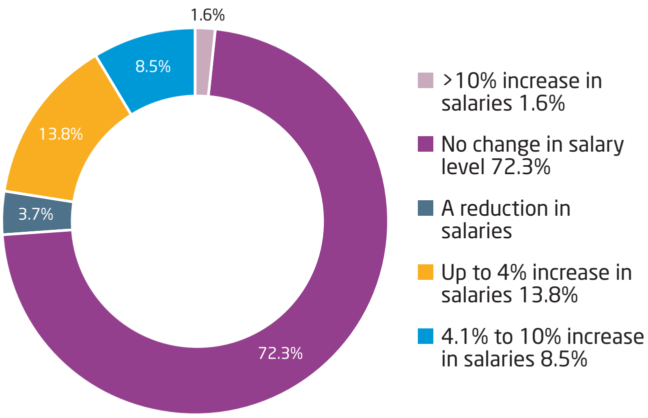
207 Section 23

The survey also found that applications per vacancy in the engineering and industrial sector went up to 52 from 32 in 2008.

Overall, AGR members are not expecting things to improve greatly in 2010. The majority (53%) predict that vacancy levels will remain the same as in 2009.

Overall starting salary levels have remained largely the same in 2009, as illustrated in Figure 25.0 with only 3.5% of surveyed employers actually citing a reduction.

Fig. 25.0: Graduate salary level changes (2008-2009)



Source: AGR Summer Survey 2009

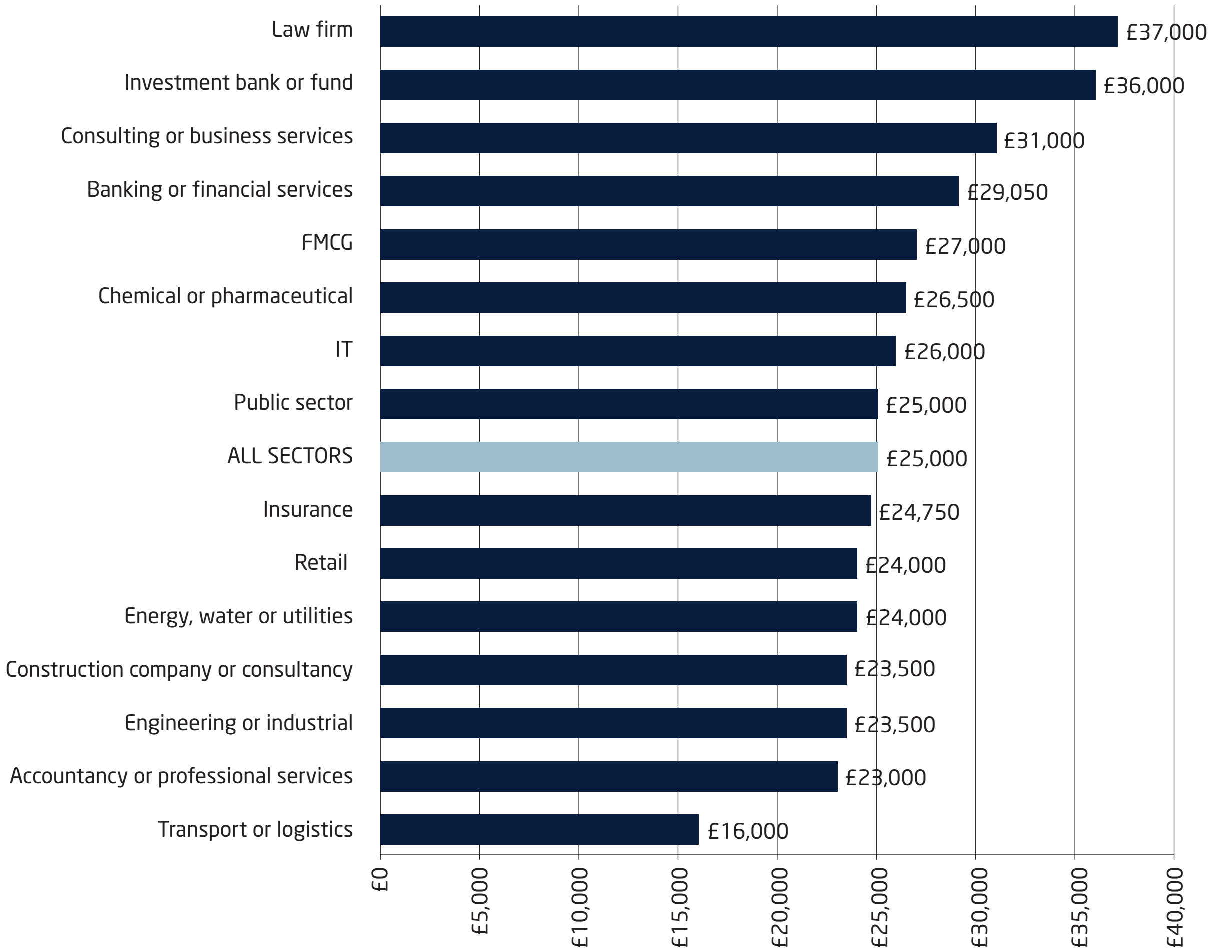
Though the number of graduate vacancies in engineering or industrial sectors has decreased since 2008, there has been a slight increase in salary levels as shown in Table 25.1. IT starting salaries are also up 4%. The 21.6% rise in starting salaries in consulting and business services stands out and this increase has pushed the graduate wage for this sector above that of banking and financial services. It is important to note that engineering and technology graduates will be employed across all of these sectors in some capacity (see Section 28.0) for full details.

Table 25.1: Change in graduate salary levels by industry sector (2008-2009)

Industry sector	Percentage change in median salary
Consulting or business services	+21.6%
IT	+4.0%
Insurance	+3.1%
Engineering or industrial	+2.2%
Banking or financial services	+2.0%
FMCG	+1.9%
Transport or logistics	0.0%
Construction company or consultancy	0.0%
Energy, water or utilities	0.0%
Retail	0.0%
Public sector	0.0%
Investment bank or fund managers	0.0%
Law firm	-1.1%
Accountancy or professional services	-3.0%

The median starting salaries in the engineering and industrial, construction and utilities sectors all sit slightly below the average, as shown in Figure 25.1.

Fig. 25.1: Median starting salaries by sector (2009)



Source: AGR Summer Review

Unsurprisingly, investment banking and legal work continue to yield the best pay for graduates. IT positions and R&D – although a fair way behind – offer good starting salaries of £28,000. Manufacturing engineering (£27,000), mechanical engineering (£25,000), electrical/electronic engineering (£24,488) and civil engineering (£24,000) also pay well. This is particularly apparent when compared with the median salary for all employee jobs, which in 2008 was £20,801.[208] Also, the Higher Education Careers Service Unit (HESCU) surveyed graduate employees' views of their current employer (Real Prospects 2009)[209] and amongst respondents the median salary reported was £23,000.

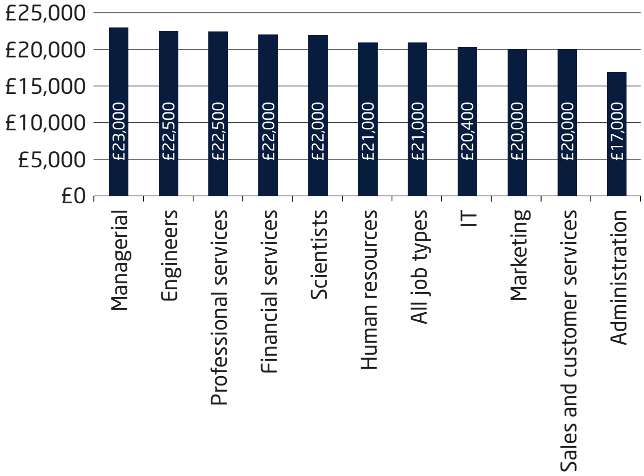
The CBI's Education and Skills Survey 2009[210] also found engineering salaries when viewed as a profession (as opposed to across the industry) to be favourable pay-wise to other graduate jobs. As illustrated in Figure 25.2, the CBI found engineers have the second highest salaries of the featured occupations, not far behind managerial roles. Among respondents, graduate engineers earn more than those in financial services.

208 ASHE 2008, ONS

209 http://www.hecsu.ac.uk/hecsu.rd/conferences_events_graduate_market_trends_summer_2009.htm

210 http://www.cbi.org.uk/pdf/20090406-cbi-education-and-skills-survey-2009.pdf

Fig. 25.2: Median salaries by job type (2009)



Source: CBI Education and Skills Survey 2009

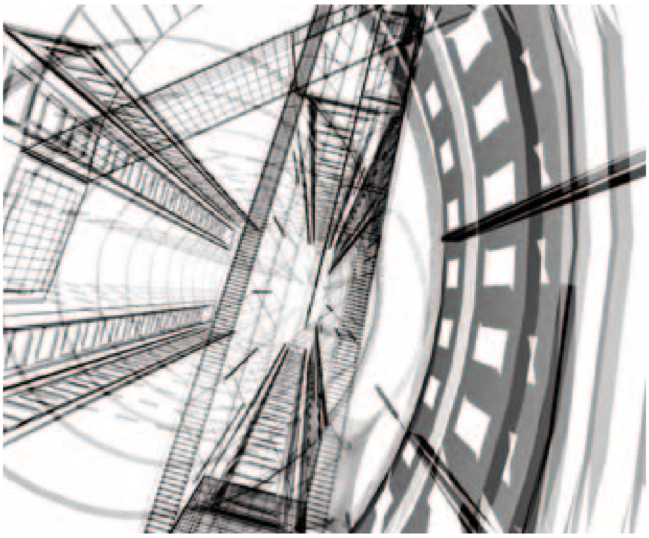
Prospects Directory salary and vacancy survey 2007/08[211] also found engineering and IT graduate median salaries to be £22,500 and £25,000, respectively. Its results, broken down by type of employer, are displayed in Table 25.2, further reinforcing the finding that starting salaries for engineering graduates are high.

Table 25.2: Median graduate salaries by type of employer (2007/08)

Employer Type	Median salary
Oil, mining & extractive industries	£30,000
Chemical manufacturers	£26,000
Computer consultants	£25,000
Energy & natural resources	£24,000
Construction industries	£23,000
Engineering products	£22,500

Source: Prospects Directory Salary and Vacancy Survey

Whereas engineering and industrial employers appear to have cut back on the number of graduate vacancies while the economic climate is uncertain, pay levels remain favourable. Analysis of Working Futures III in Section 28 predicts that the demand for STEM graduates will rise to new highs in the medium to long term future.



211 http://www.prospects.ac.uk/cms/ShowPage/Home_page/Main_menu___Research/Labour_market_information/Graduate_Market_Trends_2007/Prospects_Directory_salary_and_vacancy_survey__Winter_07_08_/p!elmkpbL#Key findings by job category

Part 3 Engineering in Employment
26.0 Earnings in engineering

26.1 Annual Survey of Hours and Earnings (ASHE)

The annual survey of hours and earnings (ASHE) provides information about the levels, distribution and make-up of earnings and hours paid for employees within industries, occupations and regions.

ASHE was developed to replace the New Earnings Survey (NES) in 2004.

Source: ONS 2009

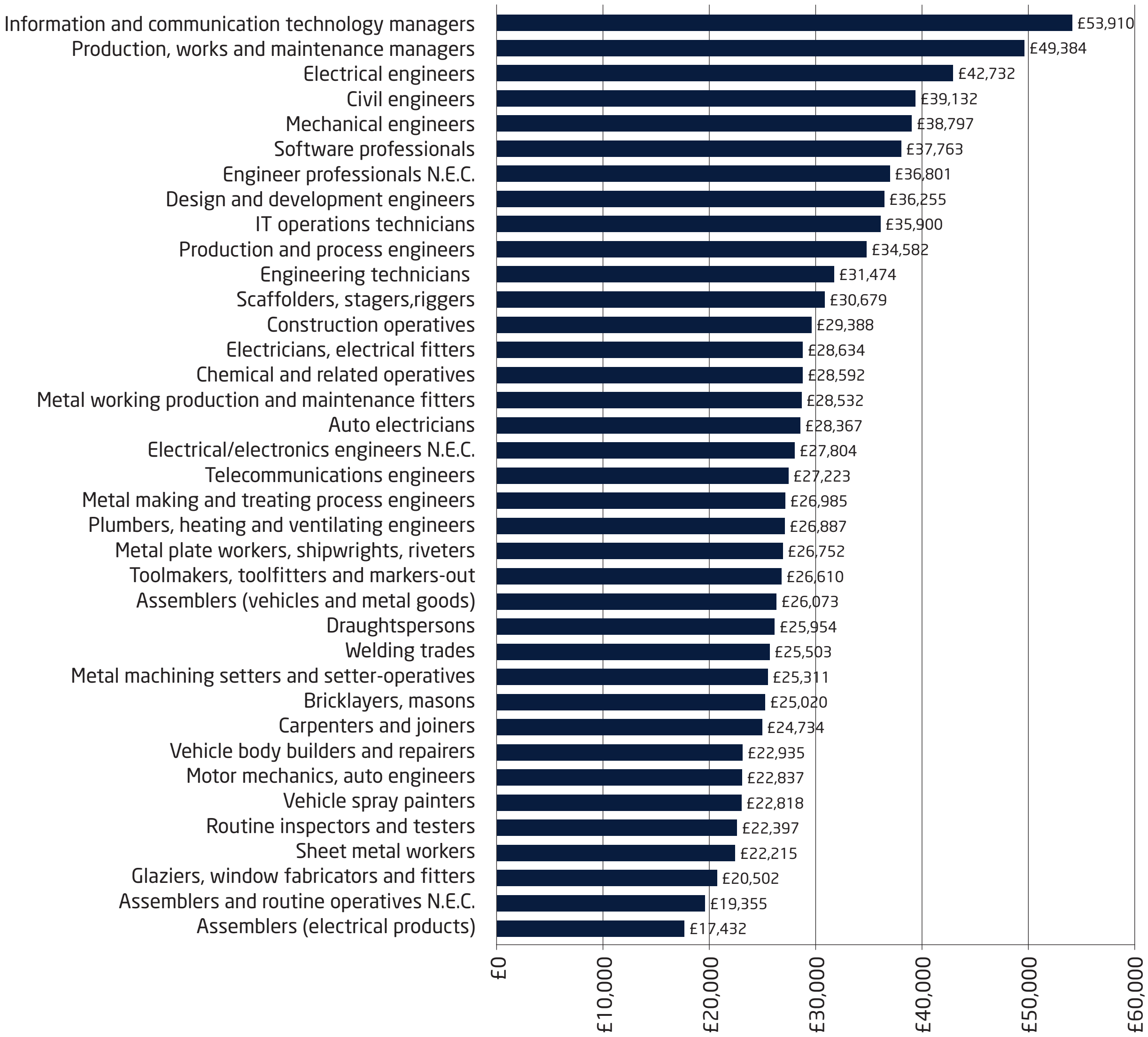
In this section, the gross annual salary of occupations within engineering[212] are extracted and presented. Figure 26.0 examines the mean salary of those occupations where the ASHE result was statistically significant.[213] As one would expect, management positions yield the highest salaries, though electrical engineers had a mean salary of £42,732 in 2008 – an 11% rise since 2007.[214] Civil engineers' mean salaries were up to £39,132 from £36,500 in 2007, and mechanical engineers also saw average gross annual pay rise from £37,131 to £38,797 in the same period.

212 According to Engineernig and Technology Board SOC 2003 list. See annex 33.3

213 CV<5%

214 See *Engineering UK 2008* for 2007 figures http://www.etechb.co.uk/_db/_documents/5831_EngUK08_LORES_20090401010212.pdf

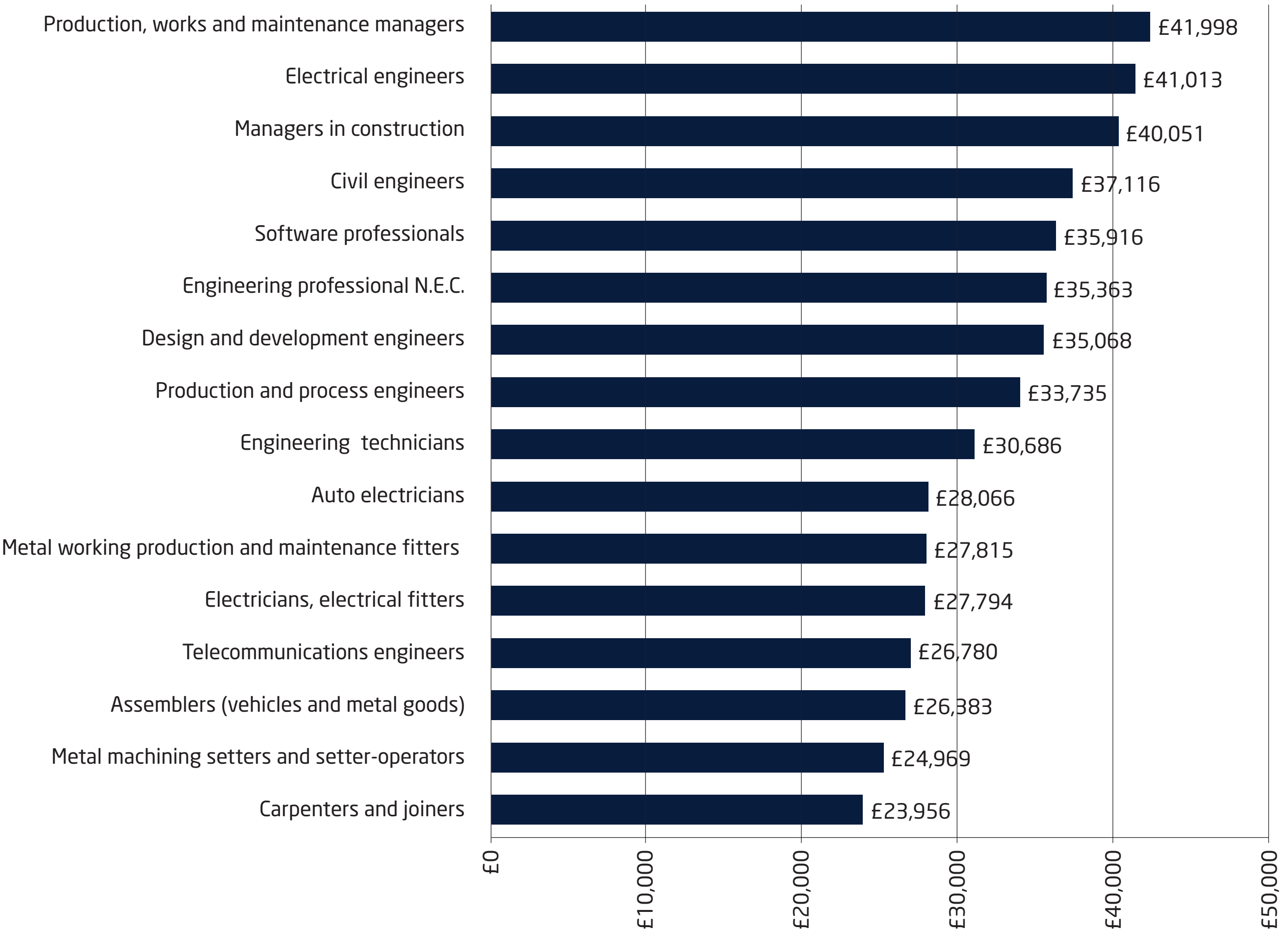
Fig. 26.0: Mean annual gross pay (2008) – UK



Source: ASHE 2009, ONS

The median gross annual salaries are generally lower than the mean annual gross salaries (Figure 26.1), though perhaps a better measure as the average isn't skewed by a few large figures.

Fig. 26.1: Median gross annual salary by standard occupational classification (2008) – UK



Source: ASHE 2009, ONS

Engineering salaries are still favourable when compared with non-engineering professions, as illustrated in Figure26.2.[215] Whilst best paid jobs in engineering appear to yield a similar salary to those of lawyers, it would seem that this is not a commonly held perception: the Engineering and Technology Board's (now EngineeringUK) Engineers and Engineering Brand Monitor (EEBM)[216] found that 80% of the general public believe that engineers are not paid as well as lawyers.

215 This data is illustrative due to not being as robust as that shown within engineering professions.

216 Section 8.0

26.2 Registered engineers salaries

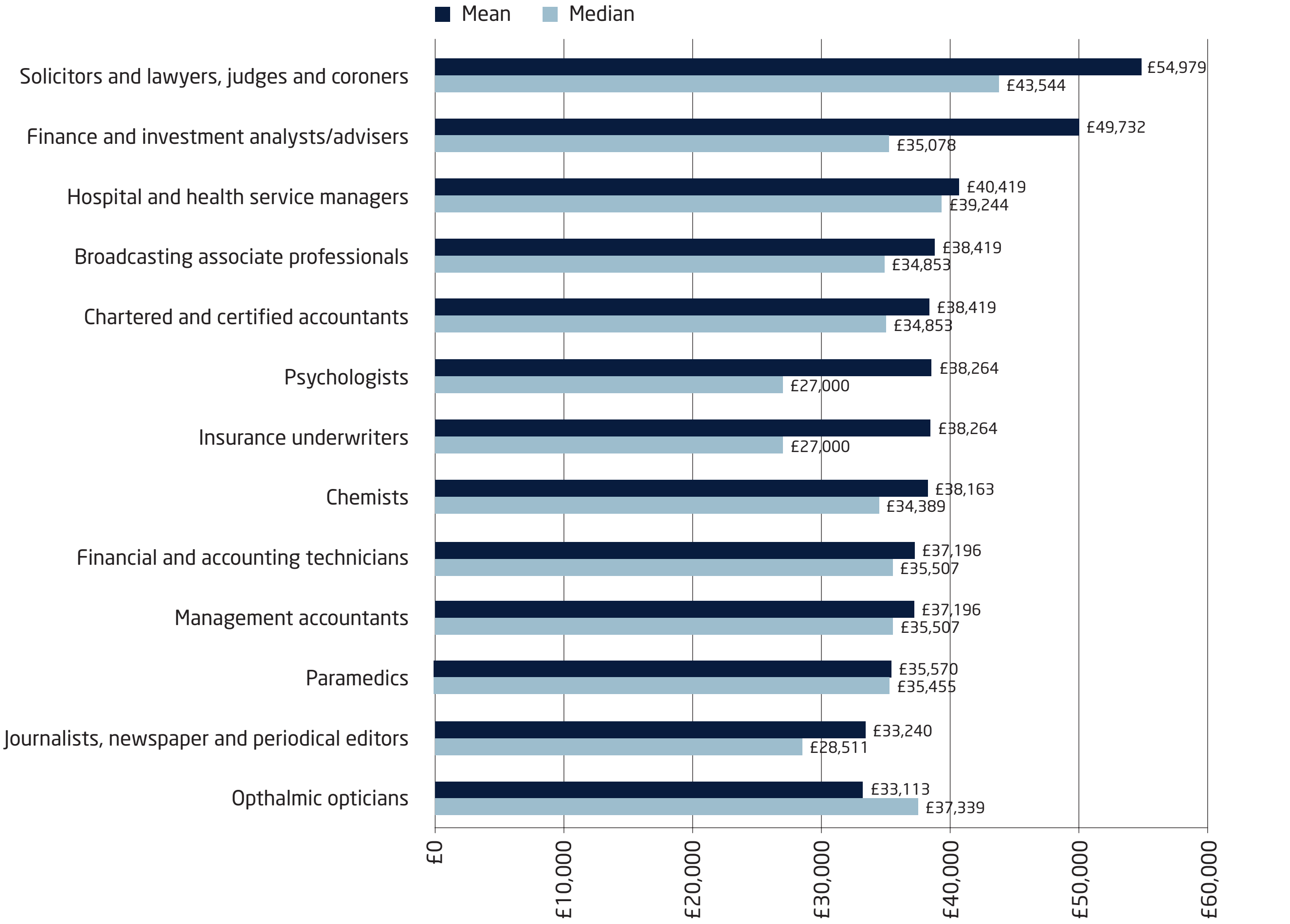
The most recent salary data for registered engineers was carried out in 2007 by the Engineering and Technology Board (now EngineeringUK). Average salaries are shown in Table 25.2.

Table 26.0: Mean and median gross salary of registered engineers (2007) – UK

	Mean gross salary 2007	Median gross salary 2007
Chartered engineer	£54,181	£50,000
Incorporated engineer	£43,759	£41,000
Engineering technician	£34,392	£33,000

Source: Engineering and Technology Board 2007 Survey of Registered Engineers

Fig. 26.2: Annual gross pay of non-engineering occupations (2008) – UK



Source: ASHE 2009, ONS

Part 3 Engineering in Employment

27.0 Professional registered engineers

In common with most countries, there are no significant constraints in the UK on who may practise or be employed as an engineer or technician. However, many employers and clients require evidence that the engineers they employ or commission are competent to practise. The Engineering Council, a chartered body originally set up by the former DTI, is the national registration body in the UK that sets standards and registers professional engineers and engineering technicians. It operates through 36 registered professional engineering institutions[217] which undertake the assessment and put forward for registration engineers and technicians who meet the Engineering Council Standard for Professional Engineering Competence (UK-SPEC).[218]

Registration is in one of four categories, Chartered Engineer; Incorporated Engineer; Engineering Technician and ICT Technician. These require a level of academic knowledge and understanding broadly equivalent to level 7, 6 at least 3 of the National Qualifications Framework for England, Wales and Northern Ireland respectively (11, 9 and 6 in the Scottish Credit and Qualifications Framework, respectively).

In addition, candidates for registration must demonstrate their competence to practise in accordance with the standard, and demonstrate that they are committed to keeping their competence current, as well as commit to acting in a professionally and socially responsible manner.

217 www.engc.org.uk/institutions

218 www.engc.org.uk/ukspec

27.1 Number of registered engineers

The number of professional engineers in the UK is estimated at between 369,000[219] and 568,000.[220] The Engineering Council estimates that approximately 180,000 are registered as either chartered or incorporated engineers. Many commentators, including the Government[221] and the Select Committee for Innovation, Universities, Science and Skills,[222] believe that more should be encouraged to register and, indeed, in 2008 the Engineering Council embarked on a campaign to persuade more to do so. Nevertheless, compared with the population of the UK, the proportion of registered professional engineers compares favourably with registration levels in comparable countries (see Table 27.0).

Table 27.0: International comparison of engineer, technologist and technician registration

	Engineering Council	**Engineers Ireland**	**Engineering Council South Africa**	**Institution of Professional Engineers New Zealand**	**Hong Kong Institution of Engineers**	**Engineers Australia**	**Engineers Canada**
Country population (thousands)	60,800	4,100	44,000	4,100	7,000	20,400	33,400
Professional Engineers/CEng	188,701	15,177	14,727	5,250	11,568	47,555	160,000
Technologists/IEng	40,466	2,468	2,944	125	1,713	708	29,991
Engineers/ 1000 population	3.10	3.70	0.33	1.28	1.65	2.33	4.79
Ratio Engineer/ Technologist	5 to 1	6 to 1	5 to 1	40 to 1	7 to 1	67 to 1	5 to 1

Source: Engineering Council

219 Engineering Professionals: Parliamentary Answer 16 July 2008 (quoting LFS 2003 data)

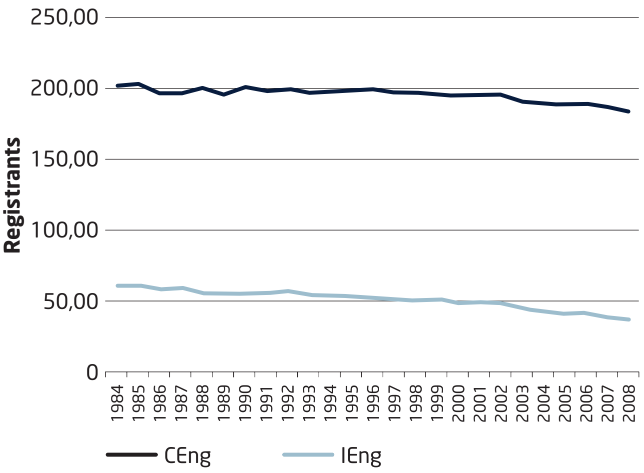
220 Engineering L4+L5 in the economy: The Demand for STEM Graduates: some benchmark projections Rob Wilson January 2009: table 3.3

221 http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/759/759.pdf

222 http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/50/50i.pdf Para 284

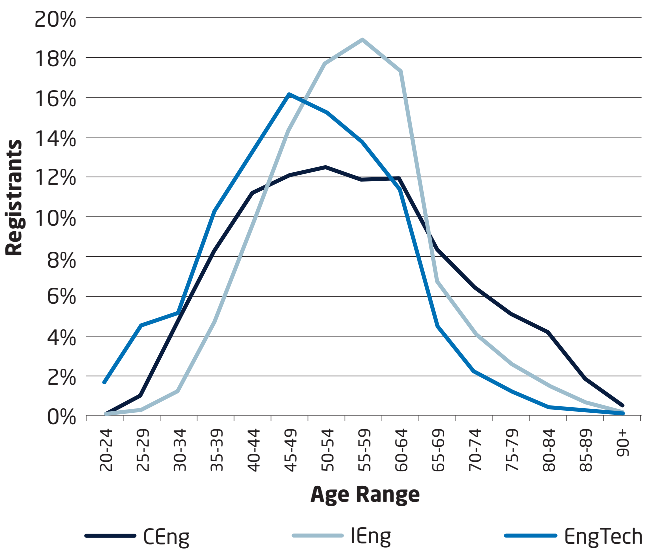
The numbers of registered chartered engineers and incorporated engineers are still gently declining, despite these efforts (Figure 27.0). In part, this is because significant numbers are retired or close to retirement (Figure 27.1). Nevertheless, there is evidence that numbers of new registrants are rising in key areas of the economy, including mechanical engineering, building services engineering and transport, with process industries and construction generally still strong. Concerted efforts to increase the numbers of registered engineering technicians, from a very low base, are showing signs of success (Figure 27.2).

Fig. 27.0: Number of registrations of chartered engineers and incorporated engineers (1984–2008) – UK



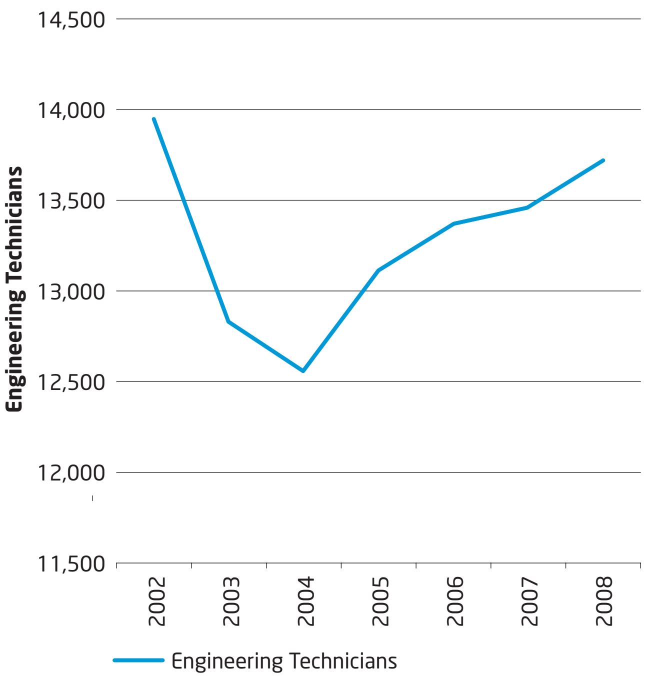
Source: Engineering Council

Fig. 27.1: Age distribution of chartered engineers, incorporated engineers and engineering technicians



Source: Engineering Council

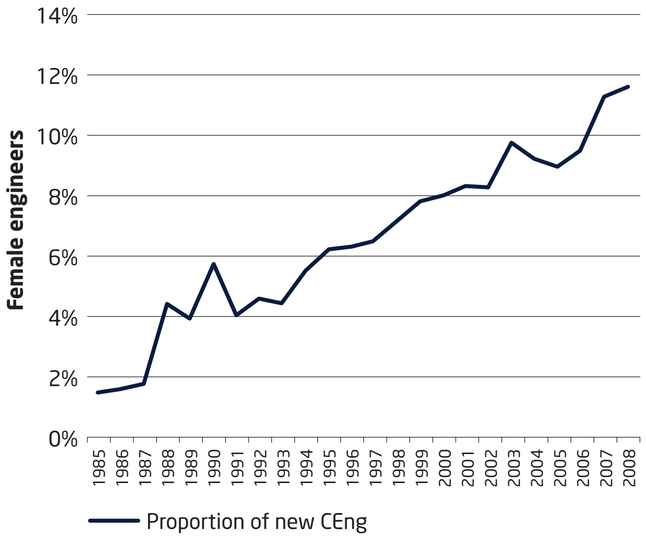
Fig. 27.2: Number of engineering technicians (2002-2008) – UK



Source: Engineering Council

The gender balance of registered engineers and technicians is strongly skewed against female engineers. The numbers registering in all categories continue to rise as a proportion of total new registrants, but progress is still rather slow (Figure 27.3). In 2008 the proportion of new female registrants was 11.6%.

Fig. 27.3: Proportion of new registrants who are female (1985-2008) - UK



Source: Engineering Council

27.2 International equivalences

As noted by the Select Committee report previously referenced, the reputation of chartered engineers internationally is very high; hence an increasing proportion of registrants are domiciled overseas. While it is not possible to distinguish between expatriated and indigenous registrants directly, samples of surnames indicate that a growing proportion is permanently resident overseas. Table 27.1 gives a breakdown of the principal countries where registrants are domiciled.

Table 27.1: Countries with more than 1,000 registrants

Country	Number of registrants
Hong Kong	10,537
Australia	5,277
USA	4,084
Canada	2,957
Ireland	2,088
New Zealand	1,699
South Africa	1,668
Singapore	1,522
Malaysia	1,299

Source: Engineering Council

Because engineering is a traded service (until 2009 the UK routinely enjoyed a net positive balance of around £2 billion in engineering services) overseas enterprises may need an assurance of competence for engineers who will never practise overseas. This must account for the international surge in interest in the comparability of professional engineering competence. The key international agreement on this is the Washington Accord.[223] This has been in existence since 1989 and offers a means of comparing academic engineering credentials between countries. It originally covered six countries, but now embraces 14, with many others – including India, China and Germany – actively seeking membership. The Washington Accord is just one of a range of accords dealing with different geographic agreements and competence standards, as can be seen from the referenced website.

Since 1951, agreements on recognition of academic credentials in Europe were established by the European Federation of National Engineering Associations (FEANI). In the last couple of years, FEANI has set up a robust system for assessing engineering degrees through the EUR-ACE system. EUR-ACE now has 12 European organisations accrediting engineering degrees to the FEANI Register.[224]

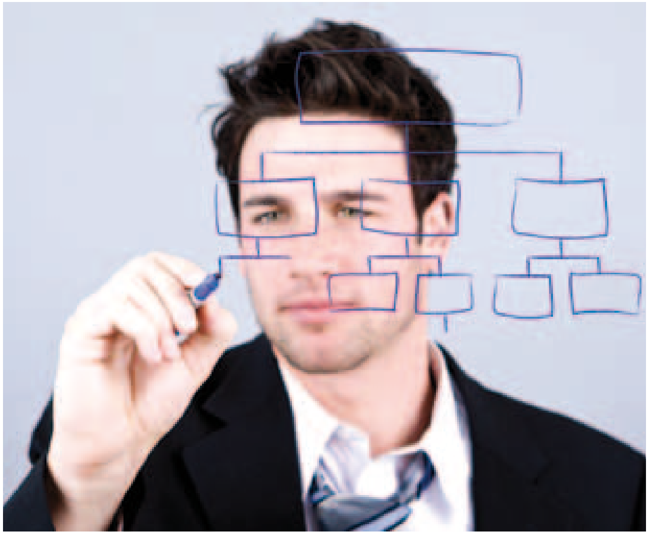
27.3 IT technician

In early 2009, the Engineering Council moved to create a new register of ICT technicians. Potential ICT technicians are spread widely throughout the economy, and the standards of their education and competence are readily comparable with those of engineering technicians. It is estimated that there may be as many as a million IT technicians working in the UK, and the establishment of the register illustrates the close links between engineering and IT. The first licence to award registration was granted to the Institution for Engineering and Technology, and initial interest has been high.

223 http://www.washingtonaccord.org/

224 http://www.enaee.eu/enaee/members.htm

Part 3 Engineering in Employment
28.0 Emotional Intelligence – the missing link to superior business performance



Emotional Intelligence

Bob Windmill, Energy and Utility Skills

Introduction

In our work and home lives we have all had experience of 'go-to' people. Often not the best qualified individuals available, these are the high performers who we turn to when challenging or non-standard tasks need to be delivered.

This case study illustrates how Wales and the West Utilities (WWU) identified its high performers and what differentiates them from their colleagues, and then put in place a change programme to bring the balance of the workforce up to the same standard. The outcome was a measurable seven figure saving in the first year.

While the research was centred on WWU, the general applicability of their programme was confirmed by a joint workshop between themselves and BT Openreach.

The conclusion is that, by combining softer, personal competences with the harder technical skills in a systematic fashion, an organisation can realise immediate bottom line benefits.

Aims/objectives of research

The aim of the research was to understand what differentiates a high performing individual from their lower performing peers in WWU. This investigation would cover both technical industry specific skills and the more general personal behaviours and competences.

The key outcome of the research was that WWU would use the knowledge gained on the performance drivers of its high performing staff to improve its bottom line results.

Business performance

It is arguable that business performance results from a combination of people and processes. Much has been written on the process side of the equation and it is unquestionable that good performance is built on excellent technical skills. However, there appears to be rather less focus on the effect of the personal behaviours of individuals on organisational performance.

Productivity

OECD data[225] shows that France and the USA are nearly 20% more productive than the UK. To give our competitors a 20% head start in an increasingly global economy puts UK plc at an immediate disadvantage and is something that must be addressed.

Total Factor Productivity – the missing link?

From an economics perspective, skills contribute around 20% to business performance[226] but at least a similar percentage is attributed to Total Factor Productivity (TFP).[227]

In economics TFP is *"a variable which accounts for effects in total output not caused by inputs"*.[228] Comin[229] characterises TFP as being a function of resource utilisation stating that *"its level is determined by how efficiently and intensely the inputs are utilised in production"*. Mason[230] similarly notes that "*at national level it [TFP] captures the ability of different countries to achieve growth in output from, in particular, more efficient deployment of existing resources.*"

In everyday language these definitions intuitively link to the concept of 'go-to' people doing a better job with the resources they have. If we accept the proposition that TFP is a key performance driver, the question then becomes that of what TFP might be in a practical, real world, sense.

225 http://stats.oecd.org/Index.aspx?DataSetCode=LEVEL

226 Leitch review 2006

227 Broadberry, S. and O'Mahony, M. (2004), `Britain's productivity gap with the United States and Europe: a historical perspective',

228 http://en.wikipedia.org/wiki/Total_factor_productivity

229 Comin, D., (2006). Total Factor Productivity

230 Mason, G., (2009). Productivity and skills at national level

Wales and the West research project

In 2007 EU Skills commissioned Business Navigators[231] to undertake a research project into the relationship between skills development and productivity improvements.[232] Working with Wales and the West Utilities[233] (WWU), one of the four Gas Distribution Network operators in the UK, the key purpose of the project was to get behind the high level economic assessments of productivity drivers in order to understand the contribution of skills development in improving their bottom line performance and the implication of the findings for WWU's day to day operations.

Performance measurement

A key enabler to this project was that WWU run a companywide performance management system which gives them visibility of the productivity of each part of their business. Data from this system showed that on average, measured over a 13 week period, productivity was only 44%. Within that measure they were able to demonstrate that 20% of employees performed better than average, 60% were in an acceptable range and 20% performed significantly below average.

This visibility was critical in understanding the performance issues, developing solutions and monitoring the effect of those solutions.

231 Further details of Business Navigators from roy.leach@bussinessnavigators.co.uk

232 EU Skills (2007) Skills Development and Performance

233 http://www.wwutilities.co.uk/

Technical skills

Investigation into the technical abilities of the three groups using established time and motion techniques showed no significant performance differences between them and that the overall efficiency of undertaking technical tasks was 94%. This clearly demonstrated that improving the technical abilities of the employees could only give a limited improvement in their overall productivity score.

Non-technical skills

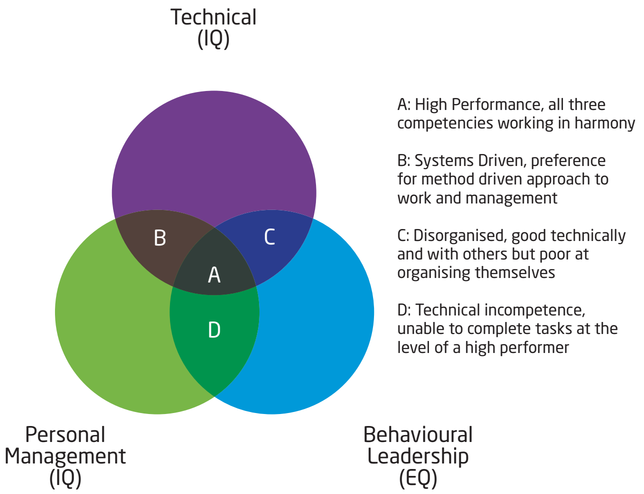
By contrast, using a mix of performance measures and qualitative interviews, the research was able to identify clear differences in both the Personal (Self) Management Competencies and Emotional & Behavioural Competencies between the three groups.

Personal (Self) Management are broadly the skills and competencies needed to manage both self and others to achieve productive outputs such as planning, organising, monitoring, implementing and reviewing. While these skills are sometimes included under the heading of Intelligence Quotient (IQ), they are identified separately in this research from the technical skills needed for an individual to operate effectively in the industry.

The emotional and behavioural competencies are those behaviours which are needed to achieve productive outputs for self and others such as self confidence, achievement drive, conscientiousness, teamwork and collaboration. These are often grouped under the heading of Emotional Intelligence and are measured using the Emotional Quotient (EQ) scale.

It is important to recognise that there are no clear cut boundaries between these skills and competency groups but they are distinct complementary entities which together provide a basis of exceptional individual and organisational performance. This is illustrated in Figure 28.0

Fig. 28.0: Skills and competence mixes



This mix of non-technical skills and competences appears to mirror many of the properties of TFP in that they are designed to improve outputs without requiring additional input. As such it represents a practical and pragmatic interpretation of TFP.

All or nothing?

While a high performer will generally be strong in each area, this is not to say that individuals with a weakness in one of the areas cannot be a perfectly adequate performer. As the research shows, 60% of the WWU workforce studies are adequate in that they produce the same amount of work as their co-workers and this amount was acceptable to the organisation. Only when there is a drive for excellence through continuous improvement does this become an issue.

Regulation and productivity

WWU are subject to economic regulation. Their income is limited by the amount that OFGEM, the economic regulator for electricity and gas, will allow them to charge the gas producers and users. Their principal route to improving profitability is through increased efficiency. At this point having one in five of their workforce producing 25% less than average and 40% less than the best performer was not acceptable.

WWU's approach

With two of their six strategic objectives relating to creating a performance culture and a learning organisation respectively, WWU knew that they could not simply order the poor performers to 'shape up or ship out' and hope to realise a sustained growth in productivity. 'Shipping out' was part of the solution which is discussed later. Equally any performance system imposed from the top would have a limited chance of sustained success.

WWU implemented a companywide Performance Management Framework (PMF) underpinned by a series of Learning and Development Programmes. Two points were regarded as critical by WWU: that the programme be Board Room to Shop Floor including all support functions, and that those affected by it should be involved in its creation and development.

The central element of the PMF was that of Performance Coaching. This was summarised by Business Navigators as:

"Raising the awareness of individuals which is the key to unlocking their potential through the power of choice which achieves personal commitment, stimulates self belief and self confidence, which in turn achieves self responsibility to improve performance."

The key elements from this definition are self awareness, self management, social awareness and relationship management. This is very different from the traditional approach of technical roles only needing technical training.

Success factors

To be judged a success the PMF had to address the two following key issues:

Realising bottom line benefits:

This was addressed by requiring each individual on the programme to make a personal commitment to be responsible to identify and deliver tangible financial benefits at a minimum of £1,000 per person for WWU within the subsequent six month period. Processes were implemented to monitor delivery of the agreed benefits.

Managing poor performers:

This was considered to be a critical factor in maintaining the motivation and performance of other employees and was addressed by making an individual's performance part of the appraisal process. Where an individual was shown by data from the monitoring system to be underperforming over a sustained period their manager was required to agree an action plan with them to address the issue. Where an individual could not meet the accepted standard within agreed timescales, with the appropriate management support, they would have to leave the business.

Benefits

A different approach is all very well but only if it produces a better bottom line result. In the case of WWU, they were able to identify bottom line savings of £5m in the first year of the programme. While it is not possible to accurately distinguish the contributions to enhanced performance from innovation and investment, there is a belief within WWU that skills development was a significant contributor and that the overall saving would not have been realised without it.

As an aside it was notable that the very best performers in WWU's business were those who had been involved in the development of the PMF – a good argument for involving the whole organisation in the process.

Implications for the engineering community

An important question for the project was whether the research findings were specific to WWU or whether they were more generally applicable. To address this point a workshop was set up between WWU and BT Openreach, which had offices in the south west. The purpose of the meeting, which was attended by executive and senior managers of both organisations, was to draw any comparisons and share potential learning on the challenges of organisational skills.

While it was clear from the workshop outputs that many comparisons could be drawn between the two organisations, it was also clear that they were ultimately two different businesses operating in separate environments. In spite of this there was a clear agreement from the participants that the findings of the research and approach adopted by WWU would be appropriate for BT Openreach and hence could be generalised at least across broadly similar organisations.

Intuitively it appears that with WWU's focus being on personal leadership and responsibility rather than improving technical skills, their approach would be generally applicable within the engineering community.

Lessons for the engineering community

This case study is just that – a case study. However it is clear from the research that no element of WWU's performance management framework is specific to their industry. This was confirmed by the joint work between WWU and BT Openreach and suggests that it would be generally applicable.

The evidence from this example is that a companywide commitment to developing EQ skills, as an adjunct to excellent technical skills, can generate substantial bottom line benefits and a number of intangible benefits such as improved workforce morale.

Part 3 Engineering in Employment
29.0 Working Futures III: implications for the engineering & manufacturing sectors

29.1 Introduction

Working Futures III (2007–17) (WFIII) is a detailed and comprehensive employment projection[234] covering the UK. The main focus of WFIII is the changing structure of employment and the implications on demand for skills, as measured by occupations.[235]

WFIII was produced at a time of economic uncertainty, with the UK population projected to increase substantially. This rise was mainly driven by net inward migration, with the economically active labour force also increasing substantially.

The WFIII projections suggest an increase in the numbers employed of around 1.65m between 2007 and 2017. Almost two million additional jobs are projected by 2017. The majority of the additional jobs will be part-time, while about a third will be full-time. The unemployment rate is expected to rise by about 0.5% over the decade as a whole. This will affect both males and females. Unemployment is likely to rise more significantly in the short term before falling back.

The main focus of this summary is the detailed projections of industrial and occupational employment levels, developed using largely extrapolative methods, based on data from the 2001 Census and Labour Force Survey (LFS) releases up to 2007.

Changes in occupational levels between years are also analysed to show changes due to replacement demand. This takes into account the need to replace those who leave their job because of retirement or other reasons. These replacement demands need to be added to any structural change (or so called expansion demand or decline) that is projected, to obtain an estimate of the overall recruitment requirement.

All data on the following pages is taken from *Working Futures 2007–17 Evidence Report 2*,[236] unless stated.

234 For details on the methodology used by Working Futures, see pp 2-6 of the Evidence Report no.2, and the Technical Report (both available at www.ukces.org.uk)

235 The new projections take into account the latest data from official sources including the LFS and ABI

236 Wilson, Homenidou & Gambin – Working Futures 2007–2017, Evidence Report 2 (UKCES, December 2008)

29.2 Context

The implications for industry employment are dependent on two main factors: the demand for the industry's output and projected productivity growth. Prospects for demand for each industry's output depend, in turn, on a whole host of factors, including technological change, productivity growth, international competition, globalisation, specialisation and sub-contracting, economic growth and real incomes and shifts in patterns of consumption.

Productivity growth affects the numbers of people that need to be employed to produce the same level of output. This depends on factors such as changes in technology and the way work is organised. The faster output increases relative to productivity, the faster employment will rise (or conversely). In many industries, output prospects are quite promising, but this is offset (in terms of the implications for jobs) by rapid productivity growth.

Within each industry analysed there is a demonstration of the historical patterns of change as well as expected future developments in employment by gender and status. While the demand factors influencing this are often specific to sectors, the supply issues are more generic in nature.

Over a long period, the number of full time jobs for men in occupations requiring physical strength has declined, while opportunities have opened up for women: especially in part-time work. These have been reinforced by an increasing supply of women wanting to take part in the economy. Certain parts of the primary, secondary and construction sectors have managed to resist the trend towards greater part-time working.

There are some trends in occupational change that are common across sectors, although there are some major differences as well. The key drivers influencing the changing skills requirements behind this change include technological change, competition, changing patterns of consumer demand, structural changes, working practices and regulatory changes.

The key message of WFIII is that education and training requirements are more likely to result from replacement demand levels than from expansion demand, even where the latter is quite large.

Patterns of change at a broad sectoral level suggest a continuation of the long-established trend away from employment in primary and manufacturing industries and in favour of the knowledge economy and services more generally.

Over the medium to longer-term (5–10 years), growth in household expenditure and the recovery of key export markets (especially those in Europe) is expected. This should result in renewed manufacturing output growth (albeit with continued loss of jobs). In manufacturing, the strongest growth is projected in high-tech industries such as electronics and pharmaceuticals. High-tech areas such as communications and computing services are also likely to perform better than average.

The manufacturing sector is projected to expand slightly over the period 2007–2017 in output terms, but strong productivity growth means that employment will continue to fall.

This has affected almost all manufacturing industries, reflecting restructuring and pressures to improve productivity in the presence of technological change and significant international competition.

In the long term, an annual decline in manufacturing employment overall of around 1.5% is expected as firms strive to maintain competitiveness. Employment in UK manufacturing is expected to fall by about 1.5% a year between 2007 and 2017, with over 400,000 thousand (net) manufacturing jobs expected to be lost over the next ten years. Despite falling employment numbers, manufacturing will continue to play a crucial role in the economy.

Engineering is expected to be the focus of some of the fastest rates of decline; with food, drink & tobacco and other parts of manufacturing being less hard hit (Table 29.0).

Table 29.0: Forecast change in manufacturing employment (2007-2017) – UK

Sector	Change 2007-2017
Other manufacturing	-123,000
Chemicals & other non-metallic mineral prods	-70,000
Wood, pulp & paper; printing & publishing	-19,000
Food, drink & tobacco	-8,000
Textiles & clothing	-34,000
Other manufacturing & recycling	8,000

Employment in motor vehicles is also set to continue to decline following major plant closures and increased pressure on manufacturers to cut costs to offset rising raw material prices. It is expected that the remaining UK motor vehicles industry will maintain its competitiveness, and higher levels of investment are forecast. Overall, however, employment will continue to decline.

The manufacturing sector has experienced a sustained period of restructuring in the face of increasing globalisation. While this is likely to remain a feature, the impact and pace of future restructuring is likely to be less severe as adjustment to the globalised economy proceeds. Over the long term, output growth in manufacturing could accelerate slightly, driven by a shift into higher value-added activities associated with productivity gains.

29.3 Occupational change

Forecasts for 2007–17 predict some major changes in the occupational profile of the UK workforce, including a proportional increase in demand for higher skills in those areas most relevant to engineering and manufacturing (Table 29.1). The main changes can be summarised as follows.

Looking at the occupations across all industries that are vital to the engineering and manufacturing sectors, there will be a continued rise in the number and proportion of employees who are managers/senior officials (+18%); in professional occupations (+16%); and in associate professional/technical occupations (+15%). These occupational groups have been gaining an increased share of employment since 1987, although the rate of increase for the next 10 years is forecast to be slower. For example, at associate professional and technical level, there was a rise of 26% between 1987 and 1997 and 25% between 1997 and 2007.

Table 29.1: Forecast change in occupational employment, all sectors total (2007-2017) – UK

Occupations	Forecast employment 2017	Increase 2007-2017	% change	% share of total employment	Change in share
Managers and senior officials	5,700	+872	+18%	17.2	+1.7
Professional occupations	4,733	+642	+16%	14.3	+1.2
Associate professional and technical	5,126	+654	+15%	15.4	+1.1
Administrative and secretarial	3,319	-396	-11%	10.0	-1.9
Skilled trades occupations	2,178	-1,226	-36%	9.6	-1.3
Personal service occupations	2,925	+443	+18%	8.8	+0.9
Sales and customer service occupations	2,522	+104	+4%	7.6	-0.1
Machine and transport operatives	2,173	-117	-5%	6.5	-0.8
Elementary occupations	3,507	-29	-1%	10.6	-0.7
Total	33,184	+1,950	+6%	100	–

At the same time, a fall is forecast in the number of people working in skilled trades and elementary occupations, as well as among machine and transport operatives. However, the decline in all these groups will be less sharp than it was during the 1987–2007 period.

Overall, almost 47% of employees in 2017 will be at associate professional level or higher, compared with just over 32% in 1987: skilled trades, machine operatives and elementary groups are predicted to decline from a share of 42% to less than 27%.

This general trend is reflected when we look at occupational change between 1997 and 2017 in greater detail. Science and technology professionals, whose numbers increased by over 41% between 1997 and 2007, will continue to increase – albeit at a slower rate (+18% between 2007 and 2017 – Table 29.2). Science and technology associate professionals rose in number by around 7% between 1997 and 2007, and this growth is forecast to continue at a similar rate over the next decade.

However, skilled metal trades (-19% and -12% respectively) and process, plant and machine operative numbers (-31% and -20%) will continue to decline slowly.

Table 29.2: Forecast change in selected sub-major occupational groupings (2007–2017) – UK

Sub-major group	2007 000s	2007 % of total	2017 000s	2017 % of total	2007-17 % change	2007-17 Net	(% change 1997-2007)
Science/tech professionals	1,091	3.5	1,283	3.9	17.6	192	(+41.1)
Science/tech associate prof.	546	1.7	586	1.8	7.4	40	(+6.5)
Skilled metal/electrical trades	1,222	3.9	1,078	3.2	-11.8	-144	(-19.4)
Process plant & mach ops	1,099	3.5	879	2.6	-20	-220	(-31.4)
Elementary: trades/plant/mach	1,016	3.3	975	2.9	-4	-41	(-22.5)

29.3.1 Changing share of occupations by industry

Changes in occupational profile within manufacturing are predicted over the period 2007–17. There is likely to be a continued strong decline among skilled trades (-19%), machine & transport operatives (-20%) and elementary occupations (-19%), while those occupations requiring higher level skills are predicted to remain at fairly constant numbers. Therefore, the latter will make up a higher proportion of employment as the other occupational groups decline in importance.

This shift of numbers up the skills scale is a continued reflection of the long-term trend of manufacturing companies moving operations overseas while keeping their research and development in the UK. Since 2002, R&D spend by the UK manufacturing industry[237] has increased by almost a quarter (+24.5%). The largest proportional rises among the major R&D spenders have been in aerospace (+53.1%), pharmaceuticals (+40.9%) and electrical machinery (+37.6%). Only a few sectors – notably communication equipment – have decreased their R&D spend.

29.3.2 Gender and mode of working

Females represent around one fifth of the total manufacturing workforce. By 2017, full-time female employment is expected to decline by 23% in manufacturing, and by 9% in engineering manufacture (Table 29.3). However, the proportion of full time employees that are female is expected to rise in engineering manufacture (from 15% to 18%) but fall in manufacturing (from 26% to 22%).

The most dramatic decline in female employment is expected to be in textiles, along with fairly sharp falls in other manufacturing & recycling and machinery, electrical & optical equipment.

Part-time employment in manufacturing is characterised by a larger proportion of female workers (69%) but the overall numbers are expected to fall greatly by 2017. By contrast, the proportion of female workers in engineering manufacture is likely to remain fairly constant, with a predicted rise in numbers of 15%. There may be a small decline in numbers of self-employed female workers in manufacturing, where women make up a higher proportion of the part-time workforce than in engineering manufacture – though numbers of self-employed women in the latter will see an increase overall.

237 Source: Office for National Statistics 2008: Expenditure on R&D performed in UK businesses

Table 29.3: Employment forecasts for engineering and manufacturing by gender and working mode (2007-2017) - UK

	Male			**Female**		
	% of total employment		**% change**	**% of total employment**		**% change**
Full Time	**2007**	**2017**	**2007-17**	**2007**	**2017**	**2007-17**
Manufacturing	74%	78%	-5%	26%	22%	-23%
Food, drink, tobacco	71%	75%	8%	29%	25%	-12%
Textiles, clothing	67%	98%	-3%	33%	2%	-97%
Wood, pulp, paper, printing, publishing	71%	73%	-7%	29%	27%	-16%
Chemicals, other non metallic mineral prods	80%	80%	-15%	20%	20%	-15%
Other manufacturing & recycling	77%	84%	6%	23%	16%	-31%
Engineering manufacture	85%	82%	-23%	15%	18%	-9%
Metals & metal goods	87%	82%	-23%	13%	18%	11%
Machinery, electrical, optical, equipment	81%	82%	-23%	19%	18%	-30%
Transport equipment	90%	84%	-24%	10%	16%	29%
Part-time						
Manufacturing	30%	39%	-10%	69%	62%	-39%
Engineering manufacture	26%	28%	24%	72%	72%	15%
Self-employed						
Manufacturing	60%	64%	10%	40%	37%	-5%
Engineering manufacture	89%	90%	-5%	9%	11%	22%

29.3.3 Replacement demand

Replacement demand is an increasingly important feature of IER occupational projections. Rather than simply considering net change in employment (expansion demand) as an indicator of demand for skills, replacement demand considers what is needed to offset outflows due to retirements etc and is a key measure in estimating education and training provision need.

Looking at replacement demand enables us to consider requirements in industries where total employment and employment levels at each occupational level may be falling (Table 29.4). The net change in most industries is negative, but this does not account for the fact that every industry also has a need to replace people retiring or leaving for other reasons. Presently, the total replacement demand for the manufacturing sector (over 930,000) more than outweighs the predicted fall in employment (around 340,000).

Indeed, in every industry and for every occupation in the table, the total net demand – once replacement demand has been taken into account – is positive. Even when both occupation and industry is considered, this remains the case with just two exceptions: machine & transport; and elementary occupations in textiles and clothing.

The effects of replacement demand on key occupational groups within manufacturing industries can be summarised as follows:

- Despite the expected net job losses in the industry, there will be a need to recruit new workers.
- There are significant replacement demands, especially for skilled trades, occupations and machine operatives. So, despite the sharp decline in employment in these areas, there is still a significant recruitment requirement.
- As a consequence, there are important implications for training requirements, especially in the skilled trades.
- There are substantial net requirements projected at all occupational levels, especially for managers & senior officials, associated professionals (where the requirement is almost identical to the replacement demand) and skilled trades and machine operatives, for the reason shown above.

Table 29.4: Replacement demand and recruitment need in manufacturing (2007-2017) – UK

	Employment 2007	Net change from 2007	Replacement demand	Total requirement	Requirement as % of 2017
Managers & senior officials	474,000	6,000	159,000	165,000	35%
Professional occupations	217,000	-16,000	76,000	61,000	28%
Associate professionals & technical occupations	346,000	-5,000	114,000	108,000	31%
Skilled trades occupations	554,000	-129,000	219,000	91,000	16%
Machine & transport operatives	536,000	-132,000	242,000	109,000	20%
Elementary occupations	291,000	-67,000	121,000	53,000	18%
All key occupations	2,418,000	-343,000	931,000	587,000	24%

29.4 Occupational requirement by sector

29.4.1 Engineering manufacture

Despite the negative net change in employment across the board in the engineering manufacture sector, the need to replace workers who are retiring (or need replacing for other reasons) easily outweighs this decline. This means that, at every key occupational level in each of these sectors, there is a need for recruitment of substantial numbers of people by 2017 (Table 29.5).

Looking at the key occupational groups as a whole, numbers are predicted to fall by 220,000. But with replacement demand taken into account, there will be a total requirement of around 180,000 by 2017: around 17% of total estimated employment for that year. Therefore, almost one fifth of all employees estimated to be working in the sector by 2017 will need to be recruited.

The largest recruitment need for an individual occupation is predicted to be for managers/senior officials, with a total of 50,000 needed by 2017 – over 28% of total estimated employment for this occupation. Of these, 21,000 are needed in the machinery, electrical & optical sector and 19,000 in metals & metal goods. However the requirement that represents the highest proportion of those employed at a similar level in a sector is in Transport Equipment (31%). In all three sectors, at least a quarter of managers/senior officials working in 2017 will have to be recruited, despite a net increase of only 5,000 overall.

The second highest requirement is for machine & transport operatives (36,000 – 18% of estimated employment). Of these, 14,000 are needed in metals & metal goods, 11,000 in machinery electrical & optical and 11,000 in transport equipment. These figures represent one fifth of the total employment requirements of both the metals & metal goods and transport equipment sectors by 2017.

The figures also forecast substantial need at three other occupational levels requiring specific skills – professional occupations (25,000), associate professional/technical (28,000) and skilled trades (27,000).

Table 29.5: Engineering manufacture – summary of requirements by occupation and sector (2007-2017) – UK

Occupation	Sector	Employment 2017	Total requirement	Requirement as % of 2017 employment
Managers & senior officials				
	Engineering manufacture	178,000	50,000	28.1%
	Metals & metal goods	58,000	19,000	32.8%
	Machinery, electrical & optical equipment	88,000	21,000	23.9%
	Transport equipment	32,000	10,000	31.3%
Professional occupations				
	Engineering manufacture	113,000	25,000	22.1%
	Metals & metal goods	26,000	7,000	26.9%
	Machinery, electrical & optical equipment	59,000	11,000	18.6%
	Transport equipment	28,000	7,000	25.0%
Associate professionals & technical occupations				
	Engineering manufacture	122,000	28,000	23.0%
	Metals & metal goods	32,000	10,000	31.3%
	Machinery, electrical & optical equipment	64,000	12,000	18.8%
	Transport equipment	26,000	6,000	23.1%
Skilled trades occupations				
	Engineering manufacture	268,000	27,000	10.1%
	Metals & metal goods	100,000	14,000	14.0%
	Machinery, electrical & optical equipment	100,000	9,000	9.0%
	Transport equipment	68,000	4,000	5.9%
Machine & transport operatives				
	Engineering manufacture	205,000	36,000	17.6%
	Metals & metal goods	72,000	14,000	19.4%
	Machinery, electrical & optical equipment	77,000	11,000	14.3%
	Transport equipment	56,000	11,000	19.6%
Elementary occupations				
	Engineering manufacture	105,000	13,000	12.4%
	Metals & metal goods	38,000	5,000	13.2%
	Machinery, electrical & optical equipment	37,000	4,000	10.8%
	Transport equipment	30,000	4,000	13.3%
All 'key' occupations				
	Engineering manufacture	991,000	179,000	18.1%
	Metals & metal goods	326,000	69,000	21.2%
	Machinery, electrical & optical equipment	425,000	68,000	16.0%
	Transport equipment	240,000	42,000	17.5%

29.4.2 Other manufacturing

Table 29.6 shows that, in other manufacturing sectors, there is also an overall decline in numbers forecast for 2007–17 (with the exception of managers/senior officials and associated professionals). However, as in engineering manufacture, replacement demand levels are predicted to lead to a significant need for recruitment. In total, over 400,000 new employees are likely to be needed in key occupational areas: 29% of the workforce.

The largest single recruitment need is predicted to be for managers and senior officials, with a total of 115,000 (39% of total estimated employment for this area) needed by 2017. Of these, 35,000 (39%) are needed in the wood, pulp & paper and publishing sector, 32,000 (46%) in food, drink and tobacco and 26,000 (33%) in chemicals & other non-metallic mineral products.

There is expected to be a need for 80,000 more associated professionals, with the majority of these (44,000) needed in wood, paper pulp and publishing. In addition, a further 73,000 machine & transport operatives will be needed by 2017 – 32,000 in food, drink & tobacco – and another 64,000 people in skilled trades (26,000 in other manufacturing and recycling). A further 40,000 employees will be needed in elementary occupations (22% of total employment) and 36,000 in professional occupations (35%).

Table 29.6: Other manufacturing – summary of requirements by occupation and sector (2017) – UK

Occupation	Sector	Employment 2017	Total requirement	Requirement as % of 2017 employment
Managers & senior officials				
	Other manufacturing	296,000	115,000	39%
	Chemicals & other non-metallic mineral prods	78,000	26,000	33%
	Wood, pulp & paper; printing & publishing	90,000	35,000	39%
	Food, drink & tobacco	70,000	32,000	46%
	Textiles & clothing	23,000	7,000	30%
	Other manufacturing & recycling	35,000	15,000	43%
Professional occupations				
	Other manufacturing	104,000	36,000	35%
	Chemicals & other non-metallic mineral prods	43,000	12,000	28%
	Wood, pulp & paper; printing & publishing	26,000	10,000	38%
	Food, drink & tobacco	21,000	9,000	43%
	Textiles & clothing	4,000	1,000	25%
	Other manufacturing & recycling	10,000	4,000	40%
Associate professionals & technical occupations				
	Other manufacturing	224,000	80,000	36%
	Chemicals & other non-metallic mineral prods	53,000	13,000	25%
	Wood, pulp & paper; printing & publishing	104,000	44,000	42%
	Food, drink & tobacco	38,000	13,000	34%
	Textiles & clothing	11,000	2,000	18%
	Other manufacturing & recycling	18,000	8,000	44%
Skilled trades occupations				
	Other manufacturing	286,000	64,000	22%
	Chemicals & other non-metallic mineral prods	63,000	10,000	16%
	Wood, pulp & paper; printing & publishing	85,000	16,000	19%
	Food, drink & tobacco	53,000	11,000	21%
	Textiles & clothing	13,000	1,000	8%
	Other manufacturing & recycling	72,000	26,000	36%
Machine & transport operatives				
	Other manufacturing	331,000	73,000	22%
	Chemicals & other non-metallic mineral prods	106,000	19,000	18%
	Wood, pulp & paper; printing & publishing	64,000	13,000	20%
	Food, drink & tobacco	101,000	32,000	32%
	Textiles & clothing	23,000	-2,000	-9%
	Other manufacturing & recycling	37,000	11,000	30%
Elementary occupations				
	Other manufacturing	186,000	40,000	22%
	Chemicals & other non-metallic mineral prods	55,000	8,000	15%
	Wood, pulp & paper; printing & publishing	37,000	8,000	22%
	Food, drink & tobacco	64,000	19,000	30%
	Textiles & clothing	12,000	0	0%
	Other manufacturing & recycling	18,000	5,000	28%
All 'key' occupations				
	Other manufacturing	1,427,000	408,000	28.6%
	Chemicals & other non-metallic mineral prods	398,000	88,000	22.1%
	Wood, pulp & paper; printing & publishing	406,000	126,000	31.0%
	Food, drink & tobacco	347,000	116,000	33.4%
	Textiles & clothing	86,000	9,000	10.5%
	Other manufacturing & recycling	190,000	69,000	36.3%

29.4.3 Construction

The construction industry will need a very large recruitment effort to meet a predicted overall demand of 816,000 employees in the key occupations (42% of estimated total employment for 2017). The largest individual occupational requirement is for 389,000 people (35%) with skilled trades. A further 169,000 managers and senior officials will be needed – accounting for 47% of total employment in the sector.

29.4.4 Mining & quarrying; electricity, gas, water

Of the predicted 2017 employment of 113,000 in key occupations in mining & quarrying, electricity gas and water, 21,000 (19%) will need to be recruited, mostly at higher occupational levels. The greatest recruitment will be needed for managers and senior officials (6,000 or 29% of the workforce), professional occupations (4,000 or 22%) and associate professionals (4,000 or 25%).

29.4.5 Other industries

For the purposes of this summary, four other industries have been considered because they may need engineers with skill sets similar to those in manufacturing, construction and mining. The only sector here which is expecting an increase in employment in the key occupational areas by 2017 is transport. Professional services and sale & maintenance of motor vehicles are expected to remain fairly steady, while communications will see a fall in numbers.

Transport is the largest sector and requires a total of 366,000 people by 2017: 124,000 of these will be machine & transport operatives and 83,000 managers and senior officials. Of the 214,000 needed in professional services, 62,000 will be senior officials/managers, 55,000 associate professionals and 48,000 in professional occupations.

Of these four, the sector with the highest *proportional* requirement by 2017 is professional services – at 35%. This is closely followed by transport (34%) and sale & maintenance of motor vehicles (33%).

Part 3 Engineering in Employment
30.0 Focus on aerospace

The Aerospace Skills Roadmap

Elizabeth Donnelly, Project Manager – Skills A|D|S

A|D|S is the trade organisation advancing UK AeroSpace, Defence and Security industries with Farnborough International Limited as a wholly-owned subsidiary. A|D|S also encompasses the British Aviation Group (BAG). It is formed from the merger of the Association of Police and Public Security Suppliers (APPSS), the Defence Manufacturers Association (DMA) and the Society of British Aerospace Companies (SBAC). For more information see www.adsgroup.org.uk. Together with its regional partners, A|D|S represents over 2,600 companies. A|D|S is also proud to support Sustainable Aviation, the Defence Industries Council, RISC, Flying Matters and host the Aerospace & Defence Knowledge Transfer Network.

Introduction

Like many other engineering industries, the aerospace sector is suffering from a severe shortage of graduates and school-leavers with the qualifications suitable for the industry.

Over the next 20 years, the UK aerospace & defence industry is set to retire close to 60% of its workforce, or on average 3% p.a. At the same time the number of science, technology, engineering & maths (STEM) students is forecast to decline by 15%, in line with the same decline in the number of 18-year-olds over the same period. UCAS figures show that university applications for STEM subjects declined by 11.7% between 2001 and 2008. Until a recent upturn between 2005 and 2008, the number of students accepted onto STEM courses at university also declined by 8.1%.[238] This equals a massive loss in experience and a need to increase recruitment by 74%.[239]

Semta, the sector skills council responsible for aerospace, commissioned a survey in 2006–7 which judged the existing skills shortages in the industry to be as illustrated in Table 30.0.[240]

Table 30.0: Skills shortages in aerospace industry

Occupations	Total Shortages %	Aerospace Shortages %
Managers and senior officials	5	19
Professional occupations	10	14
Associate professional and technical	8	28
Administrative and secretarial	4	3
Skilled trades	48	24
Sales and customer service	0	0
Process, plant and machine operatives	3	0
Elementary occupations	20	15

238 The Royal Society, *A degree of concern? UK first degrees in science, technology and mathematics* 2006

239 National Statistics, SBAC data, Roland Berger Strategy Consultants

240 Semta, *2006 Labour Market Survey of the GB Engineering Sectors*, April 2007

The aerospace industry has identified the key technologies that it expects to emerge from research and development programmes over the next 15 years in Technology Roadmaps. To ensure that the requisite skills will be available when they are needed, A|D|S has begun the process of building a series of Skills Roadmaps to identify the skills required to match the technology.

Methodology

During the summer of 2008 A|D|S's People Management Board held a series of focus groups from among its member companies to determine the broad areas where there were skills shortages. These groups identified four areas of need: leadership and management skills, technical skills, supply chain management, manufacturing and procurement and skills for the aftermarket, including Total Life Cycle Management (TLCM).

In addition, the focus groups realised that a recognisable pipeline was needed so that industry could support key initiatives to encourage young people into aerospace. To this end, a fifth roadmap for Careers in Aerospace and Defence was created.

Overview Roadmap

The Overview Roadmap is a summary of the five detailed roadmaps. It also contains the Strategic Workforce Planning tool that underpins the whole project. This key tool, developed by the National Skills Academy for Manufacturing, helps aerospace companies put in place processes to identify their current and future skills needs. Work is continuing with regional aerospace alliances to encourage their members to make use of Strategic Workforce Planning.

The Overview Roadmap contains the headlines from each of the detailed roadmaps, so that the overall aerospace skills demand can be seen at a glance.

Leadership & Management Roadmap

One of the key areas of skills demand identified by the industry is that of leadership and management. In recent years the aerospace industry has adopted new management techniques as a way of reducing costs and increasing productivity. Moving from an engineering role to managing change can prove challenging and the roadmap will identify the best way of managing this process as well as identifying other management requirements.

Technical Skills Roadmap

Following the focus group meetings that set the scope of the roadmap, the technical skills section was further divided into five areas that were aligned to the technology roadmaps. These five areas are: Airframes, with Airbus leading; Autonomous Systems led by BAE Systems; Engines led by Rolls-Royce; Equipment with GE/Smiths heading up several equipment manufacturers; and Rotorcraft headed by AgustaWestland.

A|D|S aimed to create a template within one of the areas that could be adapted for each technology stream. Each skills area could then be compared with the others to indicate progress. This approach was accepted as being the most appropriate way to tackle the subject. After consultation with Airbus UK, A|D|S adapted its Key Competencies framework to fit the Skills Roadmap and identify the future skills needs for Airframes. This template will then be adapted for each of the other technical areas.

Supply Chain Roadmap

SC21 is an industry change programme designed to accelerate the competitiveness of the aerospace and defence industry by raising the performance of its supply chains. The SC21 Roadmap will detail the skills required to manage the supply chain. In addition, the specific skills required to enhance the performance of suppliers in terms of manufacturing and procurement will be identified.

Aftermarket Roadmap

Aerospace has been changing as an industry. Airlines are more likely to sign a contract to lease planes under service agreements than to buy a plane outright. This has immense benefits for the manufacturers because they know where a large proportion of their future income is coming from. The airlines benefit from having service-ready aircraft at all times and from receiving the latest technological updates as they become available rather than having to wait until their next purchase.

The Aftermarket Roadmap will identify the skills required to maintain, repair and overhaul (MR&O) aircraft throughout the lifetime of the plane or helicopter. Aircraft entering service now are likely to still be flying in 40 years' time. Total Life Cycle Management (TLCM) refers to the need to ensure that there will be skills in the future to maintain and repair current aircraft as they get older. As engineers and technicians focus on future developments in aerospace, the Aftermarket Roadmap will ensure that the demand for aircraft maintenance and repair personnel for ageing aircraft is not forgotten.

Careers in Aerospace and Defence Roadmap

The objective of the Careers in Aerospace and Defence Roadmap is to create a clear skills pipeline from Primary to PhD. In its desire to encourage young people into engineering, the engineering sector has created a plethora of initiatives that now clutter the landscape. A|D|S decided to identify and apply coherent engineering projects that are specifically applicable to aerospace. In addition, A|D|S and the Royal Aeronautical Society are collaborating on a *Careers in Aerospace* website to supply information for anyone who is interested in working in the sector, whether they are just starting out as an apprentice, or whether they are a senior engineer looking for the next step on the career ladder.

The Primary Engineer programme is aligned to the National Curriculum and delivered in the classroom during an ordinary school day. This ensures that it's not just the gifted children or the ones who attend the after-school clubs that are exposed to engineering. The initiative is aimed at 5–11-year-olds and introduces the whole class to basic concepts, and culminates with an annual final competition to build a wheeled vehicle.

The Secondary and Advanced Engineer Leaders' Award follows on directly from Primary Engineer and encourages young people to become ambassadors for their school, supporting the learning of others. The students must also interview a scientist, engineer, technologist or mathematician for the award.

The new 14–19 Engineering Diploma combines practical application with academic knowledge and is intended to appeal to all abilities, from apprentices to research academics. A|D|S is ambitious that the Engineering Diploma becomes the "qualification of choice" for aspiring engineering undergraduates.

The Apprenticeship programme is a vital part of the skills needed by the aerospace industry. Many top managers started out as apprentices and aerospace apprentices often get the opportunity to move into further and higher education.

There are a number of successful aerospace engineering degrees which are accredited by the Royal Aeronautical Society for Chartered Engineer status. A|D|S wants to encourage all aerospace graduates to pursue CEng status. Students should also be encouraged to study for an MEng in mechanical engineering, or for an MSc in maths or physics. Many undergraduates then work as interns for aerospace companies during their vacation which gives them an insight to the working of the industry. A|D|S wants to encourage more undergraduates to choose internships and undergraduate placements.

Postgraduates can then enter the industry proper, or pursue more aerospace research by studying for a PhD. Nearly all aerospace doctorates are linked to an industrial application and aerospace companies see this as a way of accessing cutting-edge research.

Finally, A|D|S is about to establish a Defence Graduate Forum which will encourage those on graduate placements in defence companies to work together to support the forces and encourage others into the industry. These future leaders will make indispensable contacts via the Graduate Forum as well as gaining a valuable insight into the sector.

Conclusion

In conclusion, the Skills Roadmap is a living tool which will develop as circumstances change. As the roadmap develops we will be able to understand which skills will be needed and when action should be taken to ensure that the skills needs are met. The roadmap is designed to support the aerospace industry and its effective use should see a significant reduction in the skills gaps in the sector.

Part 3 Engineering in Employment
31.0 Focus on manufacturing

Manufacturing. Our future.

EEF

2009 has turned out to be one of the most difficult years for manufacturing in recent memory. The synchronised downturn across the world economy, combined with credit constraints caused by the turmoil in global financial markets, hit manufacturers hard. However, the turbulent times our economy has experienced and our reliance on financial services, cheap credit and public spending to drive a narrow and, largely, illusory decade of growth, have refocused attention on the importance of striking a better balance in our economy. And manufacturing needs to be part of that process.

Now that the effects of the economic crisis have begun to subside, we must come to terms with the fact that higher borrowing costs and greater financial market regulation will confine a decade of debt and public sector largesse to the history books. A return to pre-recession growth is likely to be a little way off just yet, but even then it is extremely difficult to see how the UK can return to business as usual. The question now is how the UK begins to build a better, more diverse economy.

And for a diverse economy to thrive it is vital that manufacturing makes a greater contribution to growth. Manufacturers must, therefore, continue to evolve, adapt and grow. UK manufacturers have improved their competitiveness, productivity and global reach. They responded to the recession at the beginning of this decade, to an uncompetitive exchange rate and to the emergence of new low cost producers with a significant shift in their business strategies.

UK manufacturers no longer compete on price or volume, focusing instead on a broad range of value-adding strategies. They have found their niche in global markets and differentiated themselves through a combination of innovation and design, production capacity, flexibility and customer service. IT solutions and lean manufacturing techniques have supported companies in driving up performance and efficiency. And significant investments in knowledge – whether wrapped in the metal of modern machinery or embodied in employee expertise – have helped companies continually to add value.

Only a stronger, globally-focused and diverse economy will enable us to generate the wealth needed to correct our economic imbalances and achieve broader national prosperity. Our economic future is, therefore, inextricably linked to the development of a strong UK manufacturing base that's open to global markets, increasingly focused on knowledge and high value and capable of exploiting fast growing markets. This is what the UK needs to focus on in 2010 and beyond. Without this change to the composition of our economy, the UK is likely to grow significantly below its long-term potential.

Moreover, there are a number of significant challenges facing us and the rest of the world in the coming decade and beyond – mitigating and adapting to the effects of climate change, the ongoing trend towards globalisation, the need to meet future infrastructure and security needs, and to adapt to demographic change. UK manufacturing is potentially able to contribute many of the solutions to these future challenges and in doing so can produce the goods and services exports needed to close the trade deficit and underpin future prosperity. If we do not develop our own domestic industrial capacity, we will continue to rely on buying the solutions from somewhere else.

The focus, therefore, must shift to supporting a more diverse, agile and innovative manufacturing base. Put simply, the UK needs to focus its scarce resources and provide clear, long-term support for manufacturing in order to stimulate and encourage the production of goods and services that allow us to pay our way in the world. But this will not happen without a different approach by both manufacturers and politicians.

For companies, that means focusing on the future and evolving to become more innovative, agile and diverse. For policy makers it will require a conscious change in strategy; a long-term plan that gives manufacturers the confidence they need to invest in a better balanced economy. Government influences market outcomes on a daily basis, through taxation and regulation and as a customer and investor. A new framework for the economy will see Government recognising this influence and being clear about what kind of economy the UK needs and what Government will do to support that shift.

Framework for the future

EEF has set out what it sees as the key principles that should underpin such a framework.

Send signals: New and developing markets are potentially more uncertain and volatile. Companies investing in these markets will look for business environments with the least political risk and highest expected return on investments. Businesses therefore need a clear signal about the Government's long term priorities. Only then will manufacturers have the confidence to invest. Government must signal the importance attached to specific technologies, markets or investments and the steps it will take to help them succeed.

Overcome obstacles: A critical part of acting before markets fail lies in identifying and addressing the obstacles to developing new markets, or significantly scaling up existing ones. Government must work with business to identify and overcome obstacles to the growth of new and developing markets, for example skills shortages, infrastructure requirements or bottlenecks in the planning system.

Be a collaborative customer: Government is a major customer for business. Its £175 billion budget offers significant purchasing power in new and emerging markets if deployed effectively. But Government must engage more closely with industry to convey its needs and support innovation in these areas. This will require significant culture change if the public sector is to focus on long-term value for the economy rather than short-term cost savings.

Target investment: Manufacturers could not succeed in competitive markets unless they prioritised investments based on a clear and consistent strategy. The same rule applies to economies. Government invests in markets directly and also in areas such as skills and innovation that support these markets. With the squeeze on public spending set to tighten, the Government must be bold and strategic in its investment decisions. This approach will require it to become better at balancing risk and communicating its decisions against a set of clearly understood criteria.

The absence of such an approach in the past has, on some occasions, allowed other countries to steal a march on UK manufacturers where they potentially had a competitive advantage. For example, Denmark, Spain and Germany have all edged ahead of the UK in the onshore wind industry, despite our geographical advantages and the leading role we have played in research in this area. Where the UK has relied on volatile price signals, our competitors adopted more predictable, long-term support which reduces the risk of investing in emerging renewable technologies.

Equally, where the UK has sent strong signals and has worked with industry to identify the obstacles to developing industrial capability in the UK, there has been a degree of success – the nuclear industry being a case in point. In January 2008, after a decade of reviews, Government gave a clear steer on the importance of nuclear in the UK's future energy mix and took practical steps – from planning reforms to defining responsibility for waste – to encourage investment in new nuclear capacity in the UK.

A new framework for industry will only achieve its goals if it is embedded in the Government's DNA. Business currently receives a confused message, because government policy often seems to be pulling in different directions. This will require more policy consistency across departments, and closer cooperation between departments and at all levels of Government.

In addition, UK manufacturers also need a competitive business environment that promotes investment. Modern manufacturing is global in its outlook and the UK's business environment plays a key role in investment decisions. Top amongst manufacturers' wish list for further progress are:

- A stable, predictable and internationally-competitive tax system that allows manufacturers to invest in modern machinery and finance operations abroad
- A simpler, demand-led skills system, where funding follows the individual learner and where providers are incentivised to respond to the demands of employees and students
- A system of regulatory budgets which place a value on the cost of regulation and allow Government to be held to account on the red-tape it imposes on business
- Long term investment in transport systems and the energy infrastructure
- Flexibility in the UK's labour markets protected by Government and ideally enhanced

Manufacturers have survived turbulent times in the past and are positioning themselves to thrive in the future. But just like manufacturing at the start of this decade, the UK economy sits at a crossroads. We can either keep our fingers crossed and hope that the economy will return to business as usual or we can learn from the lessons of the past ten years and take action to create a more dynamic, diverse and durable economic base. Both manufacturers and politicians will need to take decisive action to restore our economic competitiveness in the future.

Part 3 Engineering in Employment
32.0 Focus on nuclear

The renaissance of the nuclear industry

Dr S E Ion and Mr C Smith, The Nuclear Institute

In the Western developed world, for the first time in a generation, energy has become a critical factor for social and economic welfare and for the citizens of Europe and the UK in particular.

Globally there are over 440 nuclear power plant (NPP) units with a collective output of 370GWe[241] providing 18% of world electricity. (In Europe nuclear power produces 32% of our electricity). There are currently 28 plants under construction.

The majority of reactors worldwide are so-called 2nd and 3rd generation Light Water Reactors (LWRs). Over 250 of the world's current units have been in operation for more than 20 years and over 80 for more than 30 years. In terms of distribution internationally, Figure 32.0 shows which countries have the most systems in terms of absolute numbers and as a proportion of their electricity generating system. With over 100 plants yielding 20% of their electricity, the US has most. France has 58 plants yielding around 80%.

241 Gigawatt Electrical

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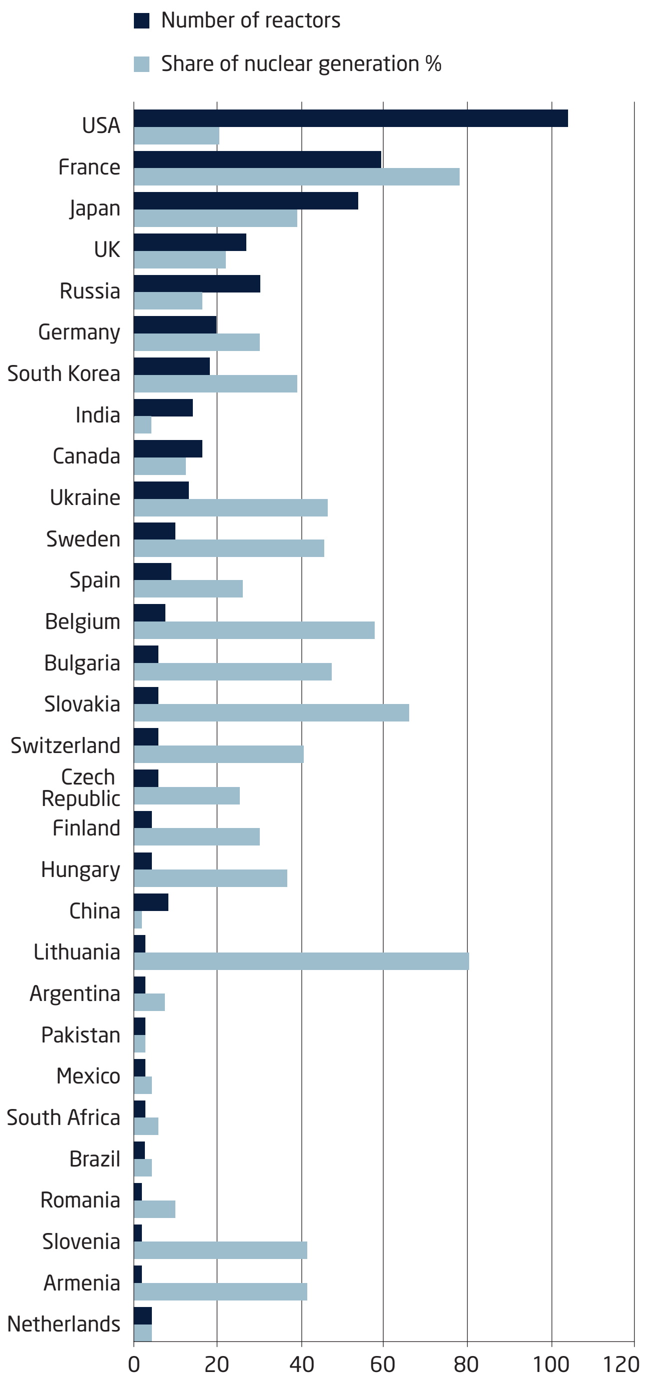
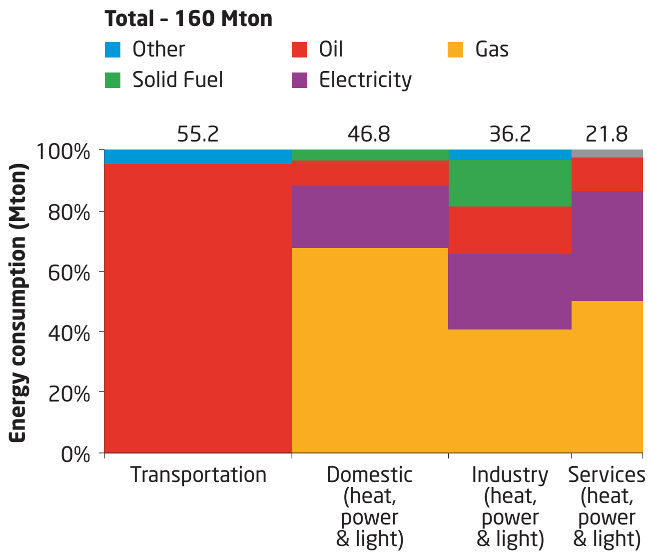
Fig. 32.0: Nuclear share of electricity generation



In the UK, around 15–17% of our electricity is currently provided from nuclear generating plants. At its peak in the early '90s, before our older systems were retired and when demand was slightly lower, NPP provided 30% of UK electric power.

If we are to decarbonise our energy demand, then the measures needed to reduce dependency on fossil fuels in transport and in use of gas in our homes will inevitably result in a massive increase in current demand for electricity (shown in Figure 32.1). This will need to be generated from low carbon sources. Otherwise, all we will do is move emissions from roads and homes into a new fleet of CO_2 emitting power stations.

Fig. 32.1: Breakdown of UK energy demand



Implications for 50% cut in CO_2 emissions by 2050?

Furthermore, unless we do more than replace our existing nuclear fleet, we will not deliver on carbon targets. Even with a massive uplift in deployment of renewables, we will struggle to stand still – even with replacement nuclear power plants.

Perhaps more important than the fact that we are at risk of failing to meet carbon targets as our nuclear plants retire is the growing concern for security of supply.

Internationally, the prospects for a significant and growing contribution of nuclear-generated electricity have grown significantly over the past decade. This has been driven by increasing confidence in the sector's ability to deliver safe, secure, economically-competitive systems internationally, built broadly to time and cost when using standardised designs. Important factors have included:

- Massive consolidation across the sector together with widespread deployment of units with a common genesis. (The original French fleet was, of course, based on Westinghouse Electric Corporation (WEC) technology)
- Enhanced safety delivered in quite different ways depending upon the design
- Much greater influence of designing for constructability, ease of deployment and for ease of long term waste management and decommissioning at both concept and detail phases of design and delivery
- Much greater reliability and hence availability and load factor: today's utilities expect – and get – percentages in the high 80s to low 90s as a matter of routine
- Much greater awareness of effective risk management in execution of major projects internationally, (although there is still some way to go here – especially in delivering 'first in country' projects)

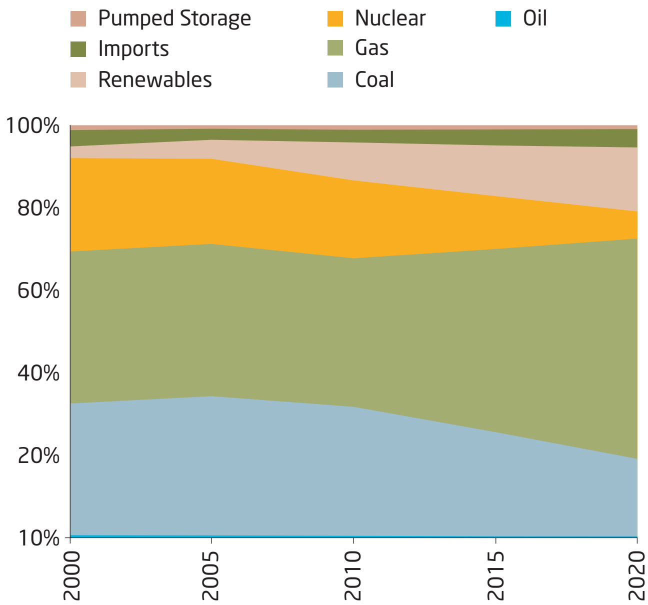
Those countries with existing nuclear power plants are seeking to upgrade and extend the life of what they now view as valuable energy assets. Many are planning for significant expansion of their fleets. The 'nuclear renaissance' is pretty much underway in every corner of the globe.

How can we be confident that the systems proposed going forward will deliver the goods?

The sector has learned lessons from the early days, when there was a multiplicity of designs. Successful NPPs in Korea, Japan and France, in particular, are testaments to fleet build and standardisation of design. This has three effects: reduced time to market, improved investor and government confidence and much improved operations through economies of scale and learning from experience. The international vendors have been rigorous in their determination to standardise designs and reap benefits from economies of scale, modularisation and a global supply chain.

The last year has seen a major change in attitudes to nuclear energy. The twin challenges of climate change and security of energy supply have led to a major rethink and the Government now recognises it as being vital for the UK's long term security and prosperity. Without new nuclear build, the UK would need to have a greater dependency on fossil fuel plants for baseload, which would not assist in delivering the low carbon strategy or providing security of supply.

Fig. 32.2: Trends in energy sources in UK electricity make up



The UK regulator has started to assess internationally-available designs as part of a formal precursor to deployment. But it is actions taken by the international utilities companies – who have a significant interest in our own power generation sector – that give the most important signals of intent to deploy or get ready to deploy new NPP in the UK. Given that there are no government subsidies, this should tell you a great deal about the utility industry's views on the relative long-term competitiveness of NPP compared with other forms of large scale power generation.

EDF bought BE and with it the key sites at Hinkley Point and Sizewell, declaring its intention to deploy four Areva-designed and supplied European Pressurised Water Reactor EPRs – two at each site. RWE and E-ON struck up a strategic partnership to pursue the other key sites being auctioned by the Nuclear Decommissioning Agency and EDF as part of the BE deal. Suez, Iberdrola, Scottish and Southern and Vattenfall have similarly maintained an interest in the UK for future projects, to enhance their knowledge and skill base in the systems likely to form the bulk of international projects deployed in the coming two decades.

Of the four international designs originally in the frame, only two remain in the UK's Generic Design Assessment process: the Areva EPR and the WEC AP1000. It is pretty certain that we will see both systems deployed here in the UK as part of global fleets.

The biggest challenges ahead relate to bottlenecks in the global supply chain which may be slow to respond to the new demands and where the UK is 'down the queue' because we have been late in firming up real orders. Human Resources will also be a challenge as there are likely to be shortages as utilities, vendors, regulators and the local supply chain all try and recruit from a pool of talent which has been somewhat neglected for two decades.

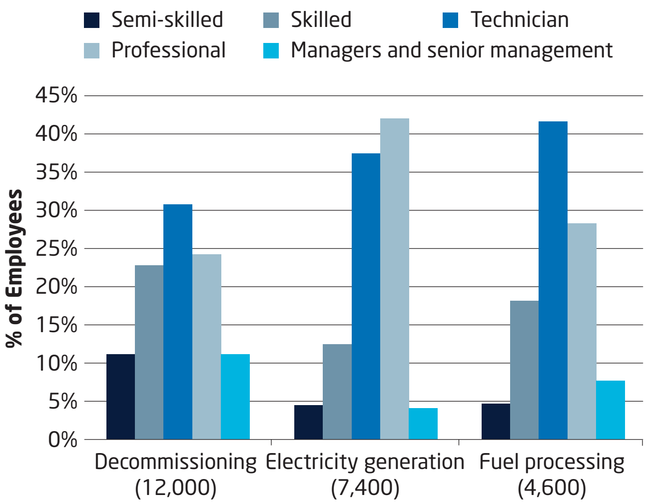
On the skills side, steps have been taken with the licensing of Cogent as the Sector Skills Council to represent the nuclear industry, and the creation of the National Skills Academy for Nuclear. Significant initiatives have been taken by our key universities. Good examples of these are the University of Manchester which, through its Dalton Institute, has taken the lead to drive forward the Nuclear Technology Education Consortium; Imperial College, which has built modules into its mainstream science and engineering courses at undergraduate and masters levels; and the University of Central Lancashire, which is developing programmes to directly support employers. Other universities are planning to include nuclear modules within their undergraduate science and engineering degrees. The new-build agenda has also impacted on proven courses such as the University of Birmingham's MSc in physics and technology of nuclear reactors, which is attracting record numbers of students. Foundation degree courses in nuclear engineering are being established and the National Skills Academy for Nuclear's quality-assured training provider network is gearing up to meet the challenges ahead.

Engineering and Physical Sciences Research Council (EPSRC) has provided research support through initiatives such as Keeping the Nuclear Option Open (KNOO). A start has been made but much more needs to be done. The issue is not just about nuclear engineers per se but rather about the supply of significant numbers of high quality domestic UK engineering graduates and technicians across all disciplines who might be attracted to the nuclear sector and spend the bulk of a 40-year career there.

Currently, the nuclear workforce in the electricity generation, decommissioning and fuel processing sectors is estimated at 44,000, with around 45% of these being in the supply chain.[242] In addition, there are approximately 12,000 personnel involved with defence programmes. Of these, more than 40% are engineering and scientific staff. Not surprisingly, the skill levels are high (Figure 32.3), with the main segments of the industry peaking at a skill level equating to technician and graduate/professional.

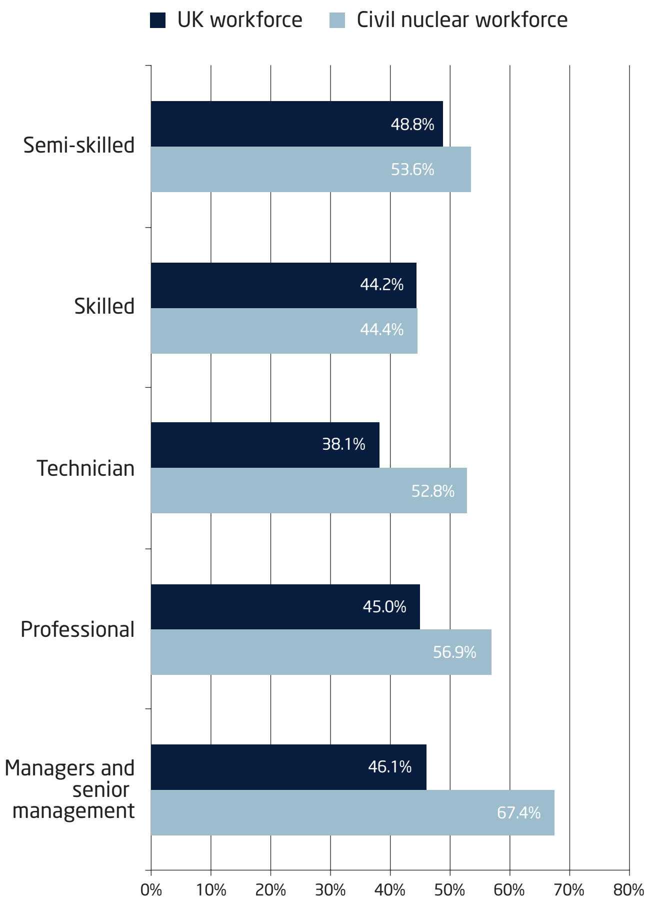
242 Cogent Nuclear Industry Labour Market Intelligence http://www.cogent-ssc.com/research/nuclearresearch.php

Fig. 32.3: Skill level of civil nuclear workforce – excluding supply chain (2009)



The over-riding factor leading to a loss of skills in the nuclear industry is retirement. The civil nuclear workforce is older than the general UK workforce and, in places, significantly older, with a younger retirement profile. As expected, the retirement projections are most severe for the more experienced personnel (Figure 32.4). A long-term commitment to succession planning is therefore needed, along with robust training and attraction mechanisms to retain the required levels of suitably qualified and experienced personnel.

Fig. 32.4: Comparison of total retirement by skill level by 2025



The first new-build nuclear power station will not come into operation until late 2017 at the earliest, with recruitment for training and commissioning of staff around early 2015. The realisable new-build scenarios show a drop in the number of personnel involved in electricity production in the short term, as the remaining Magnox plants and the Advanced Gas Reactors shut down. In the medium term, this will result in a build up of staff involved in decommissioning, while fuel processing numbers contract.

Overall, the attrition due to retirement and the changing shape of the industry will require recruitment of up to 8,000 new people in the operating workforce between now and 2025. Allowing for the direct supply chain, this requirement is estimated to be around 14,000, assuming the ratio of supply chain to operating workforce remains as currently calculated. This equates to around 1,000 new recruits per year. These will be mainly apprentices or graduates, although the attraction of new nuclear build could draw experienced staff from other sectors.

Skills planning is therefore an essential part of the future success of the industry. Employers must continue to invest in skills, not only to ensure that the UK nuclear sector remains viable but also to realise returns on that investment from the global nuclear market.

UK jobs potential

- Around 80% of nuclear new build work is conventional construction, no-nuclear
- UK industry could supply 70–80% of the value of a UK nuclear programme
- Less than 5% of current UK construction resources will be required
- With careful management, the necessary resources can be recruited and trained in time
- UK new fleet build can be a springboard for UK companies in the global supply chain

Source: The UK Capability to Deliver a New Nuclear Build Programme – 2008 Update. NiA, 28 April 2008

The UK could reap very significant benefits from a new-build programme. Estimates have shown that a fleet of new reactors would be worth £30 billion to the UK economy. This is because, although the designs may have been developed overseas, there are massive opportunities for UK-based companies to become part of the growing global supply chain. Some companies are already active internationally, supplying engineering and components to new-build programmes in Finland, China and South Africa. Fleet build in the UK could regenerate heavy manufacturing industry and provide the springboard for significant exports in the future.

Engineering UK 2009/10
33.0 Annex

33.1 QCF, NVQs and NOS

The Qualification and Credit Framework (QCF) went live in September 2008 and should be fully implemented by September 2010. It includes new operating rules for NVQ 'type' qualifications. These are set out in *Operating rules for using the term 'NVQ' in a QCF qualification title* (Ofqual Aug 2008)[243] (in future NVQ will only appear as a bracketed title).

Meanwhile, there has been much activity by SSCs in updating and rationalising their National Occupational Standards (NOS) – upon which, for example, NVQs must be solely based. However, not all SSCs have slimmed down yet. The UK Commission for Employment and Skills (UKCES) has carried out a review of NOS. It has also been overseeing relicensing of the SSCs.

Level descriptors (QCF)

The QCF level descriptors to which all qualifications and units accredited into the QCF must conform may provide a helpful tool in the future. The level descriptors are, strictly speaking, a guideline for practitioners involved in the design and delivery of qualification units. However, QCA has helpfully stated that, "the level descriptors are concerned with the outcomes of learning and not the process of learning or the method of assessment," [QCA, 2008:2]. The QCF level 3 descriptor is shown in Table 33.0.

243 Ofqual (2008b). Operating rules for using the term 'NVQ' in a QCF qualification title: http://www.ofqual.gov.uk/1947.aspx

Table 33.0: QCF (England and Northern Ireland) level 3 descriptors[244]

Level summary	Knowledge and understanding	Application and action	Autonomy and accountability
Achievement at level 3 reflects the ability to identify and use relevant understanding, methods and skills to complete tasks and address problems that, while well defined, have a measure of complexity. It includes taking responsibility for initiating and completing tasks and procedures as well as exercising autonomy and judgment within limited parameters. It also reflects awareness of different perspectives or approaches within an area of study or work.	Use factual, procedural and theoretical understanding to complete tasks and address problems that, while well defined, may be complex and non-routine Interpret and evaluate relevant information and ideas Be aware of the nature of the area of study or work Have awareness of different perspectives or approaches within the area of study or work	Address problems that, while well defined, may be complex and non-routine Identify, select and use appropriate skills, methods and procedures Use appropriate investigation to inform actions Review how effective methods and actions have been	Take responsibility for initiating and completing tasks and procedures, including, where relevant, responsibility for supervising or guiding others Exercise autonomy and judgment within limited parameters

244 QCDA (2008). Level descriptors for the QCF – Version 3. http://www.qca.org.uk/qca_20252.aspx

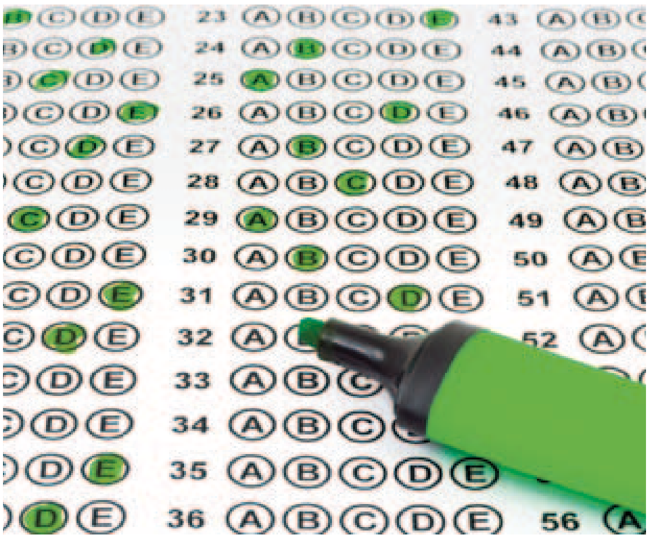
Credit

Credit in the QCF includes some notion of time-serving which is a little problematic if focus is on outcomes. However, all new units developed for the QCF must have a credit level and credit value and learners will be able to accumulate and transfer credit. The level signifies the level of challenge or difficulty. The value indicates the amount of 'notional' learning time required, on average, for a learner to achieve a unit. One credit = 10 notional learning hours.

Notional learning is different to the Guided Learning Hours (GLH) figure currently used with NQF qualifications. As with GLH, it includes activities that learners need to do while supervised in order to complete their qualification, such as:

- Classes
- Tutorials
- Practical work
- Assessments

In addition to these, however, notional learning time includes non-supervised activities such as homework, independent research, unsupervised rehearsals and work experience.[245]



245 NCFE (2009). Qualifications and Credit Framework (QCF) FAQs. www.ncfe.org.uk/download/Downloads/QCF%20FAQs%206%202%2009.doc

33.2 Glossary of Terms

Table 33.1: List of acronyms

ABI	Annual Business Inquiry	http://www.statistics.gov.uk/abi/
ALP	Association of Learning Providers	http://www.learningproviders.org.uk/
API	Age Participation Index	
ASHE	Annual Survey of Hours and Earning	
ASSCs	Alliance of Sector Skills Councils	http://www.sscalliance.org/
BERR	Department for Business, Enterprise and Regulatory Reform (England)	http://www.berr.gov.uk/
CBI	Confederation of British Industry	http://www.cbi.gov.uk/
CEM	Curriculum, Evaluation and Management	http://www.cemcentre.org/
CIE	Cambridge International Examinations	http://www.cie.org.uk/
DBIS	Department of Business, Innovation and Skills	
DCELLS	Department for Children, Education, Lifelong Learning and Skills (Wales)	http://new.wales.gov.uk/
DCSF	Department for Children, Schools and Families (England)	http://www.dcsf.gov.uk/
DEFRA	Department for Environment, Food and Rural Affairs	http://www.defra.gov.uk/
DELNI	Department for Employment and Learning Northern Ireland	http://www.delni.gov.uk/
DENI	Department of Education Northern Ireland	http://www.deni.gov.uk/
DIUS	Department for Innovation, Universities & Skills (England)	http://www.dius.gov.uk/
DWP	Department for Work and Pensions	http://www.dwp.gov.uk/
E&T	Engineering and Technology	
ECITB	Engineering Construction Industry Training Board	http://www.ecitb.org.uk/
EEA	European Economic Area	
EEBM	Engineers and Engineering Brand Monitor	
EPR	European Pressurised Water Reactor	
EPSRC	Engineering and Physical Sciences Research Council	www.epsrc.ac.uk/
EQF	European Qualifications Framework for Lifelong Learning	
FE	Further Education	
FEANI	European Federation of National Engineering Associations	
FMA	Foundation Modern Apprenticeship	
FSB	Federation of Small Businesses	http://www.fsb.org.uk/
FSS	Futureskills Scotland	http://www.futureskillsscotland.org.uk/
FSW	Futureskills Wales	http://www.learningobservatory.com/
GAD	Government Actuary's Department	http://www.gad.gov.uk/
GB	Great Britain (England, Wales and Scotland)	
GCSE	General Certificate of Secondary Education	

HE	Higher Education	
HEFCE	High Education Funding Council for England	http://www.hefce.ac.uk/
HEFCW	High Education Funding Council for Wales	http://www.hefcw.ac.uk/
HEI	Higher Education Institution	
HESA	Higher Education Statistics Authority	http://www.hesa.ac.uk/
HESCU	Higher Education Careers Service Unit	http://www.hecsu.ac.uk/
HIE	Highland and Islands Enterprise	http://www.hie.co.uk/
HK	Hong Kong	
HTF(V)	Hard-to-Fill Vacancy	
ICE	Institution of Civil Engineers	http://www.ice.org.uk/
IDBR	Inter-Departmental Business Register	http://www.statistics.gov.uk/idbr/idbr.asp
IGCSE	International General Certificate of Secondary Education	http://www.cie.org.uk/
JCQ	Joint Council for Qualifications	http://www.jcq.org.uk/
KNOO	Keeping the Nuclear Option Open	
LFS	Labour Force Survey	
LLWR	Lifelong Learning Wales Record	
LSC	Learning and Skills Council (England)	http://www.lsc.gov.uk/
MA	Modern Apprenticeship	
MAC	Migration Advisory Committee	http://ukba.homeoffice.gov.uk/
NAO	National Audit Office	http://www.nao.org.uk/
NEET	Not in Education, Employment or Training	
NES	National Employers Service	http://nes.lsc.gov.uk/
OECD	Organisation for Economic Co-operation and Development	http://www.oecd.org/
OED	Oxford English Dictionary	http://www.oed.com/
Ofgem	Office for Gas, Electricity Markets	http://www.ofgem.gov.uk/
Ofsted	Office for Standards in Education, Children's Services and Skills	http://www.ofsted.gov.uk/
ONS	Office for National Statistics – UK Statistics Authority	http://www.statistics.gov.uk/
PBS	Points-Based System	
PSSSG	Power Sector Skills Strategy Group	
QCA	Qualifications and Curriculum Authority	http://www.qca.org.uk/
RAEng	Royal Academy of Engineering	http://www.raeng.org.uk/
RDP	Research-Degree Programme	
ROSE	Relevance of Science Education	
RPI	Retail Prices Index	
SASE	Specification of Apprenticeship Standards for England	
SCQF	Scottish Credit and Qualifications Framework	http://www.scqf.org.uk/
SDS	Skills Development Scotland	http://www.skillsdevelopmentscotland.co.uk/

Semta	Science, Engineering, Manufacturing Technologies Alliance	http://www.semta.org.uk/
SEn	Scottish Enterprise	http://www.scottish-enterprise.com/
SET	Science, Engineering and Technology	
SFC	Scottish Funding Council (Further and Higher Education)	http://www.sfc.ac.uk/
SIC	Standard Industrial Classification	
SKOPE	Centre on Skills, Knowledge and Organisational Performance	http://www.skope.ox.ac.uk/
SOC	Standard Occupational Classification	
SOL	Shortage Occupation List	
SSC	Sector Skills Council	http://www.sscalliance.org/
SSV	Skills Shortage Vacancy	
SQA	Scottish Qualifications Authority	http://www.sqa.org.uk/
SQS	Sector Qualification Strategy	
SSDA	Sector Skills Development Agency	http://www.ukces.org.uk/
STEM	Science, Technology, Engineering and Mathematics	
TSB	Technology Strategy Board	http://www.innovateuk.org/
UOAs	Units of Assessment	
UCAS	Universities and Colleges Admissions Service	http://www.ucas.ac.uk/
UK	United Kingdom of Great Britain and Northern Ireland	
UKCES	United Kingdom Commission for Employment and Skills	http://www.ukces.org.uk/
UKVQRP	UK Vocational Qualifications Reform Programme	
UoC	University of Cambridge	http://www.cam.ac.uk/
UUK	Universities UK	http://www.universitiesuk.ac.uk/
WAG	Welsh Assembly Government	http://new.wales.gov.uk/
WEC	Westinghouse Electric Corporation	http://www.westinghouse.com/
WBL	Work-Based Learning	

33.3 SIC and SOC Codes

Standard Occupational Classification (SOC) Codes

The Standard Occupational Classification (SOC) was first published in 1990 to replace both the Classification of Occupations 1980 (CO80) and the Classification of Occupations and Dictionary of Occupational Titles (CODOT). SOC 1990 has been revised and updated to produce SOC 2000.

The two main concepts of the classification remain unchanged:

– kind of work performed – job

– and the competent performance of the tasks and duties – skill

Source: Office of National Statistics (ONS)

SOC Codes used with Working Futures

The analysis carried out based around Working Futures III has used the following SOC 2000 Codes at two- and three-digit levels;

a. 212 – Engineering professionals

b. 213 – ICT professionals

c. 31 – Science and technology associate professionals

d. 52 – Skilled metal and electrical trades

e. 531 – Construction trades

f. 81 – Process, plant and machine operatives

Four-digit SOC 2000 Codes – engineers and technicians

The following list of SOC codes has been used to define engineers and technicians more specifically.

1121	Production, works and maintenance managers
1122	Managers in construction
1123	Managers in mining and energy
1136	Information and communication technology managers
1137	Research and development managers
1141	Quality assurance managers
2121	Civil engineers
2122	Mechanical engineers
2123	Electrical engineers
2124	Electronics engineers
2125	Chemical engineers
2126	Design and development engineers
2127	Production and process engineers
2128	Planning and quality control engineers
2129	Engineering professionals not elsewhere classified
2131	IT strategy and planning professionals
2132	Software professionals
2433	Quantity surveyors
2434	Chartered surveyors (not quantity surveyors)
3112	Electrical/electronics technicians
3113	Engineering technicians
3114	Building and civil engineering technicians
3115	Quality assurance technicians
3121	Architectural technologists and town planning technicians
3122	Draughtspersons
3123	Building inspectors
3131	IT operations technicians
3132	IT user support technicians
3218	Medical and dental technicians
3422	Product, clothing and related designers
5211	Smiths and forge workers
5212	Moulders, core makers and die casters
5213	Sheet metal workers

5214	Metal plate workers, shipwrights and riveters
5215	Welding trades
5216	Pipe fitters
5221	Metal machining setters and setter-operators
5222	Tool makers, tool fitters and markers-out
5223	Metal working production and maintenance fitters
5224	Precision instrument makers and repairers
5231	Motor mechanics and auto engineers
5232	Vehicle body builders and repairers
5233	Auto electricians
5234	Vehicle spray painters
5241	Electricians and electrical fitters
5242	Telecommunications engineers
5243	Lines repairers and cable jointers
5244	TV, video and audio engineers
5245	Computer engineers, installation and maintenance
5249	Electrical/electronics engineers not elsewhere classified
5311	Steel erectors
5312	Bricklayers and masons
5313	Roofers, roof tilers and slaters
5314	Plumbers, heating and ventilating engineers
5315	Carpenters and joiners
5316	Glaziers, window fabricators and fitters
5319	Construction trades not elsewhere classified
5493	Pattern makers (moulds)
8111	Food, drink and tobacco process operatives
8112	Glass and ceramics process operatives
8113	Textile process operatives
8114	Chemical and related process operatives
8115	Rubber process operatives
8116	Plastics process operatives
8117	Metal making and treating process operatives
8118	Electroplaters
8119	Process operatives not elsewhere classified
8121	Paper and wood machine operatives
8122	Coal mine operatives
8123	Quarry workers and related operatives
8124	Energy plant operatives
8125	Metal working machine operatives
8126	Water and sewerage plant operatives
8129	Plant and machine operatives not elsewhere classified
8131	Assemblers (electrical products)
8132	Assemblers (vehicles and metal goods)
8133	Routine inspectors and testers
8134	Weighers, graders and sorters
8135	Tyre, exhaust and windscreen fitters
8138	Routine laboratory testers
8139	Assemblers and routine operatives not elsewhere classified
8141	Scaffolders, stagers and riggers
8142	Road construction operatives
8143	Rail construction and maintenance operatives
8149	Construction operatives not elsewhere classified

Standard Industrial Classification (SIC) Codes

The United Kingdom Standard Industrial Classification of Economic Activities (SIC) is used to classify business establishments and other standard units by the type of economic activity in which they are engaged. It provides a framework for the collection, tabulation, presentation and analysis of data and its use promotes uniformity. In addition, it can be used for administrative purposes and by non-government bodies as a convenient way of classifying industrial activities into a common structure.

Source: Office for National Statistics (ONS)

SIC 2007[246]

05 (all)	Mining of coal and lignite
06 (all)	Extraction of crude petroleum and natural gas
07 (all)	Mining of metal ores
08.1	Quarrying of stone, sand and clay
08.91	Mining of chemical and fertiliser minerals
08.93	Extraction of salt
08.99	Other mining and quarrying not elsewhere classified
09 (all)	Mining support service activities
13.96	Manufacture of other technical and industrial textiles
16.23	Manufacture of other builders' carpentry and joinery
19 (all)	Manufacture of coke and refined petroleum products
20 (all)	Manufacture of chemicals and chemical products
21 (all)	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22 (all)	Manufacture of rubber and plastic products
23 (all)	Manufacture of other non-metallic mineral products
24 (all)	Manufacture of basic metals
25 (all)	Manufacture of fabricated metal products, except machinery and equipment
26 (all)	Manufacture of computer, electronic and optical products
27 (all)	Manufacture of electrical equipment
28 (all)	Manufacture of machinery and equipment not elsewhere classified
29 (all)	Manufacture of motor vehicles, trailers and semi-trailers
30 (all)	Manufacture of other transport equipment
32.11	Striking of coins
32.30	Manufacture of sports goods
32.40	Manufacture of games and toys
32.50	Manufacture of medical and dental instruments and supplies
33 (all)	Repair and installation of machinery and equipment
35.11	Production of electricity
35.12	Transmission of electricity
35.13	Distribution of electricity
35.21	Manufacture of gas

246 These codes have been mapped back to SIC 2003.

35.22	Distribution of gaseous fuels through mains
35.30	Steam and air conditioning supply
36 (all)	Water collection, treatment and supply
37 (all)	Sewerage
38.2	Waste treatment and disposal
38.3	Materials recovery
39 (all)	Remediation activities and other waste management services
41.2	Construction of residential and non-residential buildings
42 (all)	Civil engineering
43.1	Demolition and site preparation
43.2	Electrical, plumbing and other construction installation activities
43.39	Other building completion and finishing
43.99/9	Specialised construction activities (other than scaffold erection) not elsewhere classified
45.20	Maintenance and repair of motor vehicles
49.50	Transport via pipeline
51.22	Space transport
58.21	Publishing of computer games
58.29	Other software publishing
61.90	Other telecommunications activities
62 (all)	Computer programming, consultancy and related activities
63.1	Data processing, hosting and related activities; web portals
71.12	Engineering activities and related technical consultancy
71.20	Technical testing and analysis
72.19	Other research and experimental development on natural science and engineering
74.90/1	Environmental consulting activities
74.90/2	Quantity surveying activities
80.20	Security systems service activities
95.1	Repair of computers and communication equipment
95.21	Repair of consumer electronics
95.22	Repair of household appliances and home and garden equipment

33.4 Sector Skills Council (SSC) footprints

Tables 33.2 and 33.3 lists the seven key Sector Skills Councils (SSCs) that cover the engineering and technology industry in the UK:

Table 33.2: Definition of Sector Skills Council footprint

SSC	Description	SIC 2003 Code Footprint
Cogent SSC	Chemicals and pharmaceuticals, nuclear, oil and gas, petroleum, polymers and sign making	11. 23-25 (excluding 24.3, 24.64, 24.7, 25.11, 25.12), 50.5
Construction Skills	Construction	45.1, 52.2, 45.32, 45.34, 45.4, 45.5, 74.2,
e-skills	IT, telecoms and contact centres (covering all industries as well as licensed SIC codes)	22.33, 64.2, 72, 74.86
Energy & Utility Skills	Electricity, gas, waste management and water industries	37, 40.1, 40.2, 41, 60.3, 90.01, 90.02
Proskills	Process and manufacturing of extractives, coatings, refractories, building products, paper and print.	10, 12-14, 21.24, 22.2, 24.3, 26.1, 26.26, 26.4 to 26.8
Semta	Science, engineering and manufacturing technologies	25.11, 25.12, 27 to 35, 51.52, 51.57, 73.10
SummitSkills	Building services engineering (electro-technical, heating, ventilation, air-conditioning, refrigeration and plumbing).	31.1, 31.62, 33.3, 45.31, 45.33, 52.72
ITB	**Description**	**SIC 2003 Code Footprint**
ECITB	Engineering Construction Industry Training Board	11.2, 28.11, 28.21, 28.3, 28.52, 29.11, 29.12, 29.21, 29.22, 29.23, 31.1, 33.3, 40.1, 45.11, 45.21, 45.22, 45.25, 45.32, 71.32, 74.2, 74.3, 74.5, 74.7, 90.

Source: UKCES and ECITB

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